The current state of pressure monitoring in the Gully Marine Protected Area

Leah McConney, Jessica Wingfield, Kasia Rozalska, Catherine Schram, Gary Pardy, Elise Will, Laura Feyrer, and Hal Whitehead

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THE CURRENT STATE OF PRESSURE MONITORING IN THE GULLY MARINE PROTECTED AREA

by

Leah McConney, Jessica Wingfield, Kasia Rozalska, Catherine Schram, Gary Pardy, Elise Will, Laura Feyrer, and Hal Whitehead

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The Gully is the largest submarine canyon in the western North Atlantic and is located on the eastern edge of the Scotian Shelf. Long a focus of conservation efforts due to its unique and highly diverse ecosystem, the Gully was designated a Marine Protected Area (MPA) under Canada's *Oceans Act* in May 2004. To monitor the success of the MPA at achieving its conservation objectives, 47 ecological and human pressure indicators were proposed in 2010. In 2015, an assessment was conducted on those monitoring indicators. The assessment evaluated if available data were sufficient to assess the management of the MPA in achieving its conservation objectives. This document provides an update on the 17 pressures indicators reported on in 2015. Generally, the data needed to monitor the pressure indicators are consistently available through regional and national federal programs, and in some cases, additional data sources were incorporated to those utilized in 2015. Datasets and analyses are described, suggestions are made for future improvements, and where possible, trends in the data are included.

RÉSUMÉ

McConney, L., Wingfield, J., Rozalska, K., Schram, C., Pardy, G., Will, E., Feyrer, L., and Whitehead, H. 2023. The current state of pressure monitoring in the Gully Marine Protected Area. Can. Tech. Rep. Fish. Aquat. Sci. 3563: xi + 113 p.

Le Gully est le plus grand canyon sous-marin de l'ouest de l'Atlantique nord et se situe sur le bord est du plateau néo-écossais. Depuis longtemps, le Gully est au centre des efforts de conservation en raison de son écosystème unique et très diversifié. En mai 2004, le Gully a été désigné comme Zone de Protection Marine (ZPM) en vertu de la *Loi sur les océans*. Pour évaluer le succès de la ZPM dans la réalisation de ses objectifs de conservation, 47 indicateurs ont été proposés en 2010, soit des indicateurs écologiques et de pressions humaines sur l'écosystème. En 2015, un document a été produit pour évaluer les indicateurs de monitorage et déterminer si les données disponibles étaient suffisantes pour soutenir la gestion de la ZMP dans l'atteinte de ses objectifs de conservation. Ce document fait le point sur les 17 indicateurs de pression renseignés en 2015. L'ensemble des données et des analyses sont détaillées, des suggestions sont décrites pour des améliorations futures, et lorsque cela est possible, les tendances des données sont incluses. Sur les 17 indicateurs, un seul n'a pas été inclus et un indicateur supplémentaire a été analysé, mais les résultats ne sont pas inclus ici. En général, les données nécessaires pour le suivi des indicateurs de pression sont disponibles de manière cohérente par le biais de programmes fédéraux régionaux et nationaux, et dans certains cas, des sources de données supplémentaires ont été intégrées à celles utilisées en 2015.

INTRODUCTION

The Gully is the largest submarine canyon in the Northwest Atlantic Ocean, and is an *Oceans Act* Marine Protected Area (MPA) located off the coast of Nova Scotia, 30 kilometres (km) east of Sable Island. Designated as an MPA in May 2004 by Canada's Minister of Fisheries and Oceans, this unique canyon environment provides important habitat for species at risk, including Northern Bottlenose Whales (*Hyperoodon ampullatus*; listed under the *Species at Risk Act* as Endangered) and Sowerby's Beaked Whales (*Mesoplodon bidens*; listed under the *Species at Risk Act* as Special Concern), as well as biogenic habitat such as deep-water coral assemblages.

Approximately 40 km long, 16 km wide, and containing water depths greater than 3,000 meters (m), the Gully is inaccessible to most Canadians, but is still the location of a variety of human activities that affect this unique ecosystem. Since designating the Gully as an MPA, the quantity, type, and influence of anthropogenic activity in and surrounding the site has changed over time. These human pressures are monitored to ensure that the management measures in place continue to meet the site's conservation objectives, and if not, identify additional management measures that can be implemented.

MONITORING THE GULLY MPA

The Gully Management Plan (DFO, 2017) includes an overall vision, objectives, and priorities for management. It also includes a description of the regulations, boundaries and zones, and specific actions to protect the Gully ecosystem. The second edition of the plan, which was updated in 2017, includes updates and revisions based on new environmental knowledge, experience gained in MPA management, and advice received since 2008, when the first version of the plan was published. The conservation objectives for the Gully MPA are to:

- 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

These objectives serve as a basis to assess the effectiveness of management measures in place. In 2010, an environmental monitoring framework for the Gully MPA was developed proposing 47 indicators, 17 of which were focused on human pressures (Kenchington, 2010). These pressures include: vessel traffic, fishing activities, offshore petroleum, anthropogenic debris, invasive species, and anthropogenic sound. Human pressure monitoring is essential for evaluating MPA management effectiveness by ensuring that human activities that pose risks to the site are identified and managed effectively, and that there is compliance with restrictions (Dunham et al., 2020).

In 2012, these indicators were evaluated utilizing data sources available at the time and subsequently reported on by Allard et al. (2015) in The Gully Marine Protected Area Data Assessment.

Pressure indicators were re-examined at a Monitoring Canadian Science Advisory Secretariat (CSAS) workshop convened in Winter 2021. Recommendations for a sub-set of indicators related to anthropogenic pressures are consolidated here for reporting purposes. The pressures by sector and their corresponding indicators are:

- Marine transportation:
    - Indicator 30: Number and average speed of transits through the MPA by vessels other than pleasure craft, such as commercial vessels and fishing vessels not fishing in the area
    - Indicator 31: Hours of operation within the MPA by vessels other than commercial fishing vessels or pleasure craft, such as research and monitoring vessels, other government vessels and ecotourism vessels
    - Indicator 42: Number of ships' ballast-water exchanges in close proximity of the MPA and the quantities of ballast exchanged
    - Indicator 43: Number, quantities, and types of other discharges from shipping within or in close proximity to the MPA
    - Indicator 44: Quantity of floating debris (i.e., large objects) in the Gully MPA
    - Indicator 45: Quantity of anthropogenic debris at selected monitoring sites in the Gully MPA
    - Indicator 46: Reports of known invasive species in the Gully MPA
    - Indicator 47: Quantitative characterization of anthropogenic sound within the MPA
- Fisheries:
    - Indicator 32: Commercial fishing effort within the MPA
    - Indicator 33: Commercial fishing effort in close proximity to the MPA boundary
    - Indicator 34: Unauthorized fishing activity within the MPA
    - Indicator 35: Quantities of corals removed, discarded or damaged by commercial fishing activities and research activities in the MPA
    - Indicator 36: Quantities of target organisms removed from or discarded within the MPA, and bycatch organisms (other than corals) removed from the MPA by commercial fishing
    - Indicator 39: Length of lines of, and seabed occupied by, bottomset fixed commercial fishing, research and monitoring gear set within the MPA, both as a total and subdivided by seabed habitat type
    - Indicator 47: Quantitative characterization of anthropogenic sound within the MPA
- Research:
    - Indicator 31: Hours of operation within the MPA by vessels other than commercial fishing vessels or pleasure craft, such as research and monitoring vessels, other government vessels and ecotourism vessels
    - Indicator 35: Quantities of corals removed, discarded or damaged by commercial fishing activities and research activities in the MPA

- Indicator 37: Quantities of organisms (other than corals) removed from or discarded within the MPA by research activities
- Indicator 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
- Indicator 39: Length of lines of, and seabed occupied by, bottomset fixed commercial fishing, research and monitoring gear set within the MPA, both as a total and subdivided by seabed habitat type
- Indicator 47: Quantitative characterization of anthropogenic sound within the MPA

- Offshore Petroleum:
  - Indicator 40: Number and types of offshore petroleum exploration and development activities (e.g., number of wells, platforms, etc.) on the Eastern Scotian Shelf
  - Indicator 41: Number, quantities and type of discharges from offshore petroleum installations and activities on the Eastern Scotian Shelf
  - Indicator 47: Quantitative characterization of anthropogenic sound within the MPA

Please refer to Kenchington (2010) for additional information regarding all 46 indicators and their rationale.

THE GULLY MPA REGULATIONS

The *Gully Marine Protected Area Regulations* establish the boundary and management zones. The MPA is 2,364 km^2 and is divided into three management zones.

- **Zone 1** encompasses the deep canyon environment, which includes important habitat for cold-water corals, dolphins and whales. This zone is very sensitive to human impacts and has the highest level of protection[1].
- **Zone 2** includes the canyon head and sides, feeder canyons and the continental slope. This area contains a high diversity of marine life, and has a high level of protection with a limited number of permitted activities.
- **Zone 3** includes the sand banks adjacent to the canyon, which are prone to regular natural disturbance. The natural variability of the ecosystem in this zone provides management with some flexibility to permit more activities, provided they do not damage or destroy species assemblages or their habitats.

The *Gully Maine Protected Area Regulations* make it an offence for any person to:

disturb, damage or destroy in the Gully Marine Protected Area, or remove from it, any living marine organism or any part of its habitat [sec. 4(a)].

These general prohibitions apply to the entire water column and to a depth of 15 m below the seabed. The Gully is connected to the broader Scotian Shelf ecosystem via currents and

[1] Zone 1 was expanded in 2019 to restrict bottom fishing activities in additional high coral concentration areas discovered through scientific research.

movements of marine organisms. As such, the *Gully Marine Protected Area Regulations* also prohibit activities in the vicinity of the MPA that result in the disturbance, damage, destruction or removal of organisms or habitats within the Gully MPA. The *Gully Marine Protected Area Regulations* identify certain activities that are permitted in the MPA provided they operate under relevant legal conditions. These permitted activities are:

- Commercial hook-and-line fishing directing for Halibut, tuna, shark, and Swordfish in Zones 2 and 3
- Vessel transit (in compliance with the *Canada Shipping Act*)
- Search and rescue, environmental emergency response, and clean up
- Activities related to national security, sovereignty, and public safety
- Research and monitoring activities authorized by Ministerial approval

CHALLENGES WITH MONITORING THE GULLY MPA

Being a large, offshore deep-water site, there are many challenges associated with monitoring the Gully MPA including:

- Lack of comprehensive ecological baseline/data inventory for the area to allow for a comparison over time;
- High costs associated with accessing the site and the specialized instruments required to collect data in deep water (~67% of the Gully is deeper than 300 m);
- Unpredictable weather and environmental conditions;
- Lack of consistent, long-term programs required for trends analysis and determining the difference between environmental variability and actual cause for concern; and
- In general, data regarding human use activities and pressures are designed to serve the management needs of that activity, not those of MPA management (e.g., At-Sea Observer coverage may be sufficient at the scale of the Scotian Shelf but when you scale down to the Gully MPA, higher coverage would provide better data to support site management).

Despite these challenges, scientists continue to compile and report on available datasets and make recommendations for improving data availability into the future.

FORMAT OF INDICATOR ASSESSMENT

For each relevant corresponding indicator (see above), there is a description of the importance of the indicator relating anthropogenic activities and their pressures to the site conservation priorities. Next is a summary of the data and analysis conducted during the last reporting period in 2012 and published in Allard et al. (2015). This is followed by a section describing the data, analysis, and results for the current time period (exact time period used varies across indicators and is described throughout the report), and a section evaluating existing protocols with recommendations for improvements. This report was written as a current state of pressure monitoring and knowledge for the Gully MPA as of 2020. The final review process and publication was completed in 2023 with some minor alterations to reflect recent publications and information. Some datasets were outdated at the time of publishing and results must therefore be interpreted with caution, see specific chapters for details.

CURRENT STATE OF ANTHROPOGENIC PRESSURE INDICATORS

INDICATOR 30: NUMBER AND AVERAGE SPEED OF TRANSITS THROUGH THE MPA BY VESSELS OTHER THAN PLEASURE CRAFT, SUCH AS COMMERCIAL VESSELS AND FISHING VESSELS NOT FISHING IN THE AREA

K. Rozalska and J. Wingfield

Description

Ship operators have been advised to slow down or avoid the Gully since 1994 owing to the presence of Northern Bottlenose Whales (*Hyperoodon ampullatus*) and other marine mammals. There are several aspects of vessel presence that have the potential to impact the MPA and its ecosystem, these include: noise, discharge, and pollution, the transfer of aquatic invasive species, and risk for mammal collisions. Vessels transiting at faster speeds pose a greater collision risk to marine mammals. While Zone 1 is the most sensitive zone for the resident Northern Bottlenose Whale population, whales can be found throughout the MPA, therefore vessels are requested to avoid passage through the Gully MPA if possible (Canadian Coast Guard, 2020). If passage is required, vessels are requested to decrease speed to 10 knots or less and post a lookout to increase the likelihood of sighting and avoiding marine mammals.

Summary from previous reporting period

Commercial vessel transits through the MPA (other than fishing) were assessed using satellite based Long-Range Identification and Tracking (LRIT) data. The LRIT data had a temporal resolution of 6 hours. Thirteen months of LRIT data (February 2010 to February 2011) were analyzed. There were 497 commercial vessel tracks through the Gully MPA, with an average of 38 transits per month. Transits were highest in August 2010 and lowest in February 2011 with no obvious seasonal trends.

Commercial fishing vessel traffic within the MPA was analyzed using DFO's satellite based Vessel Monitoring System (VMS) data. This system tracks vessel locations in near real-time at hourly intervals. VMS data from six years (January 1, 2005 to December 31, 2010) were obtained. Track lines for each vessel were derived and matched to commercial fisheries logbook records within 10 nm of the MPA using the vessel registration number and the date (±24 hours). Tracks with a corresponding fishing record were classified as fishing in or near the MPA, whereas the remainder were classified as transiting without fishing. There were a total of 562 transits through the MPA by commercial fishing vessels. Each year, there was an average of 47 vessels that were classified as fishing in or near the MPA, and an average of 47 that were classified as transiting without fishing.

Data, analysis and results

Commercial vessel transits

The coarse temporal resolution of LRIT datasets hinders their ability to be used to reliably determine vessel movements at the geographic scale necessary to monitor commercial traffic in the Gully MPA (Koropatnick et al., 2012). Finer scale movements, like avoidance of the Gully MPA, are lost when track lines are created using position reports that are six hours apart. Therefore, the frequency of commercial vessel transits through the Gully MPA may have been overestimated in the previous report.

In order to more accurately describe commercial vessel traffic through the Gully MPA, Automatic Identification System (AIS) data was used. AIS is an automated system for tracking and identifying vessels intended to enhance the safety of life at sea, the safety and efficiency of navigation, and the protection of the marine environment (International Maritime Organization [IMO], 2015). This system consists of transponders on vessels that transmit information to receivers on shore stations, on satellites, or on other vessels. Two signal types are transmitted via AIS: 1) dynamic messages, referred to in this document as “position reports”, which contain the date and time, the vessel’s position, course, heading, speed over ground, and other variables, and 2) static messages with details that remain constant throughout a voyage, such as the vessel’s name, destination, and vessel type (IMO, 2015; Iacarella et al., 2020).

As a requirement of the Convention for the Safety of Life at Sea (SOLAS), AIS is mandatory for all vessels of 300 gross tonnage (GT) or greater on an international voyage, cargo vessels of 500 GT or greater not on an international voyage, and all passenger vessels irrespective of size (IMO, 2015). Canada has recently updated its regulations and now requires all vessels that are 20 m or greater in length (except pleasure craft), vessels carrying more than 50 passengers, vessels transporting dangerous goods or pollutants, dredges or floating plants in a position where they pose a collision risk, and towboats that are 8 m or greater in length to carry a Class A transponder (Navigation Safety Regulations, 2020). Class A or B transponders are required for passenger vessels or vessels 8 m or greater in length carrying a passenger undertaking a voyage outside sheltered waters (Navigation Safety Regulations, 2020). Signals emitted from Class A transponders are given priority over those from Class B transponders. Other vessels, such as fishing vessels and pleasure crafts that are less than 20 m in length, may opt to have AIS on a voluntary basis. Therefore, it should not be assumed that the data represent a complete record of vessels in an area.

ORBCOMM, a Canada-based company, launches and maintains satellites that receive and relay AIS signals. Maerospace, also a Canada-based company, provides the raw AIS data and data products from ORBCOMM’s satellites to the end-user (Iacarella et al., 2020). While underway, vessels emit dynamic messages every 2 seconds to 3 minutes, depending on the vessel’s speed and shipborne equipment class (A or B) (IMO, 2015). Maerospace uses 15-17 satellites covering various areas of the world, with a combined pass frequency over Atlantic Canadian waters of approximately every 25 minutes (Iacarella et al., 2020). Therefore, the temporal resolution of the Maerospace dataset used for this report is approximately 25 minutes. However, the resolution may be coarser if transmissions were interrupted for various reasons, some of which are listed in Eriksen et al. (2018). While the satellite AIS dataset likely captures most commercial vessel traffic, it should be noted that some vessels may be missed due to signal collision, erroneous position reports, or defective AIS transmitters.

Maerospace AIS position reports were obtained and provided to DFO by the Canadian Space Agency. Although more data were available, only data from January 1, 2018 through December 31, 2019 were analyzed for this report given the time and computing power required to download and decode the data. Data were decoded using R scripts (R Core Team, 2020) written by Angelia Vanderlaan (DFO). Due to interruptions in the data stream, data gaps occurred on January 16, June 7 and August 17, 2019. No gap spanned more than several hours, so the results reported here are not expected to be noticeably impacted[2].

In May 2021, a pre-existing error in the time stamps of the Maerospace AIS dataset was discovered. There were two-time stamps associated with each position report, one within the

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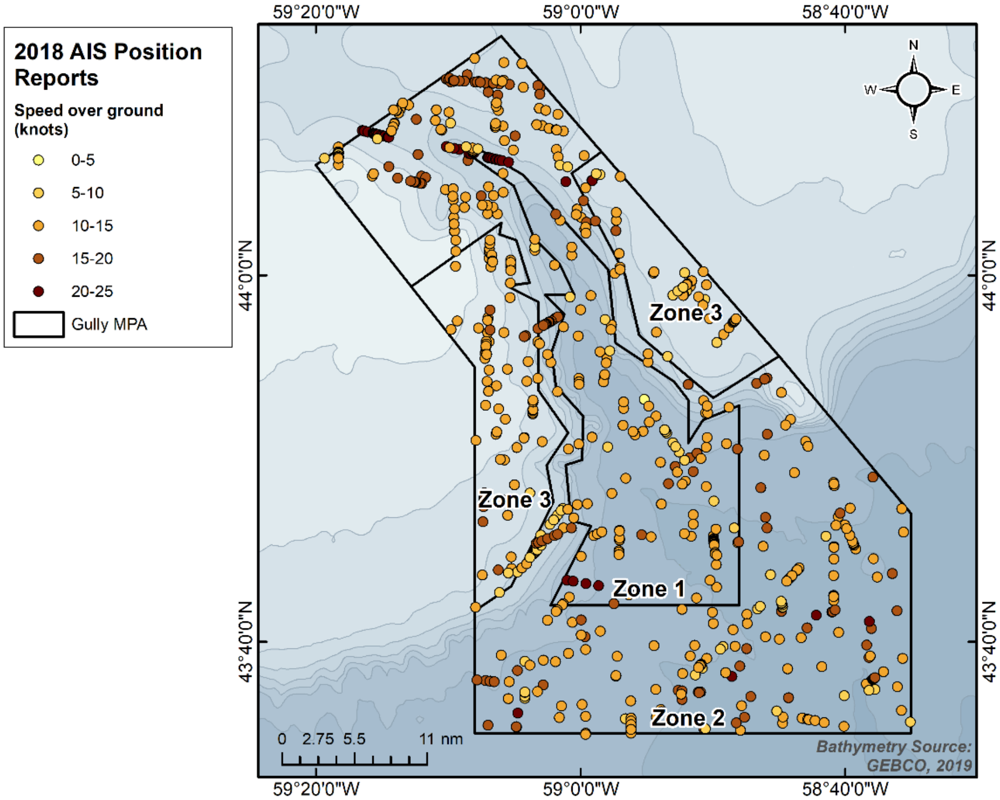
[2] AIS data files for July 12 2019 23:00 GMT, January 16 2019 09:00, 10:00, and 11:00 GMT, June 7 2019 20:00 GMT, and August 17 2019 10:00, 11:00, and 12:00 GMT were missing. There were no data available for the entire hour for the dates and hours listed. Files from January 16 2019 08:00 and 12:00 GMT and June 7 2019 19:00 were partially affected by the interruption of the stream, therefore some data exists for these hours, but it is not a complete record.

coded message itself and another appended by Maerospace. The decoder selected the appended time stamp, which was incorrect. This provided an explanation for why several track lines appeared irregular and had implausible calculated speed values in the previous analysis, but meant that the analysis had to be redone. Due to time restraints, it was not possible to decode the data again. Instead, the number of days commercial vessels were present and the number of unique vessels present per day within the Gully MPA using only the date associated with each of the position reports was used. To ensure that the dates were not affected by the time stamp error, four days of data throughout 2018 (Jan. 1, Apr. 3, Jul. 31, and Oct. 17) and four days of data throughout 2019 (Feb. 7, May 22, Aug. 30, and Nov. 10) were re-decoded using the correct time stamp. The differences between the corrected and uncorrected time stamps for corresponding position reports received within a large area surrounding the Gully MPA (~91,494 km^2) for the eight days were calculated. The maximum time difference was approximately two hours, and 80% of position reports (4126 of 5122) differed by less than one hour. The date was the same in both datasets for 92% of the position reports (4736 of 5122). When the dates differed, it was only by one day in all cases.

Fishing vessels that are less than 20 m in length are not required to carry AIS, and fishing vessels that do carry AIS also carry VMS (Navigation Safety Regulations*,* 2020). Therefore, fishing vessel presence was analyzed separately using VMS data and the results are presented in the next section: 'Fishing vessel transits'. The occurrence of non-commercial vessels (pleasure craft, research vessels, etc.) within the Gully MPA was analyzed as part of a separate indicator (Indicator 31).

Only position reports received from within or intersecting the boundaries of the Gully MPA were used in the analyses (Figure 30-1). Every vessel is assigned a unique Maritime Mobile Service Identity (MMSI) number that is included in each position report. Invalid MMSI numbers (less than or greater than nine digits) were removed from the dataset. The remaining valid MMSI numbers were first searched in IHS Markit's Maritime Portal Sea-web database, then various web databases, primarily MarineTraffic, in order to determine the vessel type and assign vessels into broad type categories. Only position reports from commercial vessels were retained. Commercial vessels were divided into two categories: cargo vessels and tankers. The cargo vessel category included general cargo ships, container ships, bulk carriers, open hatch cargo ships, wood chips carriers, and vehicle carriers. The tanker category included crude oil, oil/chemical, crude/oil products, chemical/products, combination gas, and products tankers.



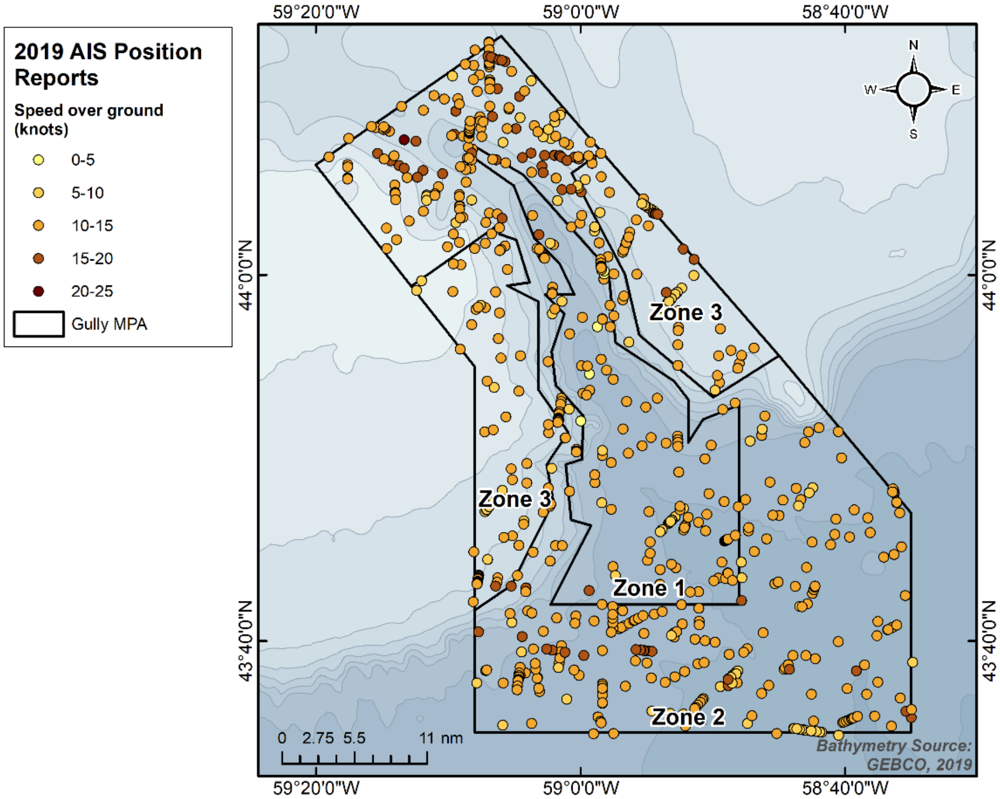


Figure 30-1: Commercial vessel position reports received from within the Gully MPA (black polygon) in 2018 (top) and 2019 (bottom), shaded according to the reported speed (knots).

The incorrect time stamps prevented the creation of accurate track line segments, and therefore reported speed over ground values associated with each position report had to be used rather than calculated speeds. Simard et al. (2014) described reported speeds in terrestrial AIS datasets as often missing or 'contaminated by erroneous values'. However, others have used the reported speed values in analyses of terrestrial AIS data (van der Hoop et al., 2012; Conn and Silber, 2013; Konrad, 2020), with Shelmerdine (2015) describing reported speeds as one of five fields with 'consistent accuracy'. Speeds were reported in all Maerospace AIS position reports received from commercial vessels within the Gully MPA in 2018 and 2019, and only one position report was removed in 2019 due to an implausible speed (62 knots for a bulk carrier). Therefore, reported speeds could be used to produce a sufficient approximation of how fast commercial vessels were likely travelling through the MPA. However, calculated speeds have been found to be faster than reported speeds (Greig et al., 2020), and it should therefore be noted that vessel speed through the Gully MPA has potentially been underestimated in this report.

All analyses were completed in R version 3.6.3 (R Core Team 2020). The packages "padr" (Thoen, 2019), "lubridate" (Grolemund and Wickham, 2011), and "scales" (Wickham and Seidel, 2019) were used in analyses and the packages "ggplot2" (Wickham, 2016) and "egg" (Auguie, 2019) were used to create Figures 30-2 through 30-4.

There were 111 days in 2018 and 118 days in 2019 during which at least one commercial vessel occurred within the Gully MPA. There were 80 unique commercial vessels within the MPA in 2018 and 92 in 2019. There were 50 cargo vessels and 30 tankers present in 2018, and 53 cargo vessels and 39 tankers present in 2019. Commercial vessel presence spanned the entire year in both years, with often only one vessel present on each day (Figure 30-2). The greatest number of commercial vessels present within the Gully MPA during a single day was three in both years (Figure 30-2). In both years, January had the fewest number of days with at least one vessel present (three in 2018 and five in 2019) (Figure 30-3). In 2018, December had the greatest number of days with at least one vessel present (13). In 2019, March had the greatest number of days with at least one vessel present (16) (Figure 30-3).

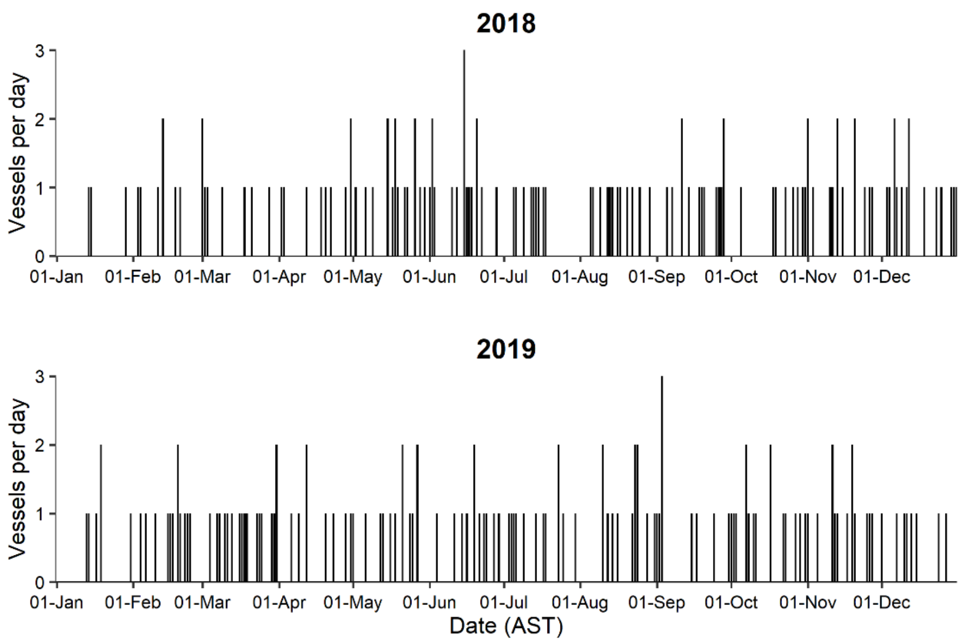


Figure 30-2: The number of unique commercial vessels that occurred within the Gully MPA on each day in 2018 and 2019.

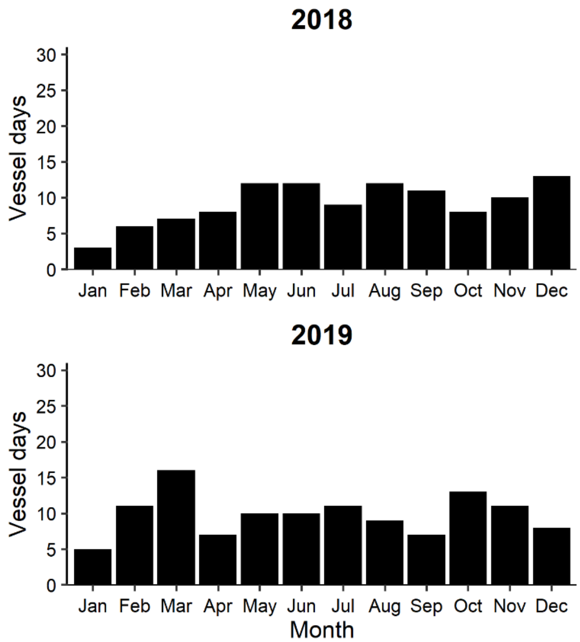


Figure 30-3: The number of days in each month during which at least one commercial vessel was present within the Gully MPA in 2018 and 2019.

On average, cargo vessels and tankers traveled at similar speeds through the Gully MPA (Table 30-1), but cargo vessels had higher maximum speeds (>20 knots maximum speed for both years) than tankers (16.9 knots maximum in 2018; 15.9 knots maximum in 2019). In 2018, vessels transited at slightly faster speeds from May to November, and at slower speeds from January to April and in December (Figure 30-4). In 2019, median speeds were between approximately 10 to 13 knots for all months (Figure 30-4). Most commercial vessels travelled at speeds greater than 10 knots most of the time through the Gully MPA: 88% and 81% of position reports in 2018 and 2019, respectively, included reported speeds greater than 10 knots.

Table 30-1: The mean, minimum, and maximum speed over ground (knots) reported by commercial vessels while within the Gully MPA for both vessel types combined and for each type separately in a) 2018 and b) 2019.

a) 2018

Vessel type	**Mean speed**	**Minimum speed**	**Maximum Speed**
All	**13.6**	**4.6**	**23.2**
Cargo	*14.2*	*6.6*	*23.2*
Tanker	*12.3*	*4.6*	*16.9*

b) 2019

Vessel type	**Mean speed**	**Minimum speed**	**Maximum Speed**
All	**12.61**	**4.6**	**20.3**
Cargo	*12.5*	*4.6*	*20.3*
Tanker	*11.5*	*5.9*	*15.9*

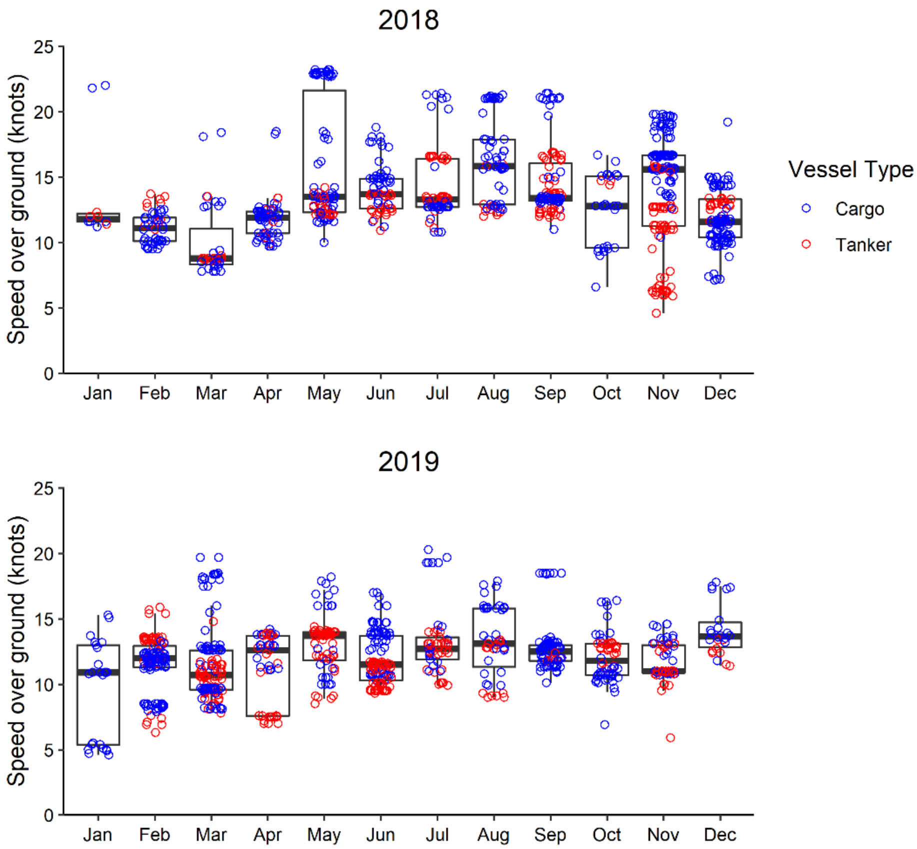


Figure 30-4: Monthly boxplots (Tukey method) of reported speeds (knots) for position reports received from commercial vessels within the Gully MPA in 2018 (top) and 2019 (bottom). Points are shaded by vessel type for display purposes, but the boxplots were calculated using all data in each month combined, regardless of vessel type.

The results presented here provide a broad summary of commercial vessel presence in the Gully MPA. Incorrect time stamps meant that accurate track line segments could not be created, and therefore it was not possible to estimate the amount of time commercial vessels spent within the MPA on an hourly scale. However, the results presented in this report still provide useful summaries of vessel occurrence in the Gully MPA that can be interpreted by a wide audience.

Fishing vessel transits

DFO's VMS National Program is a satellite-based positional tracking system used for surveillance and compliance monitoring for many offshore fishing fleets in Canada. Most fishing fleets active near the MPA, except those licensed for harpoon and trolling gear and the Bluefin Tuna fishery, have been required to provide hourly position reports using VMS since 2010 (Allard et al., 2015). In addition, some units provide vessel speed and course.

The original intent of this indicator was to monitor vessels travelling at speeds that could pose a vessel strike risk to cetaceans. Vessels that are fishing in the area may travel at speeds that pose a risk to cetaceans when transiting to their fishing location or when heading back to shore.

During the previous reporting period, vessel transits were classified as either fishing or not fishing based on whether they could be matched to a Maritime Fishery Information System (MARFIS) landing record within 10 nm of the Gully MPA. As stated in the previous monitoring report (Allard et al., 2015), this led to some transits being misclassified. MARFIS records often contain rounded or incorrect geographic coordinates. Therefore, some transits that appeared to be engaged in fishing activity based on the movement pattern of the vessel were not matched to a MARFIS record. Alternatively, some vessels transiting straight through the MPA and its 10 nm buffer were classified as fishing. In addition, the report did not consider that most fishing trips include a combination of fishing and transit with different vessel speeds, and thus different levels and types of risks, occurring throughout the same trip.

Due to the challenges identified with the methodology employed during the last reporting period, an alternate approach was adopted to include an analysis of the time spent by fishing vessels travelling at various speeds within the MPA. VMS records were obtained from January 1, 2011 to December 31, 2018 from the Marine Security Operation Centre (MSOC) and DFO's National VMS Program for an area approximately 20 km surrounding the MPA. Some VMS records include instantaneous vessel speed, however this value was missing for 39% of the records within the MPA. Therefore, for each vessel successive points were joined by straight lines and speed was calculated in knots based on the time elapsed and distance travelled. VMS records were processed using ArcGIS version 10.7.1 (ESRI). VMS reports greater than 5 hours apart were considered as separate vessel tracks, in order to disregard periods of time where vessels left the area or had stopped reporting. Track lines were clipped to the MPA boundary. If a track line crossed the MPA boundary, the elapsed time was recalculated to reflect the change in track length due to clipping. Vessel track lines above 15 knots were considered errors. The instantaneous vessel speeds within the MPA had a maximum of 13.2 knots. Examination of many segments above 15 knots showed they were errors where a sudden departure from a vessel track occurred. It is likely that similar errors still exist in the dataset, but were not captured if their calculated speed was below 15 knots. Some of the track lines that crossed the MPA have start and end coordinates outside of the MPA. Since most successive VMS points are 1 hour apart, it is possible that these vessels did not actually spend time within the MPA, causing an overestimate in the analysis. However, these track lines only accounted for 0.2% (30 hours) of the total calculated time spent within the MPA, and were retained in the dataset.

The total hours fishing vessels spent in the MPA, categorized by speed, is summarized in Figures 30-5, 30-6, 30-7, 30-8 and 30-9. Figures 30-10, 30-11 and 30-12 show the total number of track segments per 200x200 m cell for 3 speed categories: less than 5 knots, 5- <10 knots and 10-15 knots. While the speed of vessels during fishing can vary based on conditions and gear type, typically vessels that are actively fishing are travelling at speeds of 5 knots or less. The most frequently used fishing gear in the MPA is bottom longline, followed by pelagic longline. Previous analysis of VMS and gear type in this area showed that bottom longline gear is typically deployed/retrieved while vessels are travelling at less than 5 knots, and pelagic longline gear is deployed/retrieved at less than 5.5 knots (Spatial Metrics Atlantic Ltd, 2012). Another study conducted on the Scotian Shelf used a threshold of 4.5 knots for the upper speed limit for pelagic longline fishing (Butler et al., 2019). Therefore, Figures 30-5 and 30-7 show an approximation of the amount of time that vessels spend fishing in the MPA. Generally, vessels travelling at speeds greater than 5 knots are transiting. Note Figures 30-6 and 30-8 show vessel hours travelling between 10 and 15 knots speed which is considered high-risk transit speed for cetacean ship strikes.

From 2011 to 2018, fishing vessels spent a total of 16,377 hours within the Gully MPA, the majority of which was from vessels travelling at speeds of less than 5 knots (14,113 hours). Fishing vessels spent 2,234 hours travelling between 5 and <10 knots. A small amount of activity was observed from vessels travelling between 10 and 15 knots (29 hours). Seasonally, two peaks (January-March and July-September) in vessel time were observed in all three speed categories (Figures 30-5 and 30-6). On an annual basis, there is a decreasing trend in the amount of time vessels spent in the MPA travelling at less than 5 knots. From 2011 to 2018, time spent in the MPA decreased from 3,205 hours to 781 hours (Figure 30-7). Vessel hours in the 5 to <10 knots category remained relatively consistent over the time period.

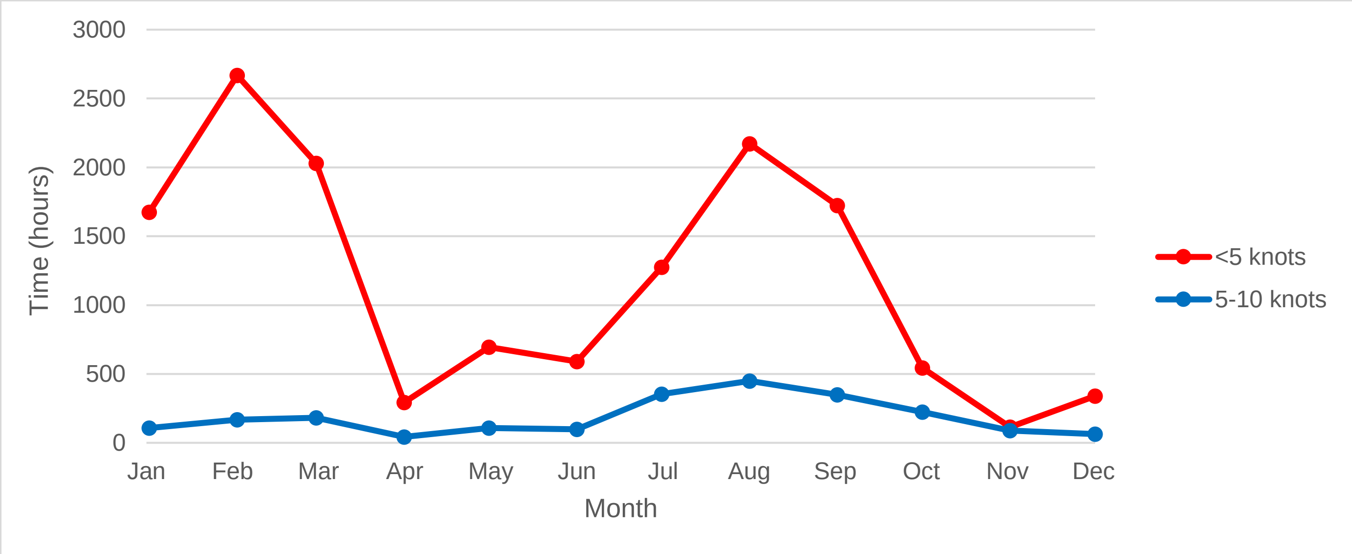


Figure 30-5: Fishing vessel hours spent in the Gully MPA broken down by month and classified by speed based on 2011-2018 VMS data.

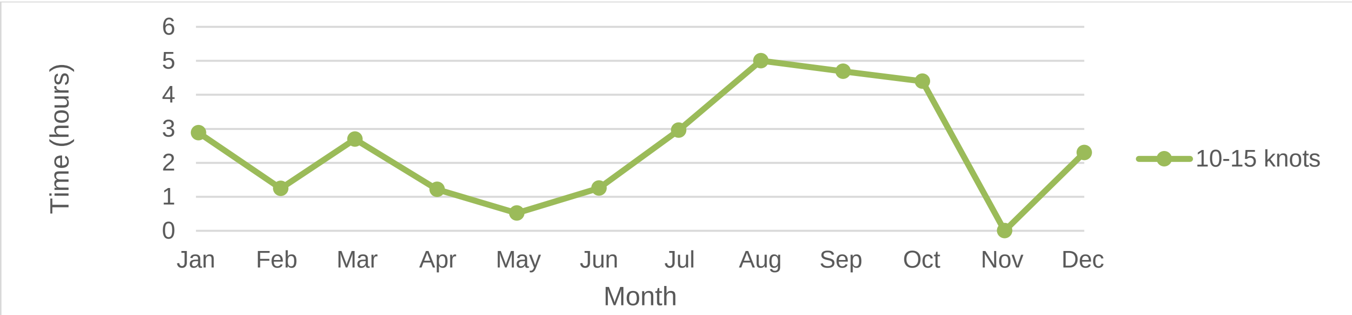


Figure 30-6: Fishing vessel hours spent in the Gully MPA broken down by month for vessels travelling between 10 and 15 knots based on 2011-2018 VMS data.

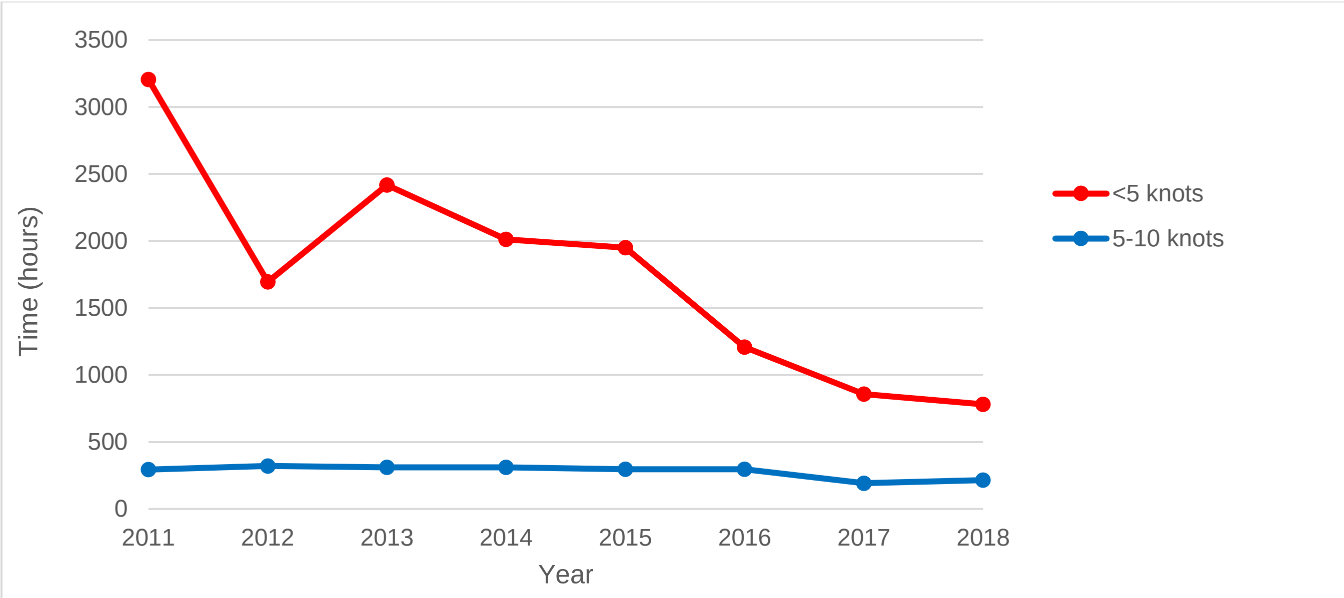


Figure 30-7: Fishing vessel hours spent in the Gully MPA broken down by year and classified by speed based on 2011-2018 VMS data.

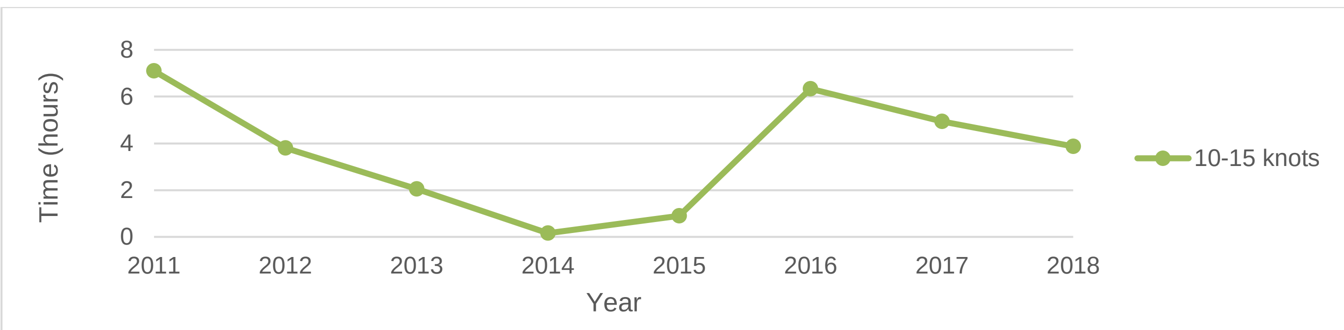


Figure 30-8: Fishing vessel hours spent in the Gully MPA broken down by year for vessels travelling between 10 and 15 knots based on 2011-2018 VMS data.

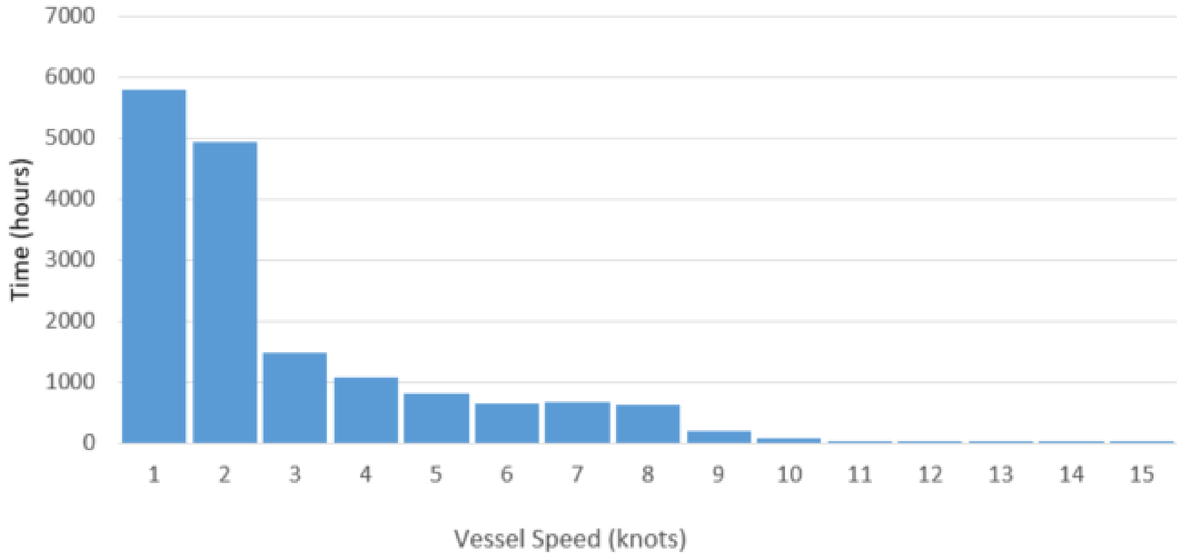


Figure 30-9: Fishing vessel hours spent in the Gully MPA by speed calculated from VMS data for 2011-2018.

Although the risk of cetacean disturbance by vessels estimated to be fishing has been decreasing annually since 2011, the risk associated with fishing vessel transits has remained constant (Figure 30-7). The risk from fast moving vessels (10-15 knots) remains small (an average of 3.7 vessel hours per year). Due to the changes in methodology for this indicator, the results of this analysis cannot be compared to results from the previous reporting period.

The three speed categories were mapped to provide a better understanding of where the physical disturbance and ship strike risk was distributed within the MPA. The majority of the vessel activity for speeds less than 5 knots was located in the northwestern section of Zone 2 and along the shelf edge, which coincides with landings data described in Indicator 32 (Figure 30-10). A large proportion of the 5- <10 knot activity approaches the MPA along the shelf edge with fewer vessels in this speed category crossing Zones 1 and 2 (Figure 30-11). When compared to the other two speed categories, the 10-15 knot traffic is relatively light and sporadic with very few vessel tracks crossing through Zone 1 (Figure 30-12).

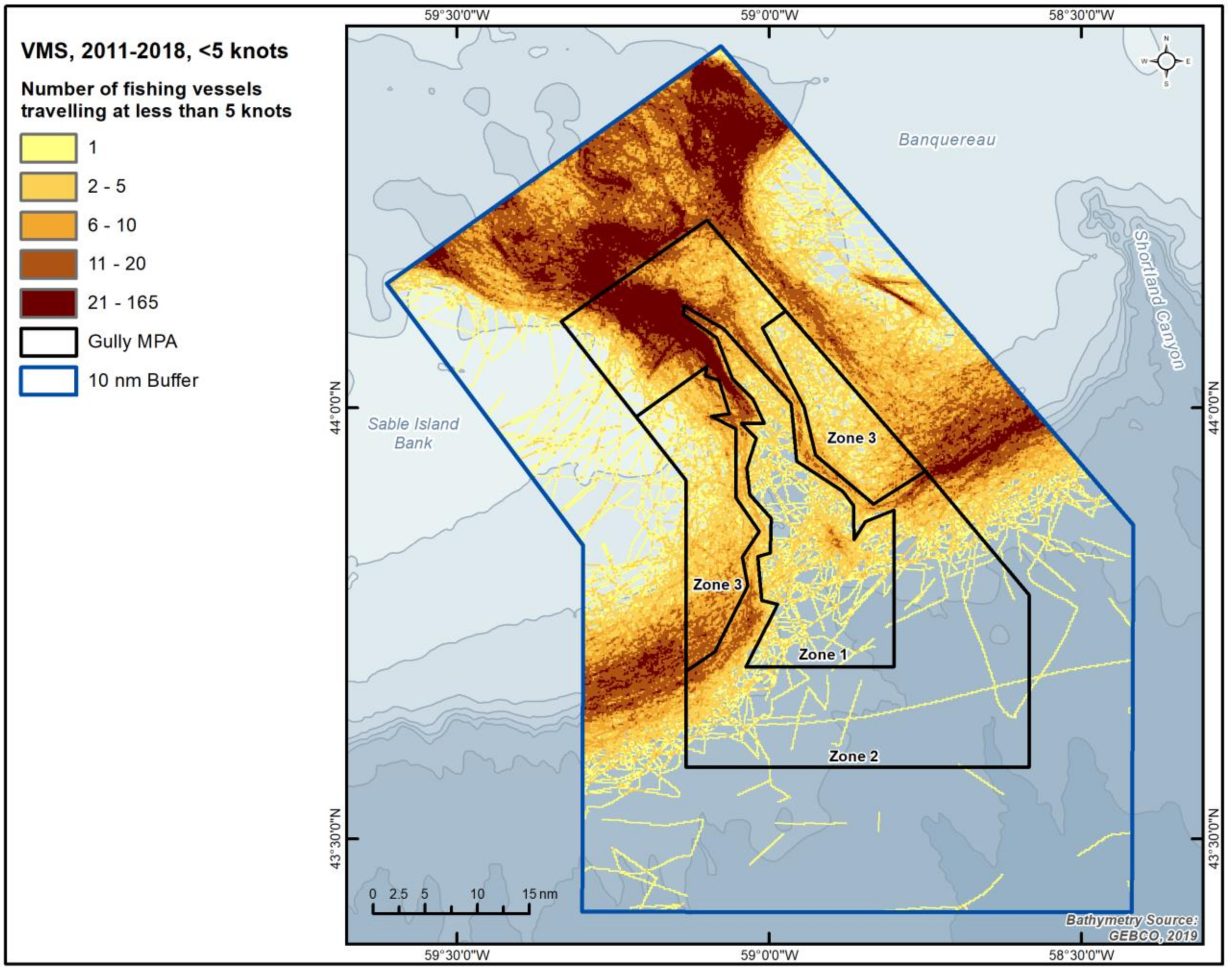


Figure 30-10: Fishing vessels travelling less than 5 knots from 2011-2018 VMS data.

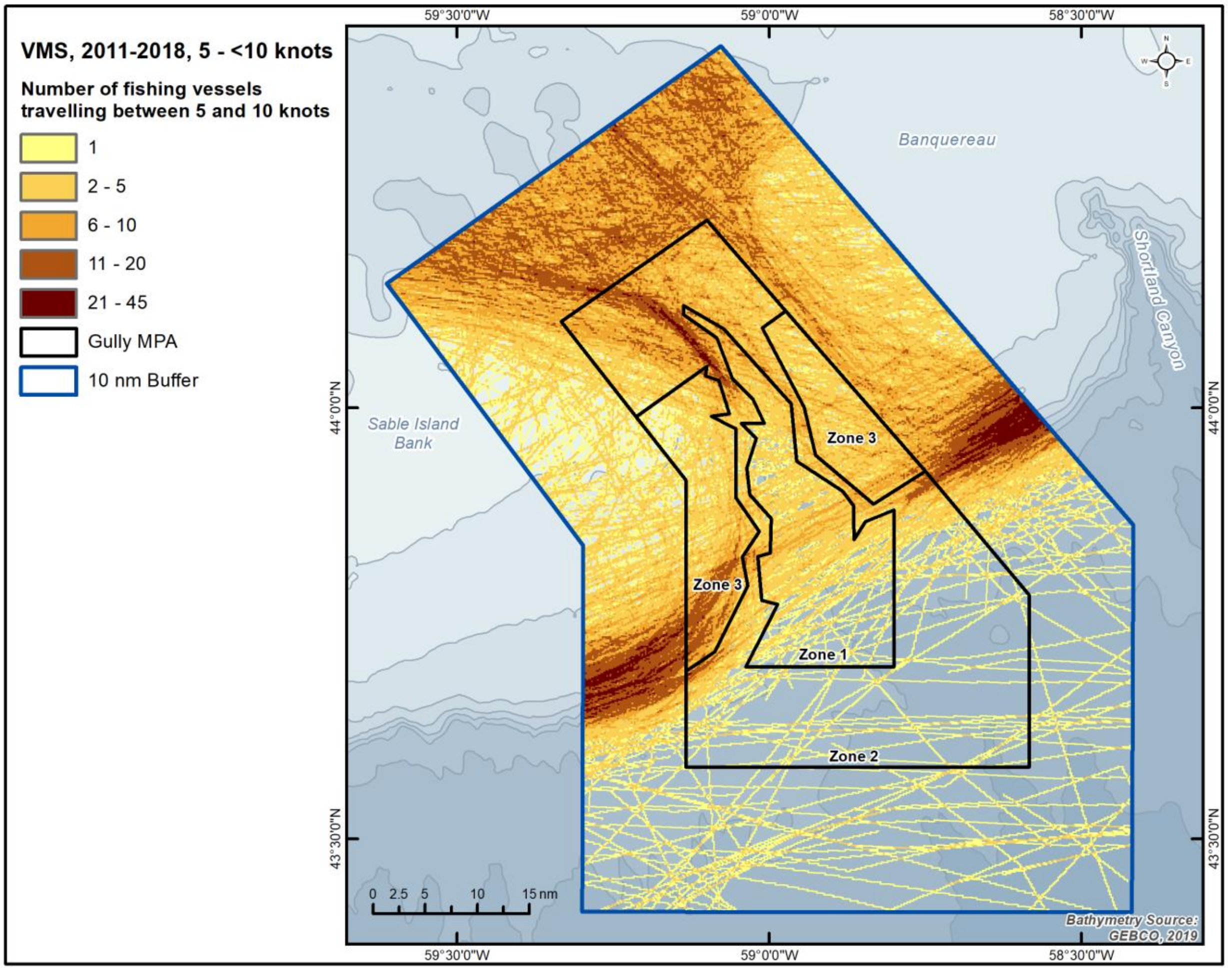


Figure 30-11: Fishing vessels travelling between 5 and 10 knots from 2011-2018 VMS data.

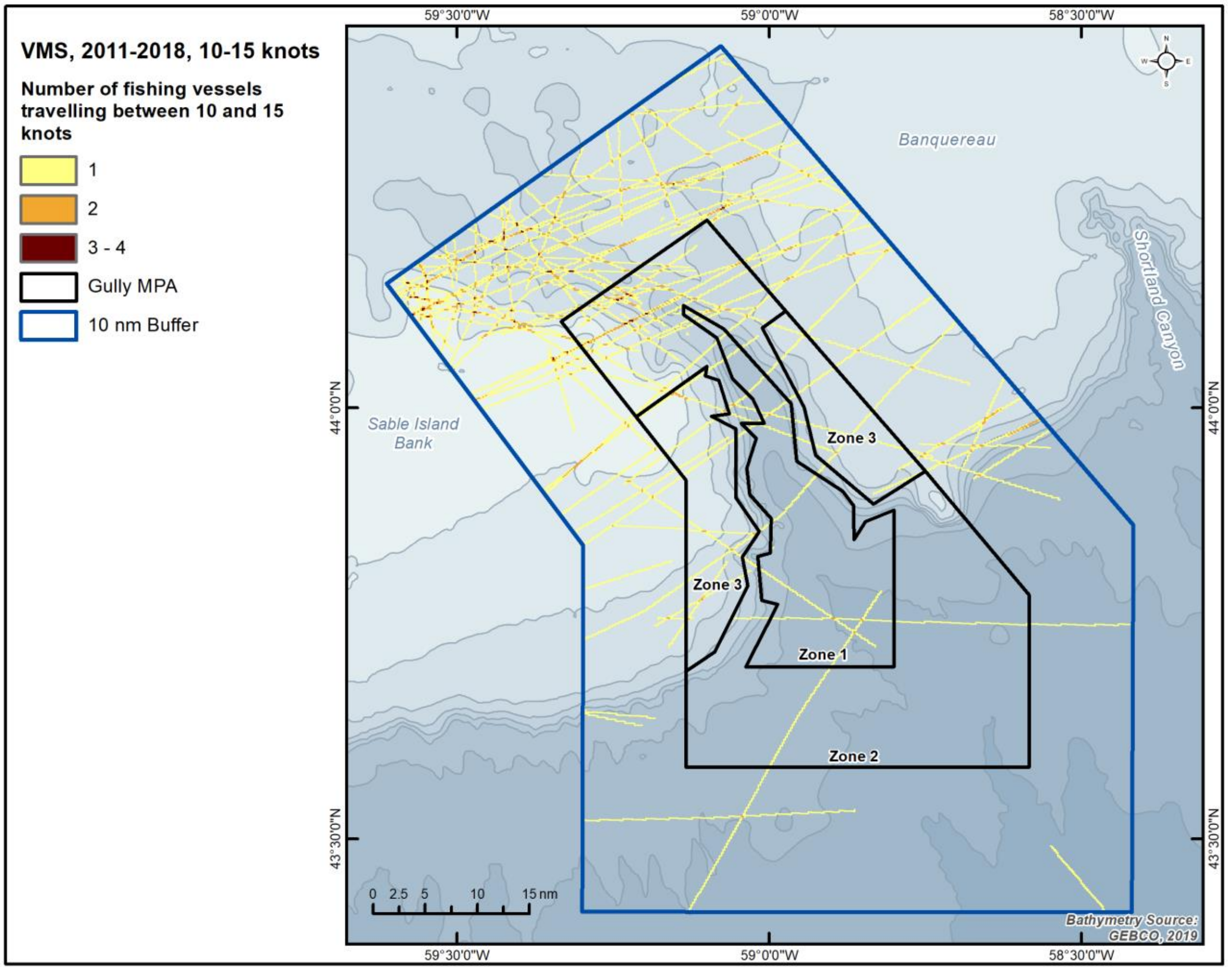


Figure 30-12: Fishing vessels travelling greater than 10 knots from 2011-2018 VMS data.

Evaluation of existing protocols and recommendations for the future

Commercial and fishing vessels have very different behaviour within the MPA. Commercial vessels transit straight through the MPA at fairly constant speed and direction. However, fishing vessels may spend many hours within the MPA travelling at various speeds and directions while engaging in fishing behaviour. Therefore this indicator should continue to be assessed in two sections to address both types of vessels. The suggested wording for the two sections of this indicator is:

Number and speed of transits through the MPA by commercial (cargo and tanker) vessels.

Hours spent by fishing vessels in the MPA, analyzed by speed.

This indicator previously focused on vessel collision risk, which led to a greater concern for the presence of vessels moving at high speeds. However, vessels have the potential to disturb ecosystem components regardless of their speed by introducing noise and light pollution, and discharges into the natural environment (Parks et al., 2007; Erbe et al., 2019; Pirotta et al., 2012; Putland et al., 2018). Thus, the focus for this indicator should be placed on all vessels regardless of their travelling speeds.

There are several analyses that could be explored in the future:

- Comparison of vessel activity inside and outside of the Gully MPA: By clipping AIS and VMS data to the Gully MPA boundaries, it is not possible to compare the level of vessel activity, and thus risk to cetaceans and other conservation priorities, inside and outside of the MPA boundaries. If a buffer surrounding the MPA was selected for comparison, it would provide more context on the effectiveness of the marine transportation management measures in place. Additionally, if vessel activity is high just outside the MPA boundary, it should be examined closely as this activity may still impact the MPA.
- Vessel-sourced light pollution: Discussions should be held with the appropriate DFO Science subject matter experts to determine if this marine transportation pressure should be monitored for the Gully MPA going forward.
- Classify the data by vessel size: The indicator was originally designed to focus on high vessel speeds and the associated risk for ship strikes but the size of the vessel could also have implications for potential impacts on ecosystem components.
- For datasets with correct time stamps, the AIS position reports from commercial vessels should be joined to form track lines, which would allow for the estimation of time spent in the Gully MPA by commercial vessels, and for the calculation of average speed of each transit. Vessel density mapping using AIS data including commercial vessels from 2019 for the Northwest Atlantic including the Gully MPA area has been completed and has been published as a DFO technical report (Veinot et al., 2023).

INDICATOR 31: HOURS OF OPERATION WITHIN THE MPA BY VESSELS OTHER THAN COMMERCIAL FISHING VESSELS OR PLEASURE CRAFT, SUCH AS RESEARCH AND MONITORING VESSELS, OTHER GOVERNMENT VESSELS, AND ECOTOURISM VESSELS

L. McConney and J. Wingfield

Description

This indicator examines vessels that spend time in the MPA for purposes other than navigation or fishing. With the exception of certain fisheries, innocent passage, national defence and emergency response, the *Gully Maine Protected Area Regulations* stipulate that any person proposing to carry out an activity in the MPA must submit a plan to the Minster for approval. “Operation within the MPA” implies a targeted activity besides transiting whereby the vessel slows down, stops, keeps station, deploys some kind of sampling equipment, or navigates along transect lines for the purpose of data collection (e.g., use of fisheries sonar to estimate biomass of pelagic fish or sub-bottom profiling to collect geophysical data).

Although the general navigation risks posed by these vessels are identical to the risks associated with commercial shipping and fisheries (i.e., presence, noise, strikes, and discharges), their non-linear movement patterns and typically longer residency times in Zone 1 warrant attention beyond that given to straight-line traverses or fishing in Zones 2 and 3. Some research and monitoring operations, including cetacean photo-identification and approved biological sampling, introduce additional pressures given their targeted and potentially disruptive nature.

Summary from previous reporting period

Records from MPA activity approvals and cruise reports since MPA designation (May 2004) to the fall of 2011 were compiled and utilized to estimate the duration of activities within the Gully MPA.

With the exception of mesopelagic and marine mammal surveys, most trips were 1-2 days in duration. It was noted that there were challenges associated with compiling this information as not all proponents submitted post-activity reports. Return rate of this information improved towards the end of the last reporting period due to the introduction of a standard report form.

Available data, analysis, and results

Approved activity plans and post-activity reports submitted to the Marine Planning and Conservation (MPC) Program remain the primary sources for monitoring of this indictor. Data from 2012-2019 were used for this analysis. Automatic Identification System (AIS) data from 2018-2019 were also used to examine vessel activity within the MPA.

Note that the reporting among activities varied significantly in details provided with respect to time in the MPA. In some cases very specific breakdowns of transiting and operational time (e.g. hours and minutes) were provided, while others provided less precise time estimates (e.g. one day).

Similar to the previous reporting period, the majority of trips were 1-2 days in length with the exception of research activities associated with marine mammals. Generally, activities associated with marine mammal research are of longer duration as time must be spent locating the animals, and in some cases multiple interactions are needed for biopsy sampling and tagging to be completed.

The number of research activities and the amount of time spent in the Gully MPA varied year-to-year, with no clear trend between 2012 and 2019 (Table 31-1).

Table 31-1: Hours of operation within the entire MPA by vessels such as research/monitoring vessels, other government vessels and ecotourism vessels from 2012 to 2019. Blue shaded cells indicate time spent conducting the survey, rather than total time spent in the Gully MPA. Orange cells are estimates based on the activity plans as no post-activity report was submitted or time spent in the MPA was not provided in the post-activity report.

Activity	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**Total 2012-2019**
Modigliani Eco Tour	12								**12**
Marine mammal visual and acoustic surveys (towed hydrophone array)	120								**120**
Centre for Offshore Oil and Gas Environmental Research (COOGER) Seawater Sampling		6							**6**
Body condition, reproductive status, foraging and behaviour of cetaceans		257							**257**
Atlantic Zone Monitoring Program (Spring and Fall surveys)	12	16	48	31	29	65	39.5	20	**260.5**
Acoustic Mooring Deployment/Retrieval	6	5	6	6	6	6	6	6	**47**
Adventure Canada Marine Mammal Education and Observation			12.3		36	36			**84.3**
Dalhousie University Northern Bottlenose Whale and Sowerby's Beaked Whale Research				384	432	24		171	**1,011**
Multidisciplinary Oceanographic Research Mission					120				**120**
DFO Maritimes Research Vessel (Multi-Species Trawl) Survey				4	13	24			**41**
Snow Crab Bottom Trawl Survey				24	24	24	24	24	**120**
JASCO Drifter/Observer Buoy						10			**10**
Joint Industry-DFO Atlantic Halibut Longline Survey (fixed stations only)		13.38	17.63	18.21	22.8	11.3	78.3	22.03	**183.65**
Deep Connections 2019 (remotely operated vehicle video transects)								12.8	**12.8**
Annual Total Time (hours)	**150**	**297.38**	**83.93**	**467.21**	**682.8**	**200.3**	**147.8**	**255.83**	**2,285.25**
Annual Total Time (days)	**6.3**	**12.4**	**3.5**	**19.5**	**28.45**	**8.4**	**6.2**	**10.7**	**95.2**

Due to the challenges with the activity plan data described above, AIS data from 2018 and 2019 were also analyzed to provide additional insights into non-commercial non-fishing vessel activity in the Gully MPA. See Indicator 30 for a detailed description of the AIS dataset, including an explanation for why it was not possible to create track lines. All position reports from non-commercial and non-fishing vessels that occurred within or that intersected the boundaries of the Gully MPA (Figure 31-1) were extracted to create the dataset for this indicator. These data are meant to supplement information provided in the activity plans, and should be interpreted with caution. Vessels below the size and passenger limits for which an AIS transmitter is mandatory could be missing from this dataset. Some of these vessels may carry Class B transponders, which are lower priority for signal transmission than Class A transponders, and therefore some signals may not have been relayed to the satellite. Some of the fisheries-related surveys were conducted by a fishing vessel (e.g., Joint Industry-DFO Atlantic Halibut Longline Survey) and are therefore not included in this dataset.

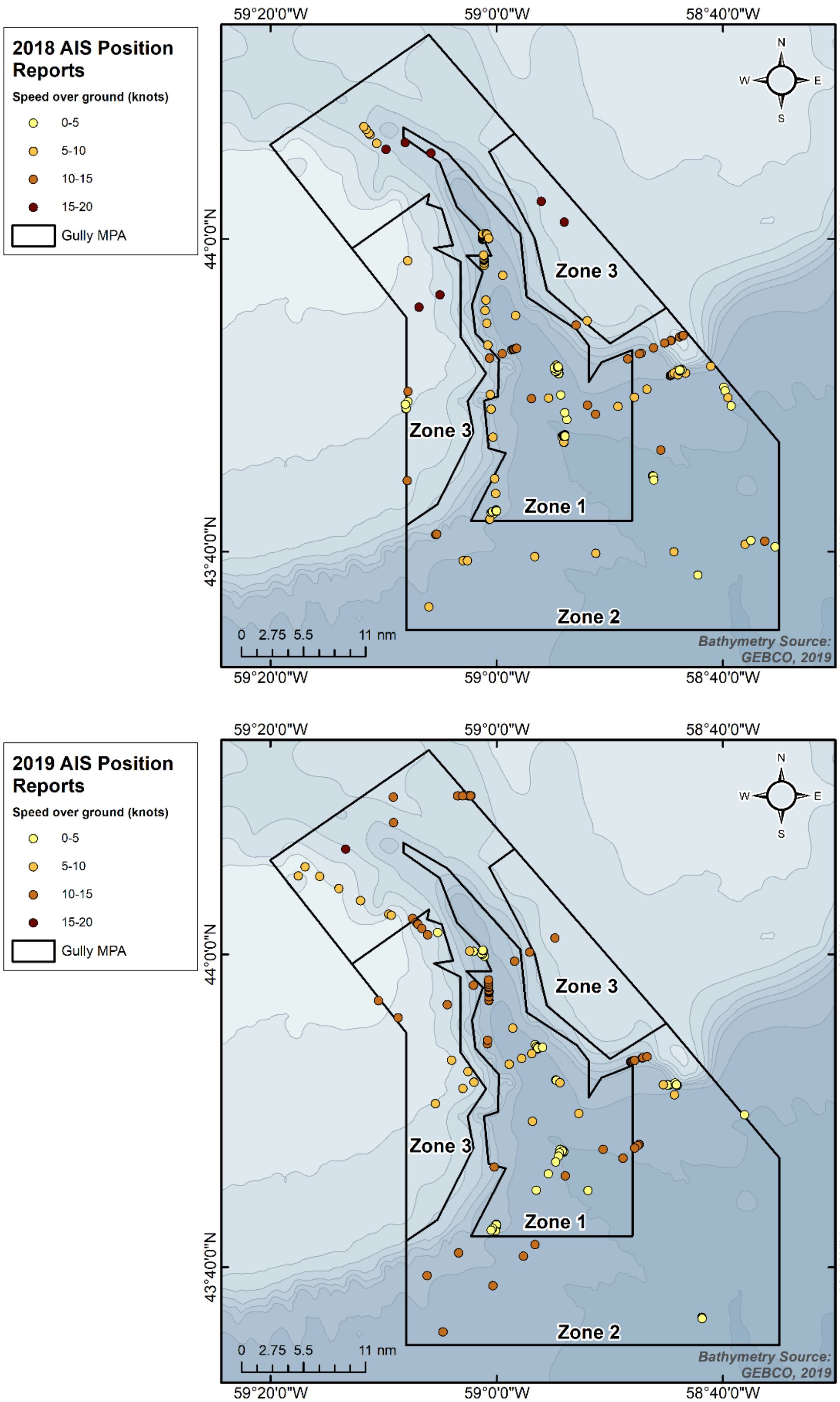


Figure 31-1: Vessel position reports received from within or that intersected the outer boundaries of the Gully MPA (black polygon) in 2018 (top) and 2019 (bottom), shaded according to the reported speed (knots).

Each vessel was assigned to one of the following categories: research, offshore supply, cruise ship, military, mobile drilling rig, and Canadian Coast Guard. The CCGS Hudson was included in the research category in 2018 as it was known to be on a research mission. The position reports were used to summarize the number of unique vessels present per day and the number of days vessels occurred within the Gully MPA. The erroneous time stamps prevented the creation of track line segments, therefore mean, minimum, and maximum of reported speed over ground values are presented, rather than calculated values. All analyses were completed in R version 3.6.3 (R Core Team, 2020). The packages “padr” (Thoen, 2019), “lubridate” (Grolemund and Wickham, 2011), and “scales” (Wickham and Seidel, 2019) were used in analyses and the packages “ggplot2” (Wickham, 2016) and “egg” (Auguie, 2019) were used to create Figure 31-2.

The number of days during which at least one vessel from each category occurred in the Gully MPA during 2018 and 2019 was calculated (Table 31-2). Note that this does not indicate that a vessel was present for the entire day but is the number of days during which at least one position report from a vessel in each category occurred within or intersected with the boundaries of the Gully MPA. The total number of unique vessels and the number of days during which they occurred were similar in 2018 and 2019 (Table 31-2). Of all the vessel categories, research vessels were present in the Gully for the greatest number of days in both years (Table 31-2). In 2018, the CCGS Hudson was present for the greatest number of days (6) compared to any other vessel. There was only one day (April 16) in 2018 during which multiple vessels (2) were present in the Gully MPA (Figure 31-2). In 2019, there was only ever one vessel present per day (Figure 31-2). Vessels in every category, except the mobile drilling rig, had maximum speeds in exceedance of the recommended 10 knots in the Notice to Mariners (Table 31-3). Additionally, the average speeds for cruise ships and military vessels in 2018 and military and offshore supply vessels in 2019 were greater than 10 knots (Table 31-3).

Table 31-2: The number of unique vessels and the number of days during which at least one vessel from each category was present in the Gully MPA in 2018 and 2019.

Vessel type	2018		2019	
	# of unique vessels	**Days present**	**# of unique vessels**	**Days present**
Research	3	7	3	6
Offshore Supply	2	3	3	4
Cruise Ship	2	2	---	---
Military	1	1	1	1
Mobile Drilling Rig	1	2	---	---
Canadian Coast Guard	---	---	2	2
Total	**9**	**15**	**9**	**13**

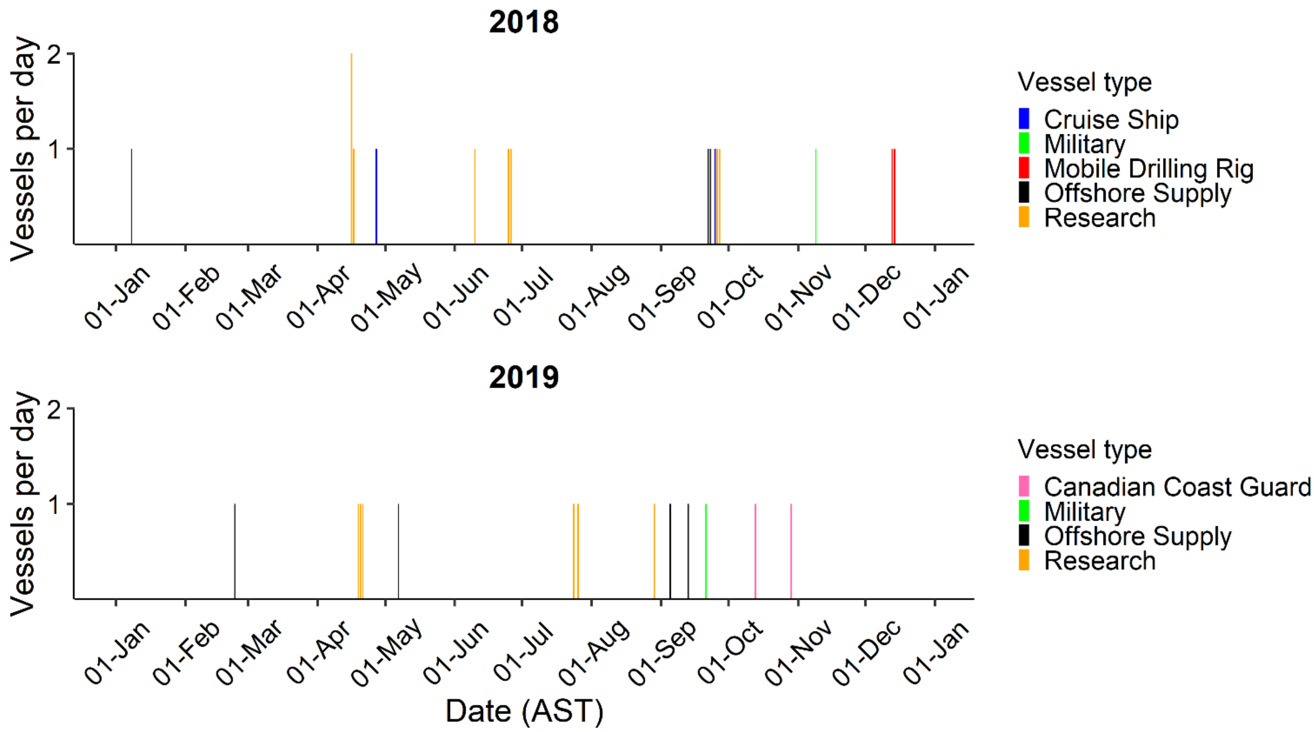


Figure 31-2: The days in 2018 and 2019 during which at least one vessel from each category was present within the Gully MPA.

Table 31-3: The mean, minimum, and maximum speed over ground (knots) reported by vessels in each category from within the Gully MPA in 2018 and 2019.

Vessel type	2018			2019		
	Mean speed (kn)	Min speed (kn)	Max speed (kn)	Mean speed (kn)	Min speed (kn)	Max speed (kn)
Research	4.2	0.0	12.6	4.8	0.0	13.0
Offshore Supply	2.1	0.3	10.6	10.2	5.0	15.1
Cruise Ship	17.9	16.3	18.7	---	---	---
Military	16.6	16.4	16.8	11.6	10.3	12.6
Mobile Drilling Rig	3.5	3.5	3.5	---	---	---
Canadian Coast Guard	---	---	---	9.9	4.7	13.5

Evaluation of existing protocols and recommendations for the future

While the submission of post-activity reports has increased since the last reporting period, the template should be more prescriptive to ensure a more consistent level of detail from activity proponents going forward. Specific suggestions for the reporting template related to this indicator include:

- Total transit and operational time within the MPA
- Time spent within Zone 1 of the MPA

- Identification of the type(s) of activity conducted by general categories (e.g., passive acoustic monitoring, active acoustic monitoring, water sampling, etc.) to better understand the scope for disturbance

AIS, activity plans, and post-activity reports should continue to be analyzed as components of this indicator. AIS data captures a broader class of vessels (e.g., military) while activity plans and post-activity reports provide a greater level of detail, therefore together, they provide a more complete picture of vessel activity.

Vessel size and the nature of activities undertaken by these vessels should be also considered, as smaller research vessels that move slowly through the Gully present different risks than larger faster-moving vessels such as cruise ships. It is recommended that vessel speed continues to be considered in the analysis for this indicator, as it sheds further light on vessel behaviour within the MPA. It is recommended, that vessel track lines and calculated vessel speed from AIS data be used moving forward if a corrected data set is developed.

INDICATOR 32: COMMERCIAL FISHING EFFORT WITHIN THE MPA

C. Schram and K. Rozalska

Description

Pressures from commercial fishing include removal of biomass; potential for entanglement; bottom disturbance; noise and light; and can cause negative impacts on marine mammals, sea turtles, birds, sensitive benthic species, and the seabed. Furthermore, lost and irretrievable gear poses a risk to marine environmental quality. While not all of these pressures and impacts will be individually assessed within this report, assessing the level of fishing effort within the MPA is a first step to understanding the impact that fishing effort may be having in the MPA. Indicator 32 and Indicator 33 (examines fishing effort in close proximity to the MPA) support the monitoring of fisheries that operate within and adjacent to the MPA. The intent with Indicator 32 is to track effort expended in the MPA as an indicator of fishing pressure over time. This indicator uses recorded fishing sets for demersal (groundfish) and pelagic longline fisheries, fishing that is permitted under the *Gully Maine Protected Area Regulations*, to measure fishing effort.

Summary from previous reporting period

During the compilation of data and analysis for the current 2012-2018 period, it was noted that the previous report (The Gully Marine Protected Area Data Assessment) period completed their analysis on a truncated dataset due to a technical error. Therefore, the complete dataset for 2005 to 2011 was re-analyzed and is described below.

The previous reporting period tallied the number of demersal and pelagic longline sets reported in Zones 2 and 3 between 2005 and 2011 (Table 32-1). The number of demersal longline sets was variable over the time period and there was a marked drop in 2006. This may be because no commercial index sets occurred in the Gully as part of the annual Joint Industry-DFO Atlantic Halibut Longline Survey from 2005 to 2006. In the demersal longline fishery, the final year of the first reporting period (2011) had the greatest level of effort. For pelagic gear, the number of sets recorded within the MPA remained low throughout the study period.

The updated cumulative spatial distribution of demersal and pelagic longline sets for the previous reporting period have also been updated due to the truncated dataset in Allard et al. (2015). Most demersal longline activity occurred in the northwest portion of the MPA and extended outside of the northwest MPA boundary. Pelagic longline activity was sparse within the MPA, although some significant effort was concentrated in a narrow band outside the eastern boundary and along the shelf edge. The patterns and conclusions in Allard et al. (2015) and the patterns and conclusions from the updated dataset in this report do not differ significantly.

Table 32-1: Number of fishing sets per year within the Gully MPA for 2005-2011 (update of Table 32-1 in Allard et al. 2015).

Gear Type	2005	2006	2007	2008	2009	2010	2011
Demersal Longline	79	36	76	76	96	75	118
Pelagic Longline	5	1	3	11	13	8	4

Available data, analysis and results

The number of pelagic and demersal longline sets was tallied for the second reporting period. Commercial fisheries logbook data for 2005-2018 was obtained from DFO's Commercial Data Division, which is stored in the Maritime Fishery Information System (MARFIS) . The number of unique pelagic and demersal longline sets was tallied for the current reporting period, 2012-2018. A unique ID for each set is stored in the LOG_EFRT_STD_INFO_ID field in the MARFIS database. The logbook data does not differentiate between demersal and pelagic gear, however, this distinction was obtained from the LIC_SPC_DESC field. Records with longline gear licenced for groundfish or Halibut were categorized as demersal longline. Whereas records with longline gear licenced for Swordfish or tuna were categorized as pelagic longline. Although a pelagic or demersal longline set can span several kilometres, only one coordinate is required for reporting. The coordinate is often rounded to the nearest minute. After examination of demersal longline data from MARFIS, and the At-Sea Observer database, it seems that this gear is not used at depths greater than 1,000 m, likely due to the steep slope in the MPA. Any MARFIS records deeper than 1,000 m were considered to have errors in their coordinates and were removed from maps. While there is relative certainty that the locations were recorded incorrectly, there is still a likelihood that they were located somewhere within the MPA boundary, therefore, using the precautionary principle these records were retained in the data tables for analysis purposes. Thirteen records were removed from the maps, out of a total of 3,416 within the boundary and in the vicinity of the MPA, which is defined as a 10 nautical mile (nm) buffer around the MPA boundary.

An alternative approach to estimating fishing effort is to use VMS data (described in Indicator 30). The locations of fishing vessels can be used to estimate the distribution and time spent by fishing vessels in the MPA using longline gear. To explore using this method, VMS records were combined with commercial logbook records (MARFIS) to determine which vessel tracks were used by pelagic and demersal longline gear. Yearly maps were created to display the distribution of fishing vessels by gear type. A comparison of the results from using VMS and MARFIS data showed that both the temporal trends and spatial distribution of fishing effort matched between the two types of analyses. Since the VMS maps did not provide additional information on fishing effort, they are not included here. Two sample maps are included (see Appendix A) to show the overall distribution of vessels using pelagic and demersal longline gear. This method could be further explored in future reporting periods.

Indicator 32 examines fishing effort in the MPA, while Indicator 33 examines effort in the 10 nm buffer. To facilitate comparison between spatial distribution of effort inside and around the MPA, effort maps for demersal and pelagic longline have been included in the analysis for Indicator 32 which include the 10 nm buffer (See Figures 32-3, 32-4, 32-5, and 32-6). Table 32-2 and Figures 32-1 and 32-2 show the number of sets varied over time for both pelagic and demersal gear. The locations of unique sets were aggregated using a 3 km^2 hexagon grid to show the spatial distribution of fishing sets for each gear type and reporting period (Figures 32-3 to 32-6). Table 32-3 shows a tally of the 3 km^2 hexagon grid cells that contain demersal and pelagic longline records within the MPA and within the 10 nm buffer.

Table 32-2: Number of demersal and pelagic longline sets per year inside the Gully MPA between 2012 and 2018.

Sets/year inside the MPA	2012	2013	2014	2015	2016	2017	2018
Demersal Longline	75	69	72	71	37	29	33
Pelagic Longline	6	36	12	21	25	13	14

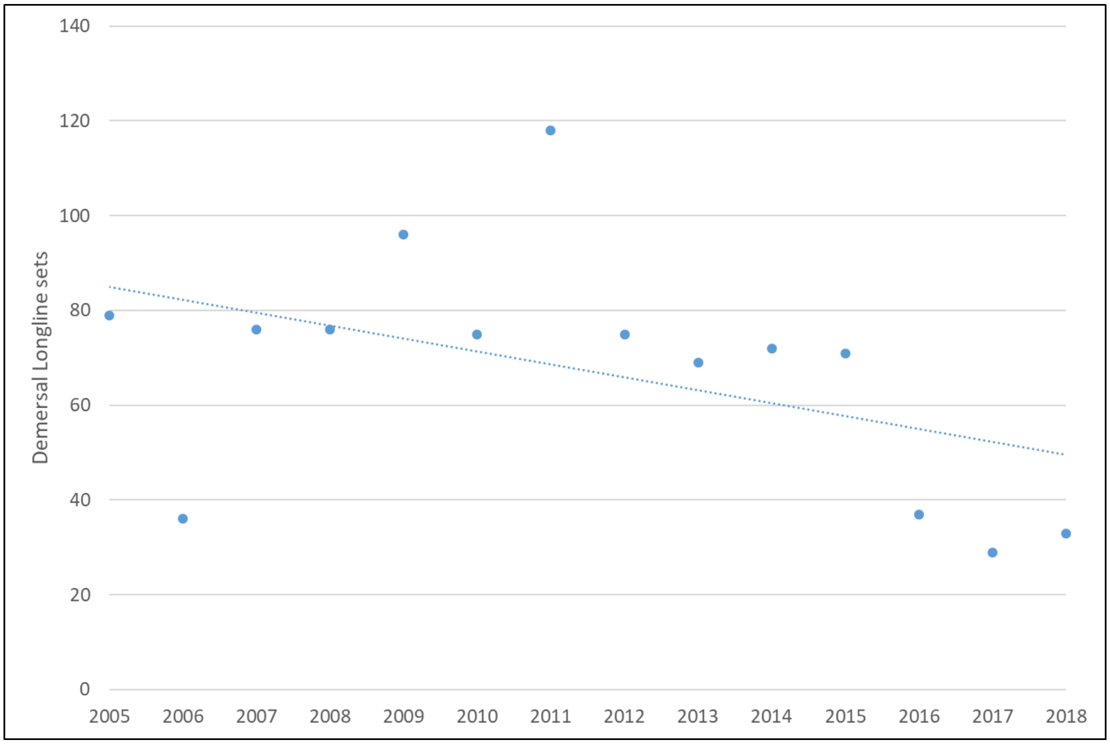


Figure 32-1: Demersal longline sets per year (2005-2018) inside the Gully MPA.

The yearly average of demersal longline sets inside the MPA was lower for the second reporting period. The average sets per year from 2005-2011 was 79 (s=25), while the average from 2012-2018 decreased to 55 (s=20). Sets per year decreased over the entire 2005-2018 study period, indicating that demersal longline effort within the MPA has decreased over time.

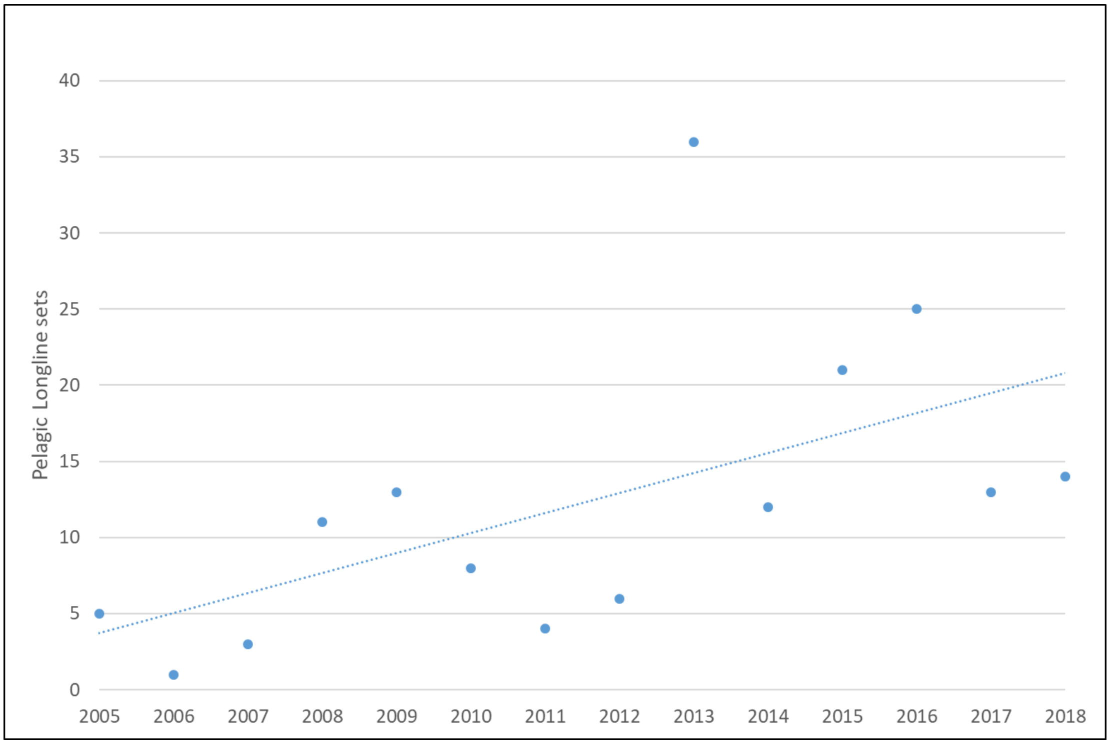


Figure 32-2: Pelagic longline sets per year (2005-2018) inside the Gully MPA.

The yearly average of pelagic longline sets inside the MPA increased in the second reporting period, from an average of 6 sets per year from 2005-2011 (s=4), up to an average of 18 sets per year (s=10) from 2012-2018. Sets per year generally increased during 2005-2018, indicating that pelagic longline effort within the MPA has increased over time.

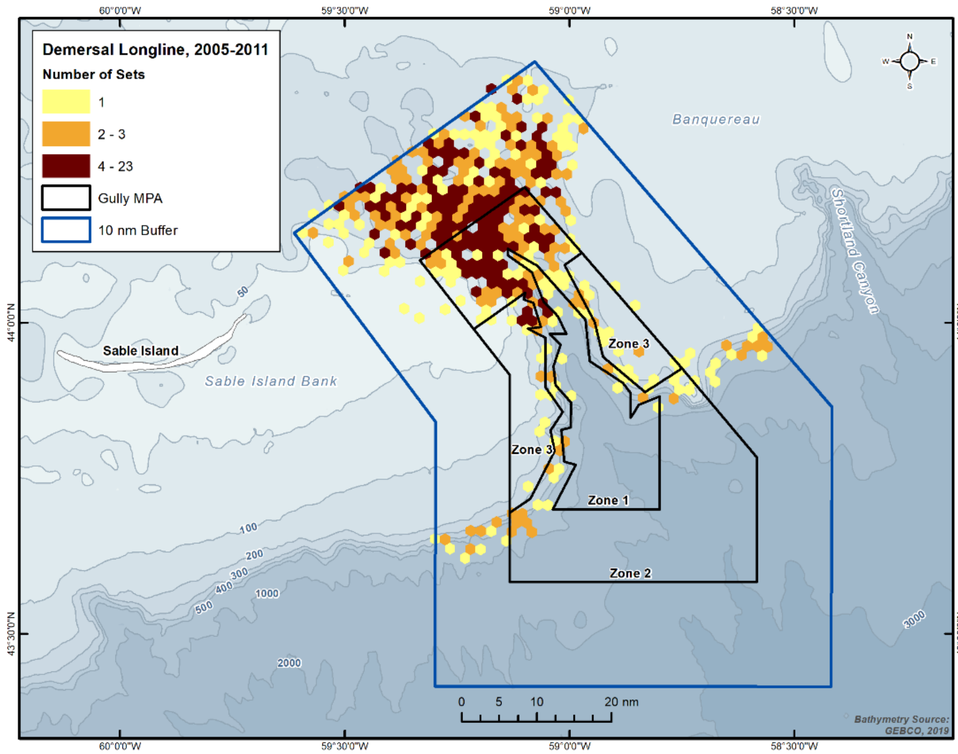


Figure 32-3: Demersal longline sets for 2005-2011 in the Gully MPA (black outline) and the 10 nm buffer (blue outline). Grid size = 3 km^2.

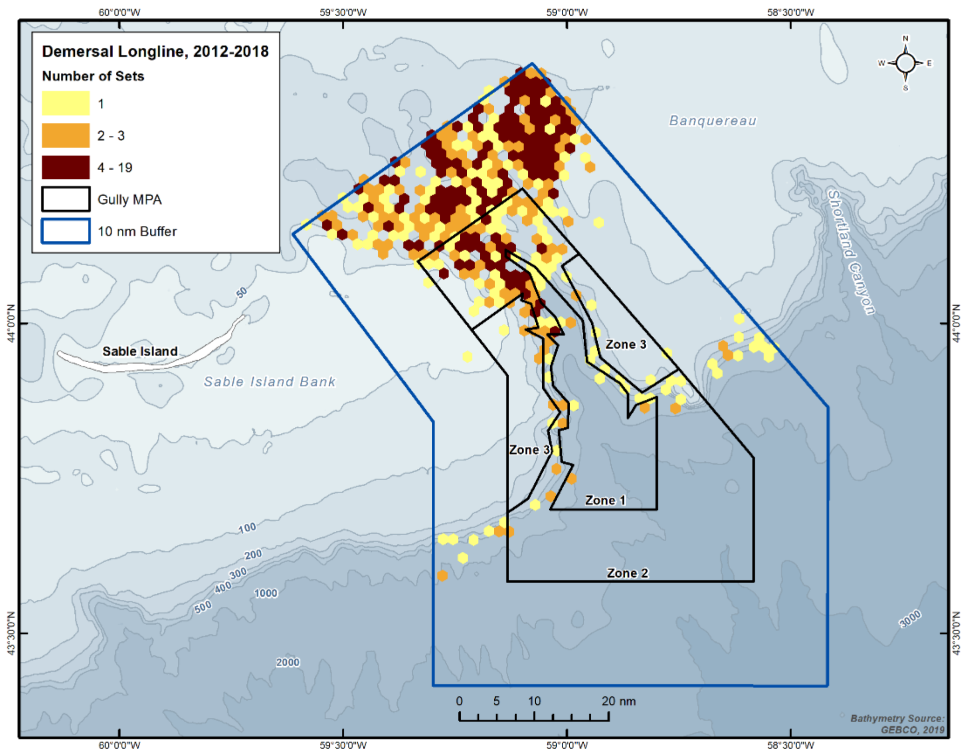


Figure 32-4: Demersal longline sets for 2012-2018 in the Gully MPA (black outline) and the 10 nm buffer (blue outline). Grid size = 3 km^2.

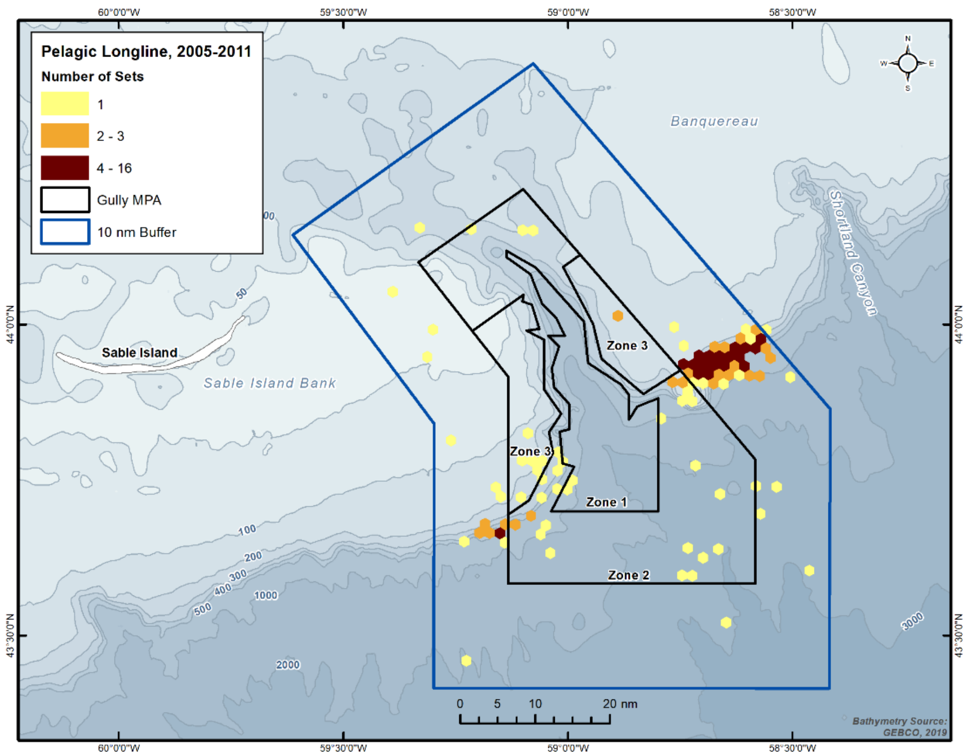


Figure 32-5: Pelagic longline sets for 2005-2011 in the Gully MPA (black outline) and the 10 nm buffer (blue outline). Grid size = 3 km^2.

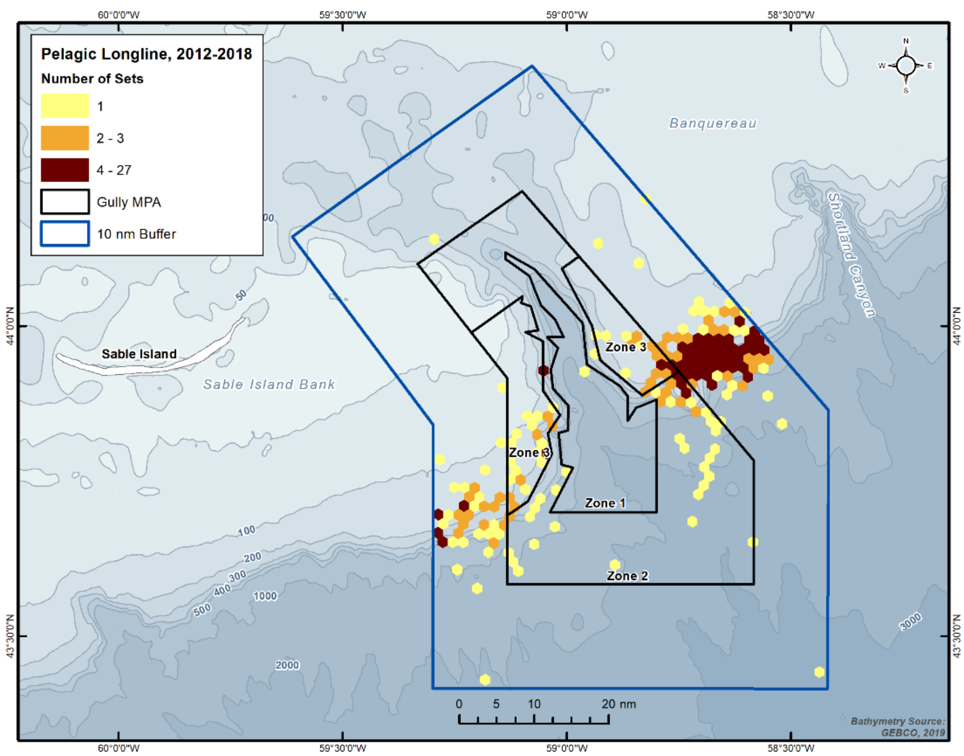


Figure 32-6: Pelagic longline sets for 2012-2018 in the Gully MPA (black outline) and the 10 nm buffer (blue outline). Grid size = 3 km^2.

Table 32-3: Number of fished hexagonal grid cells (3 km^2) inside the MPA and in the 10 nm buffer.

Fished Cell Location	Year	Demersal Longline	Pelagic Longline
MPA	2005-2011	161	36
	2012-2018	122	73
10 nm buffer	2005-2011	247	59
	2012-2018	255	114

The spatial distribution of sets over the two reporting periods for both demersal and pelagic longline remained fairly similar (see Figures 32-3, 32-4, 32-5, and 32-6 and Table 32-3). Overall, demersal longline fished cells within the MPA decreased in the second reporting period (2012-2018) and increased slightly in the 10 nm buffer. Inside the MPA, demersal longline sets are more concentrated around the canyon head in Zone 2 where the depth is shallower. One difference between the two reporting periods is that in 2005-2011 period there was a concentration of activity in Zone 2 of the MPA, whereas in the 2012-2018 period some of this activity shifted out of the MPA into the northern corner of the 10 nm buffer. This is consistent with Figure 32-1 which illustrates that effort within the boundary of the MPA has declined over time and Table 32-3 which indicates that fished cells in the MPA decreased from 2012-2018.

For the pelagic longline fishery, effort increased in the second reporting period. Pelagic longline fished cells almost doubled, both inside and surrounding the MPA from 2012-2018. While pelagic effort increased, the distribution of pelagic longline sets remained fairly consistent over the two reporting periods. In both periods the effort within the MPA was concentrated along the shelf edge, primarily on the eastern side of the MPA in Zones 2 and 3. In the second reporting period there was an increase in effort on the eastern side and an increase in activity on the western side of the MPA.

For both demersal and pelagic longline, the number of sets and number of fished cells was larger in the 10 nm buffer than inside the MPA in both reporting periods, indicating that effort is largely outside of the MPA.

In the maps for both demersal and pelagic longline there was one hexagon that seemed to overlap with Zone 1 of the MPA, where no commercial fishing is allowed. This is likely a reporting error. The set is still counted towards overall effort within the MPA.

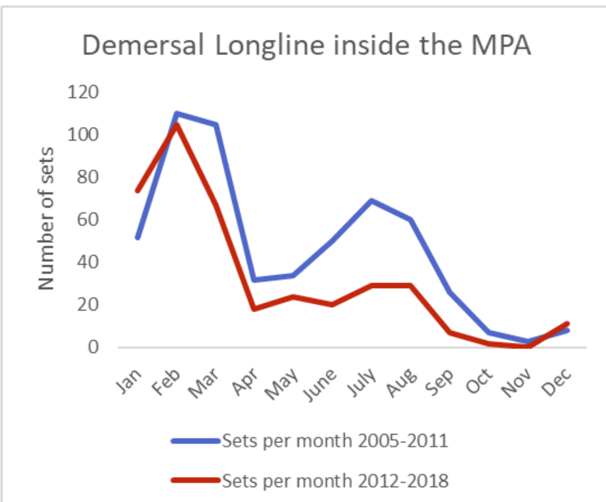
During the last reporting period, a suggestion was made to analyze sets by month to monitor changes to fishing at a finer time scale, therefore this analysis was conducted for this reporting period (Tables 32-4 and 32-5).

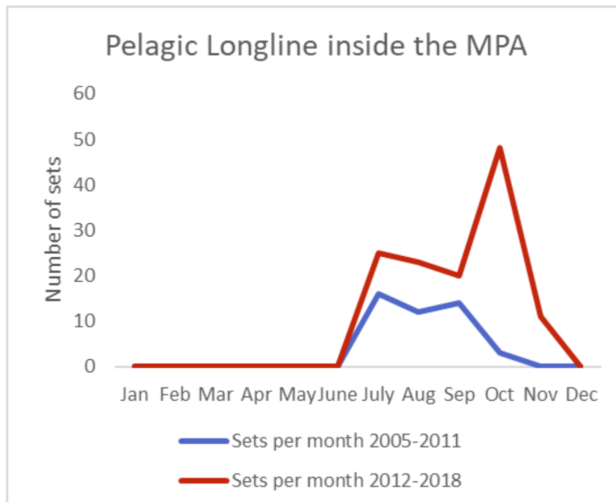
Table 32-4: Total number of sets per month for demersal and pelagic longline for 2005-2011.

Sets per month in the MPA	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Demersal Longline	52	110	105	32	34	50	69	60	26	7	3	8
Pelagic Longline	0	0	0	0	0	0	16	12	14	3	0	0

Table 32-5: Total number of sets per month for demersal and pelagic longline for 2012-2018.

Sets per month in the MPA	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Demersal Longline	74	105	67	18	24	20	29	29	7	2	0	11
Pelagic Longline	0	0	0	0	0	0	25	23	20	48	11	0





Figures 32-7 and 32-8: Sets per month for the two reporting periods (2005-2011 and 2012-2018) for demersal longline and pelagic longline gear inside the MPA.

Tables 32-4 and 32-5 provide the sum of all fishing sets for each reporting period broken down by month. Both the demersal and pelagic fisheries are open year round, therefore months with zero sets indicate a lack of activity, not a closed fishery. The monthly trend for both demersal and pelagic longline sets inside the MPA are very similar between the two reporting periods (Figures 32-7 and 32-8). The demersal longline fishery records higher sets per month in the winter, slightly lower sets throughout the summer, and very little activity in the fall. The pelagic longline fishery is active throughout the summer and fall, with higher average sets per month in the second reporting period. Consistent with the above analysis, a decline in effort was observed for the demersal longline fishery in the second reporting period, particularly in the summer months. Effort for the pelagic longline fishery was higher in the second reporting period, particularly in the fall.

Evaluation of existing protocols and suggestions for future monitoring

An annual calculation of the number of sets is a simple indicator of overall fishing effort in the MPA for pelagic and demersal longline fisheries; however more complex analyses could be conducted to further examine fishing effort in the MPA. Calculations that take into account the number of hooks per set could also be incorporated using available datasets (MARFIS, Commercial Index of Halibut Survey, and At-Sea Observer Program reports). This analysis could provide additional detail on the level of fishing effort taking place in the MPA as longline sets can vary widely in the number of hooks per set.

INDICATOR 33: COMMERCIAL FISHING EFFORT IN CLOSE PROXIMITY TO THE MPA BOUNDARY

C. Schram and K. Rozalska

Description

As described for Indicator 32, this indicator monitors fishing pressure over time. For the purposes of this report, “close proximity” has been defined as a 10 nautical mile (nm) buffer around the MPA boundary. “Fishing the line” has emerged as a pattern in harvesting activity around the world, where fishing effort is concentrated at the boundary of an MPA in the hopes of benefitting from a spillover effect from the MPA into the surrounding waters (Kellner et al., 2007). This indicator aims to track all fishing effort in close proximity to the MPA and determine how fishing patterns have changed over time in the areas surrounding the MPA, and whether increased fishing effort in the buffer is an indication of the spillover effect. The previous report analyzed only longline fishing in proximity to the MPA since longline is the only fishery permitted in the MPA. To provide a more complete picture of fishing displacement, this report will attempt to address all fishing activity surrounding the MPA.

The previous report addressed commercial fishing effort in close proximity to the MPA boundary in the analysis for Indicator 32. The analysis for Indicator 33 in the previous report focused on the quantity of organisms removed by commercial fishing activities in close proximity to the MPA. For this report, Indicator 33 addresses commercial fishing effort in close proximity to the MPA, which is consistent with the wording of the indicator. The analysis for the quantity of organisms removed by commercial fishing activities in close proximity to the MPA has been moved to Indicator 36.

Summary from previous reporting period

The number of demersal and pelagic longline sets within 10 nm of the Gully MPA was tallied for each year of the study period (Table 33-1). Similar to trends noted within the MPA, demersal longline activity surrounding the MPA was lowest in 2006 and highest in the last two years of the study period (2010 and 2011). This was likely a result of region-wide changes in the directed halibut fishery, with an increase in the available quotas in the region in the latter half of the time series (DFO, 2015a). Pelagic longline effort in close proximity to the Gully remained low and relatively constant throughout the study period. As was noted in the summary for Indicator 32, during the data compilation and analysis for the current 2012-2018 period, it was noted that the previous report was analyzed using a truncated dataset due to a technical error, therefore the complete dataset for 2005 to 2011 was re-analyzed and is described below.

Table 33-1. Sets per year for 2005-2011 in the demersal and pelagic longline fisheries in the 10 nm buffer around the Gully MPA (update of Table 33-1 in Allard et al., 2015).

Sets/year in the 10 nm buffer	2005	2006	2007	2008	2009	2010	2011
Demersal Longline	95	69	71	76	101	201	149
Pelagic Longline	41	4	13	38	18	32	54

Available data, analysis and results

The number of pelagic and demersal longline sets in the 10 nm buffer has been tallied for the current reporting period, 2012-2018, using the MARFIS data and methods described for Indicator 32.

Table 33-2: Sets per year for 2012-2018 in the demersal and pelagic longline fisheries in the 10 nm buffer around the Gully MPA.

Sets/year in the 10 nm buffer	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**
Demersal Longline	160	164	174	141	110	107	62
Pelagic Longline	24	52	48	114	108	26	50

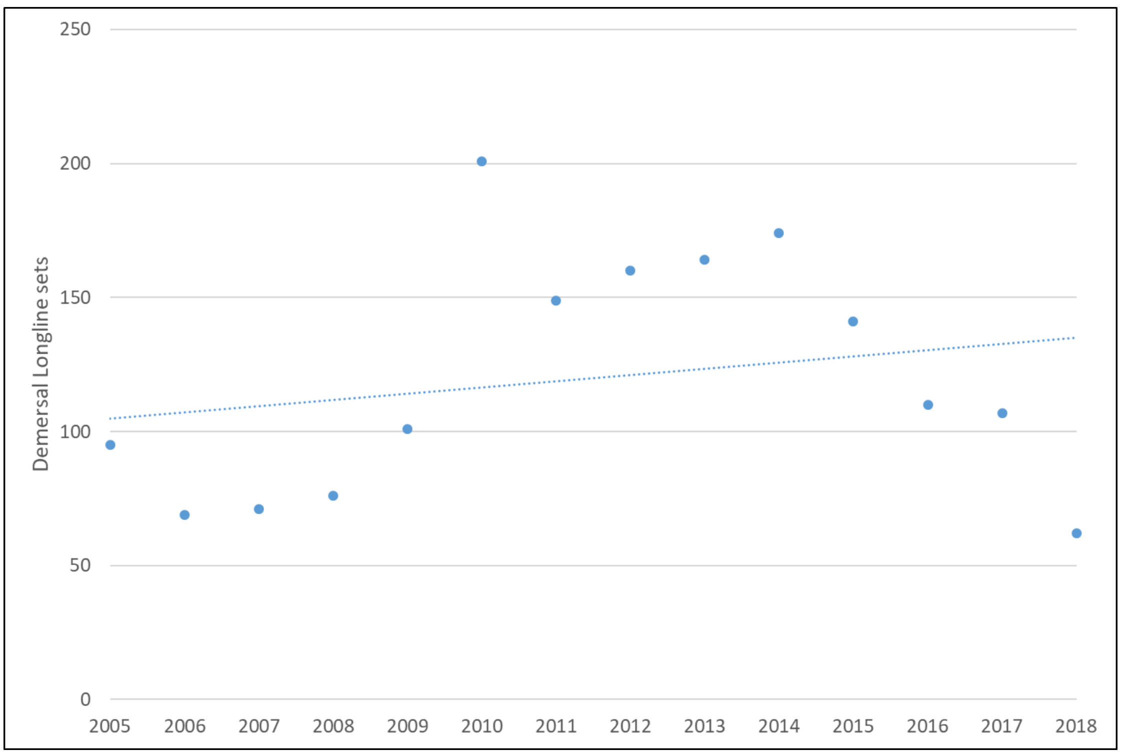


Figure 33-1: Demersal longline sets per year (2005-2018) in the 10 nm buffer around the Gully MPA.

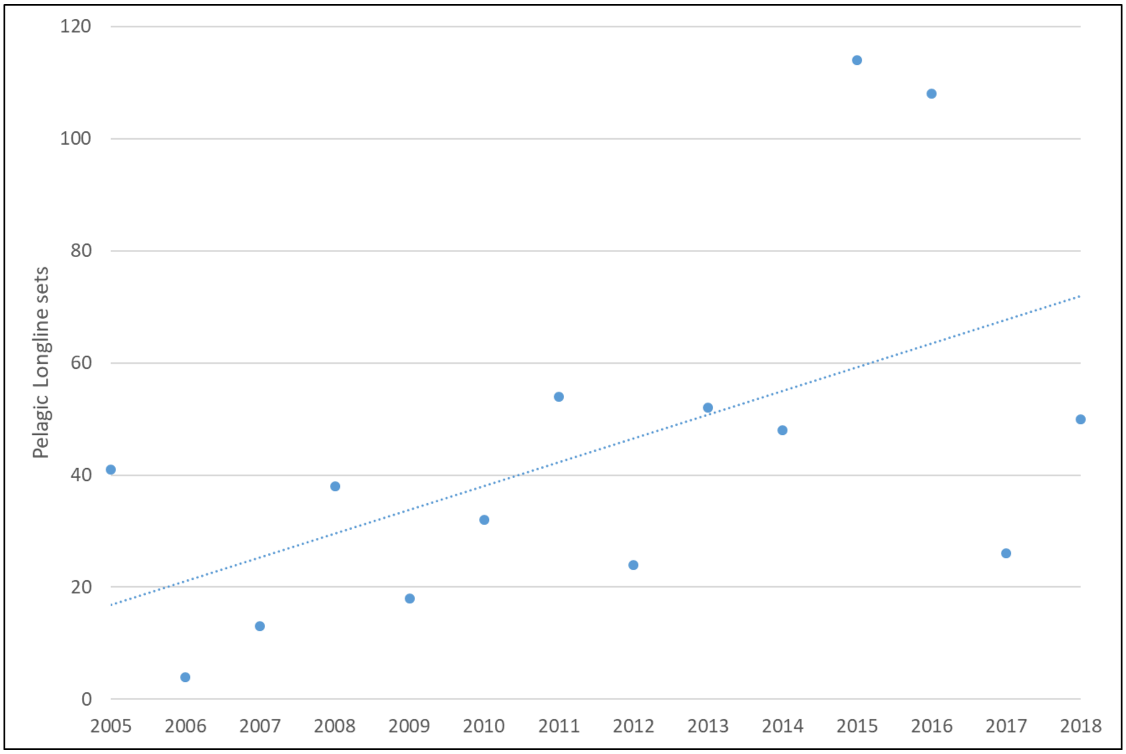


Figure 33-2: Pelagic longline sets per year (2005-2018) in the 10 nm buffer around the Gully MPA.

The average number of demersal longline sets per year in the 10 nm buffer around the Gully MPA for 2005-2011 was 109 (s=49), while the average sets per year for 2012-2018 was 131 (s=40).The number of sets per year over the entire study period (Figure 33-1), increased slightly over time. This increase in effort within the 10 nm buffer in the second reporting period is consistent with the spatial distribution of demersal longline sets over time within the MPA (Figures 32-3 and 32-4). In those figures, there was a shift in the distribution of effort from within the MPA boundaries and into the 10 nm buffer in 2012-2018.

The yearly average of pelagic sets in the 10 nm buffer around the Gully MPA increased in the second reporting period, from an average of 29 sets per year (s=18) from 2005-2011 up to an average of 60 sets per year (s=36) from 2012-2018. While the number of sets per year was fairly variable, the trend line showed a steady increase in effort over the study period. This is consistent with effort inside the MPA boundary, where there was also a steady increase in pelagic sets effort over time. Distribution of pelagic longline effort also remained fairly similar between the two periods.

To facilitate comparison between spatial distribution of effort inside and around the MPA, effort maps for demersal and pelagic longline have been included in the analysis for Indicator 32 which include the 10 nm buffer (See Figures 32-3, 32-4, 32-5, and 32-6). Spatial distribution of demersal longline effort in the 10 nm buffer remained fairly consistent over the two reporting periods, with a more noticeable concentration of sets in the northern corner of the buffer in the 2012-2018 map. Spatial distribution of pelagic longline effort in the 10 nm buffer also remained consistent between the two reporting periods. Pelagic effort was concentrated around the shelf edge, primarily on the eastern side of the MPA in the 10 nm buffer, although there was an increase in effort on the western side in the second reporting period, which is consistent with the finding that pelagic effort increased overall in 2012-2018.

During the last reporting period, a suggestion was made to analyze sets by month to monitor changes to fishing at a finer time scale, therefore this analysis has been conducted for this reporting period.

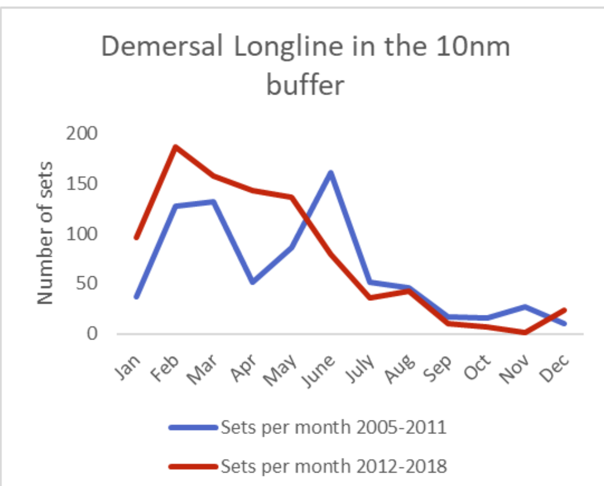
*Table 33-3: Number of sets per month for demersal and pelagic longline in the 10 nm buffer around the Gully MPA between 2005-2011.**

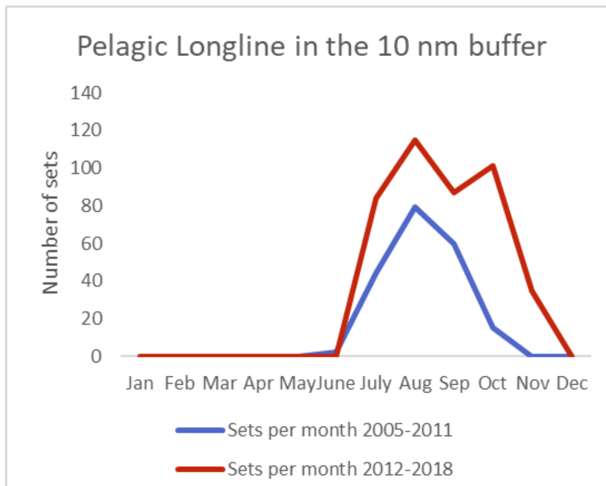
Sets per month, in the 10 nm buffer	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**June**	**July**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**
Demersal Longline	37	127	132	52	86	161	51	46	17	16	27	10
Pelagic Longline	0	0	0	0	0	2	44	79	60	15	0	0

*Based on an updated dataset.

Table 33-4: Number of sets per month for demersal and pelagic longline in the 10 nm buffer around the Gully MPA for 2012-2018.

Sets per month, in the 10 nm buffer	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**June**	**July**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**
Demersal Longline	96	187	157	143	136	79	36	42	10	7	1	24
Pelagic Longline	0	0	0	0	0	0	84	115	87	101	35	0





Figures 33-3 and 33-4: Number of sets per month for demersal and pelagic longline sets in the 10 nm buffer around the Gully MPA between 2005-2011 and 2012-2018.

Tables 33-3 and 33-4 provide the sum of all fishing sets for each reporting period broken down by month. Both the demersal and pelagic fisheries are open year round, therefore months with zero sets show a lack of activity, not a closed fishery. The monthly trend for both demersal and pelagic longline sets inside the MPA were fairly similar between the two reporting periods. The demersal longline fishery is active year-round and generally records higher sets per month in the winter and spring, and slightly lower sets throughout the summer and fall. However, there was a notable dip in activity during the spring months in 2005-2011. Effort in the second reporting period was higher than 2005-2011 in the winter months, but was slightly lower than 2005-2011 in the summer and fall.

The pelagic longline fishery is active only throughout the summer and fall. Effort was highest for both reporting periods in the summer and tapered off in the late fall. The average sets per month were higher in the second reporting period, consistent with overall increased effort in the 10 nm buffer.

In addition to the demersal and pelagic longline fisheries, there are several other fisheries that are active in the vicinity of the Gully MPA. Figures 33-5 and 33-6 show the number of sets over the 2012-2018 period for the Snow Crab and Hagfish trap fisheries. Figure 33-7 shows Sea Cucumber and Arctic Surfclam fishing areas that overlap with the 10 nm buffer around the MPA. Due to privacy screening the sets for Sea Cucumber and Arctic Surfclam cannot be shown, however the fishing area polygons give an indication of where fishing activity may be occurring in the vicinity of the Gully MPA.

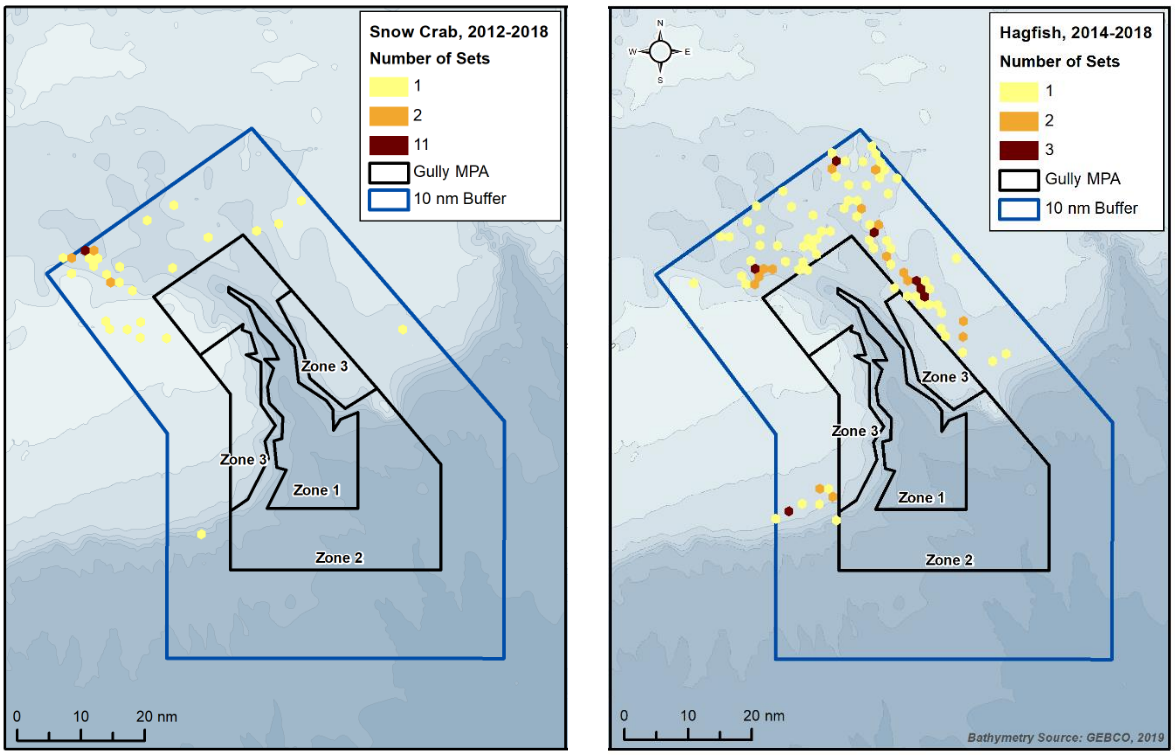


Figure 33-5 and 33-6: Number of sets for the Snow Crab fishery (left) and Hagfish fishery (right) for 2012-2018 in the 10 nm buffer around the Gully MPA.

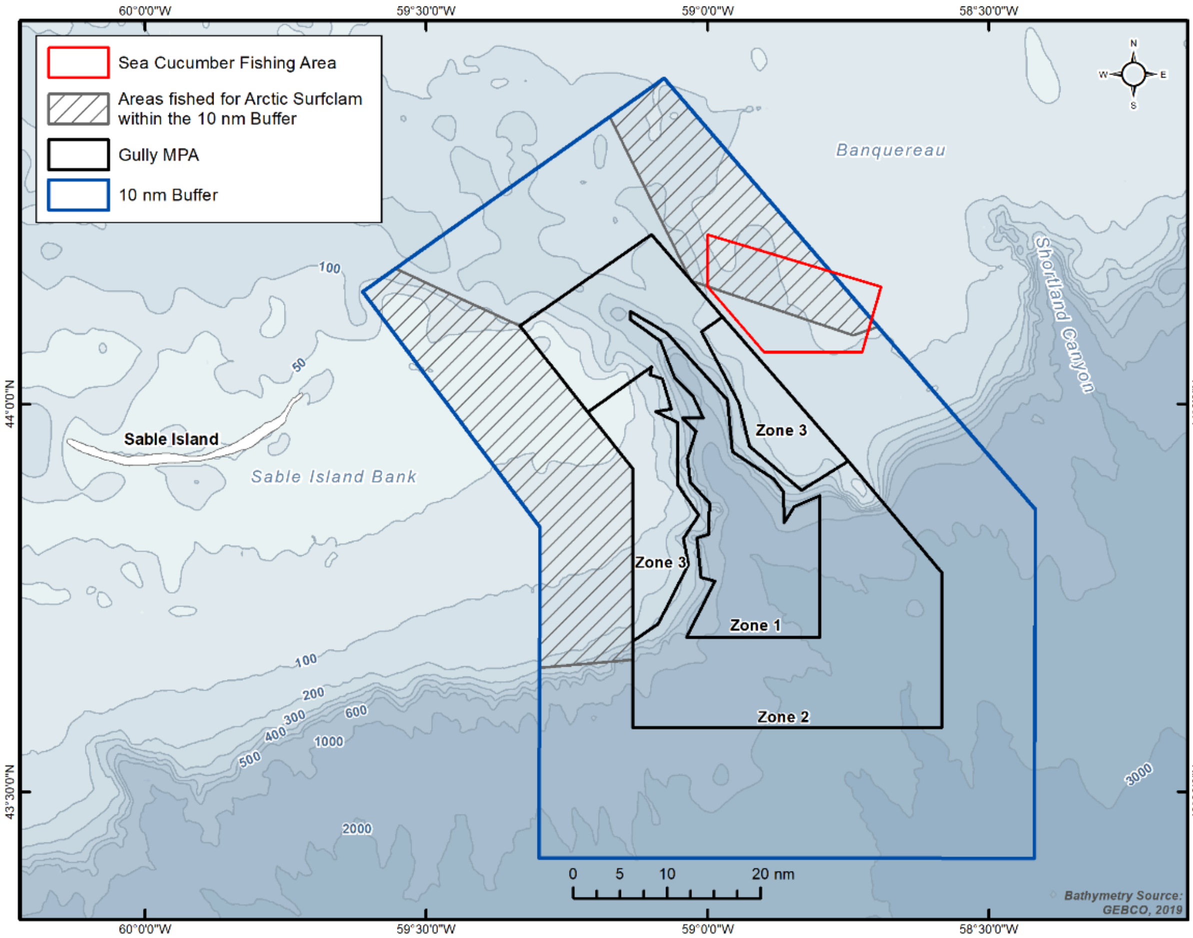


Figure 33-7: Sea Cucumber and Arctic Surfclam fishing areas that overlap with the 10 nm buffer around the Gully MPA.

Evaluation of existing protocols and suggestions for future monitoring

For future monitoring it may be possible to combine this indicator and Indicator 32 (Fishing effort within the MPA) and assess fishing effort within the MPA and in close proximity to the MPA boundary in the same indicator, provided that an analysis of biomass removals from the 10 nm buffer remains as part of the assessment (currently conducted for Indicator 36). Effort for fisheries that are active in the 10 nm buffer, but not permitted to occur within the MPA, i.e. Snow Crab and Hagfish, should continue to be analyzed in future reports to enable a comparison over time to fully address the intention of Indicator 33 as described by Kenchington (2010).

Additionally, future reports could explore increasing the area of the buffer as there have been suggestions from industry that a larger buffer might be more appropriate to assess activities such as pelagic longline which is very long and can cover large areas depending on oceanographic conditions.

INDICATOR 34: UNAUTHORIZED FISHING ACTIVITY WITHIN THE MPA

L. McConney

Description

As the only commercial extraction allowed in the MPA, fishing is a pressure that demands constant surveillance and monitoring to ensure regulatory compliance. In particular, Zone 1 contains species-rich benthic habitats and a year-round endangered population of entanglement-prone cetaceans utilizing the entire water column of the MPA. Fisheries are completely eliminated from Zone 1 to achieve the operational objective of complete ecosystem protection for the canyon core and its myriad of habitats, while certain fixed-gear fisheries (e.g., demersal longline and pelagic longline) are allowed in Zones 2 and 3.

Unauthorized fishing activity within the MPA could include fishing out of season, deploying inappropriate gear, fishing unlicensed species, and setting gear in zones closed to some or all fisheries. The broad concern for this indicator is with any kind of fishing that is not in compliance with the *Gully Marine Protected Area Regulations* and the associated *Fisheries Act* licencing regime. For practical reasons, the primary focus for monitoring is the detection of fisheries operating within the Gully MPA or parts thereof when they are not licenced to do so (i.e., fishing in a closed area).

Summary from previous reporting period

Information for this indicator was acquired from the DFO Conservation and Protection's (C&P's) Department Violations System (DVS) database and through ongoing communication between Marine Planning and Conservation (MPC) and C&P. Data from MPA establishment in May 2004 to September 2012 were used. During that timeframe, there were 5 fisheries-related incidents in DVS for the Gully MPA and there were no prosecutions attempted for violations in the MPA.

Available data, analysis, and results

Information for this indicator was acquired from the DFO C&P's DVS database. The DVS database was queried for violations related to the Gully MPA from October 2012 to July 2020 to provide a continuation of data since the last reporting period.

Three incidents of unauthorized fishing occurred in August 2019:

- After mistakenly towing fishing gear in the Gully MPA, the fishing vessel self-reported to DFO. A warning was issued.
- While on patrol, a vessel was boarded while fishing in Zone 2 of the Gully MPA and was charged with undersized Atlantic Halibut and incomplete logbook.
- While on patrol, a vessel that spent part of their trip in Zone 2 of the Gully MPA was boarded prior to landing. Results are pending, with a trial scheduled for fall 2020.

Two of the 3 unauthorized fishing events were related to at-sea patrols conducted by fishery officers using the Mid-Shore Patrol Vessels (MSPV). The previously reported fisheries-related incidents occurred in 2004, 2008, 2011, and 2012. With so few fisheries-related incidents entered into the DVS system since MPA establishment, trend analysis is not possible at this time.

Evaluation of existing protocols and recommendations for the future

The Gully MPA's remote location presents the biggest challenge for surveillance and enforcement activities because of the expense and lack of assets needed for manned surveillance patrols in offshore areas. Although the use of technology (e.g., VMS and AIS) have made the detection of unauthorized activities in the Gully MPA more practical, in general, detections via technological means must still be corroborated by other surveillance intelligence (e.g., logbook entries, At-Sea Observer Program reports, vessel patrols, and aerial surveillance reports) before enforcement can proceed. While surveillance flights can be tasked for further investigations if necessary, resources for aerial surveillance are limited and due to constrained fuel capacity, once a surveillance plane reaches the Gully MPA, they only have a finite period of time to collect information. Additionally, there are challenges facing the use of Canadian Coast Guard vessels. Due to the age of the fleet, vessels are often not available due to maintenance and repairs, leaving C&P without a vessel that can reach the site.

Suspicious and suspected unauthorized fishing activity is not logged in the DVS database. Therefore, if suspicious activity is noted by VMS but cannot be corroborated by other surveillance intelligence, it is not tracked and therefore cannot be incorporated into the monitoring data.

MPC will need to continue to work with C&P to better understand the types of evidence required to issue warning or pursue prosecution, and to ensure that there are sufficient resources in place to conduct the types of enforcement activities that will result in successful prosecutions of unauthorized fishing activity.

INDICATOR 35: QUANTITIES OF CORALS REMOVED, DISCARDED OR DAMAGED BY COMMERCIAL FISHING ACTIVITIES AND RESEARCH ACTIVITIES IN THE MPA

L. McConney

Description

Pressures facing deep sea cold-water corals have been identified by a host of documents and publications, such as the Coral and Sponge Conservation Strategy for Eastern Canada (DFO, 2015b). Coral is likely to be impacted by almost any activity undertaken on or near the seabed that results in contact. This indicator is focused on direct anthropogenic perturbations, and more specifically, removals and discards of corals associated with bottom fisheries and deployments of scientific sampling equipment. Unintentional capture or entanglement leading to surface retrieval is possible with both commercial fishing and research/monitoring. Targeted sampling of whole or partial colonies (e.g., “snips” collected by a remotely operated vehicle (ROV) mechanical arms for genetic material) may also be approved as a component of benthic research and monitoring programs (i.e., when there are demonstrable benefits to the MPA). Each source of removal, commercial fisheries and research/monitoring, is treated as a separate sub-indicator but the two can be aggregated for a composite total.

Summary from previous reporting period

The At-Sea Observer Program database records between 2005 and 2011 were queried for the commercial fishing aspect of this indicator while 2004 to 2012 documentation associated with approved research programs (e.g., science cruise reports, post-activity reports, Multispecies Trawl Survey data) were reviewed for interactions with coral.

Between 2005 and 2011, there were observer records from 12 trips and 104 sets, none of which reported coral bycatch. In 2006, 2010 and 2011, directed research on corals resulted in the removal of coral samples (e.g., 3 to 5 samples in 2006). The total number of samples was not included in the previous report and would require discussion with the principal investigator. There was also accidental damage to corals from research activities. Survey gear (deep water camera, Campod) may have unintentionally impacted corals upon bottom contact. Quantification of these impacts is not available. Additionally, a mesopelagic trawl survey in 2007 made contact with the canyon wall (Kenchington et al., 2009) resulting in the unintended removal of 2.5 kg of coral.

Available data, analysis, and results

Commercial fishing

MARFIS and At-Sea Observer data from 2012 to 2018 were reviewed for reports of coral discarded from commercial fishing gear. No coral was recorded in either dataset.

Research activities

Activity approvals and post-activity reports for research programs conducted in the Gully from 2013 to 2019 were reviewed for evidence of removing, discarding or damaging corals (Table 35-1). The weights and/or quantity of coral removed and the species was noted where detailed.

Table 35-1: Number of colonies, weight and species of corals removed from the Gully MPA as a result of research activities from 2013 to 2019.

Project	**Year**	**Number**	**Weight (kg)**	**Species**
Joint Industry-DFO Halibut Longline Survey	2013	---	10	*Paragorgia arborea*
Deep Connection Cruise	2019	1	---	*Dictyaulus* sp.
		1	---	*Paragorgia* sp.
		1	---	*Geodia barretti*
		1	---	*Keratoisidinae nodal*
Snow Crab Bottom Trawl Survey	2019	6	0.2	*Pennatula aculeata*
	2018	5	0.5	*Pennatula aculeata*
Multispecies Trawl Survey	2017	1	0.002	*Pennatula aculeata*

In 2013, three coral records associated with the Joint Industry-DFO Halibut Longline Survey occurred on three different sets in Zone 2 of the Gully MPA. The Deep Connection cruise in 2019 collected coral and sponge samples for analysis. Several sea pens were removed in 2018 and 2019 due to the Snow Crab Bottom Trawl Survey, while a single sea pen was accidentally brought up in a trawl associated with the Multispecies Trawl Survey in 2017 (Murillo et al., 2018). Due to the limited quantities of activities reporting the removal, discarding, or damage of corals, no trends analyses were conducted at this time.

Evaluation of existing protocols and recommendations for the future

During the CSAS workshop, it was recommended that the benthic indicators be expanded to include sponges in addition to corals. If the benthic indicators are modified in this manner, it is recommended that this pressure indicator be modified in the same manner to collect and report on parallel data. The suggested wording for this indicator is:

Quantities of corals and sponges removed, discarded or damaged by commercial fishing activities and research activities in the MPA.

Commercial fishing

Fishing interactions with coral communities in the Gully was well documented pre-MPA designation (Cogswell et al., 2009) but no coral was identified during the 2005-2011 and 2012-2018 reporting periods. Table 36-4 in Indicator 36 displays the frequency of At-Sea Observer trips in the Gully MPA. Increasing observer coverage in the Gully MPA is one way to ensure accurate reporting of coral bycatch.

Research activities

While the submission of post-activity reports has increased since the last reporting period, the template should be more prescriptive to ensure a more consistent level of detail is provided by activity proponents going forward. Specific suggestions related to this indicator include:

- A section for species, number of, and weight of all corals removed
- Coordinates of the location from which the coral was removed

INDICATOR 36: QUANTITIES OF TARGET ORGANISMS REMOVED FROM OR DISCARDED WITHIN THE MPA, AND BYCATCH ORGANISMS (OTHER THAN CORALS) FROM THE MPA BY COMMERCIAL FISHING

C. Schram and K. Rozalska

Description

This indicator adds catch information to the records described earlier for fishing effort in and around the MPA. Corals are addressed above in Indicator 35 given their overall significance to the MPA's benthic conservation objectives. Indicator 36 aims to monitor all removals from the MPA, including both target organisms and bycatch species. Target species in this case refer to species that have specific exceptions in the *Gully Marine Protected Area Regulations* to allow for fishing (s.8 of the *Gully Marine Protected Area Regulations*). Bycatch is used as an all-encompassing term meant to include everything else that is removed from the water, regardless of whether it is landed or discarded. The monitoring of bycatch in the Gully includes organisms that are caught incidental to the target species, for example the Atlantic Cod, hake and Cusk often taken with halibut gear, or the marlin, Sunfish and turtles occasionally hooked by large pelagic gear. Discards are organisms that are returned to the ocean, which can include non-commercial species and undersized target species. Although there are no management measures specific to bycatch in the *Gully Marine Protected Area Regulations*, fisheries operating in the MPA must comply with the fisheries management measures set by DFO. Commercially valued groundfish are generally kept and landed at the wharf, unlike non-commercial fish which are typically discarded. Some at-risk species are subject to special handling procedures and bycatch reporting protocols, notably wolffish and skates that co-occupy some halibut grounds. Whether pelagic bycatch is landed or discarded is governed by a similar set of market drivers, licence conditions and conservation needs. Sea turtles, whether alive or dead, are normally de-hooked or cut free and released back into the water; they are never removed and recorded as catch in eastern Canadian fisheries (Atlantic Leatherback Turtle Recovery Team, 2006; DFO, 2016).

Summary from previous reporting period

The data source used for this indicator is logbook data submitted by industry as a condition of licence, and observer report data submitted by At-Sea Observers. Data from 2005-2011 were used for the previous reporting period. Similar to previous indicators, during the data compilation and analysis for the current 2012-2018 period, it was noted that the previous report was based on a truncated Maritime Fishery Information System (MARFIS) dataset, therefore the complete dataset for 2005 to 2011 was re-analyzed and is described below.

Available data, analysis and results

Commercial fisheries logbook data stored in MARFIS was used to display catch weight landings (round weight) from 2005-2018. As described in Indicators 32 and 33, species caught by demersal longline deeper than 1,000 m were assumed to have errors in their coordinates and were therefore removed from distribution maps. While there is relative certainty that the locations were recorded incorrectly, there is still a likelihood that they were located somewhere within the MPA boundary, therefore using the precautionary principle these records were retained in the data tables for analysis purposes. For each catch weight value, privacy screening was conducted to determine whether weights could be publicly displayed. If the MARFIS records for a given species during a particular year or time range had at least five unique licence IDs, five fisher IDs and five vessel IDs within the 10 nm buffer, the total landed weight is displayed in the tables below. Those that did not pass are not displayed in order to protect the identity or fishing activities of fishers. In addition, At-Sea Observer Program data from 2012 to 2018 were obtained to describe bycatch and discarded species.

Catch records between the two reporting periods show that the overall totals were fairly similar, with some notable differences in particular species. Landings of Atlantic Halibut were slightly lower during 2012-2018 at approximately 85% of the previous periods' landings. This is consistent with indications that groundfish effort in the MPA has declined in the 2012-2018 period. For example, fewer sets were reported in the Gully between 2012-2018 as seen in Indicator 32. It is particularly notable that Atlantic Halibut (demersal longline) effort has decreased in the MPA despite an overall increase in the total allowable catch (TAC) in the Maritimes Region. Atlantic Halibut in NAFO areas 3NPOs4VWX5Z had a TAC of 1375 metric tonnes in 2005, which increased to 2128 metric tonnes in 2012 and to 4164 metric tonnes in 2018 (DFO, 2018a; DFO, 2019).

While landings of various tuna including Albacore, Bigeye, Yellowfin and unspecified tunas declined in the second reporting period, at approximately 41% of the landings from 2005-2011, the other pelagic species saw increased landings (Table 36-1 and Figure 36-1). Swordfish landings doubled in 2012-2018, and the landings of Bluefin Tuna were approximately six times higher during 2012-2018 than they were in 2005-2011. This is also consistent with findings from Indicator 32 which showed an increase in pelagic longline effort in the 2012-2018 period.

Table 36-1: Catch weights (kg) for target species within the Gully MPA for 2005–2011 and 2012-2018, obtained from MARFIS.

Target Species	**2005-2011 (kg)**	**2012-2018 (kg)**
Atlantic Halibut	255,255.3	218,088.4
Swordfish	53,542.9	106,676.1
Tuna (Albacore, Bigeye, Yellowfin, and Unspecified)	5,148.3	2,150.5
Tuna (Bluefin)	1,120.4	6,965.1
Total	**315,006.9**	**333,880.1**

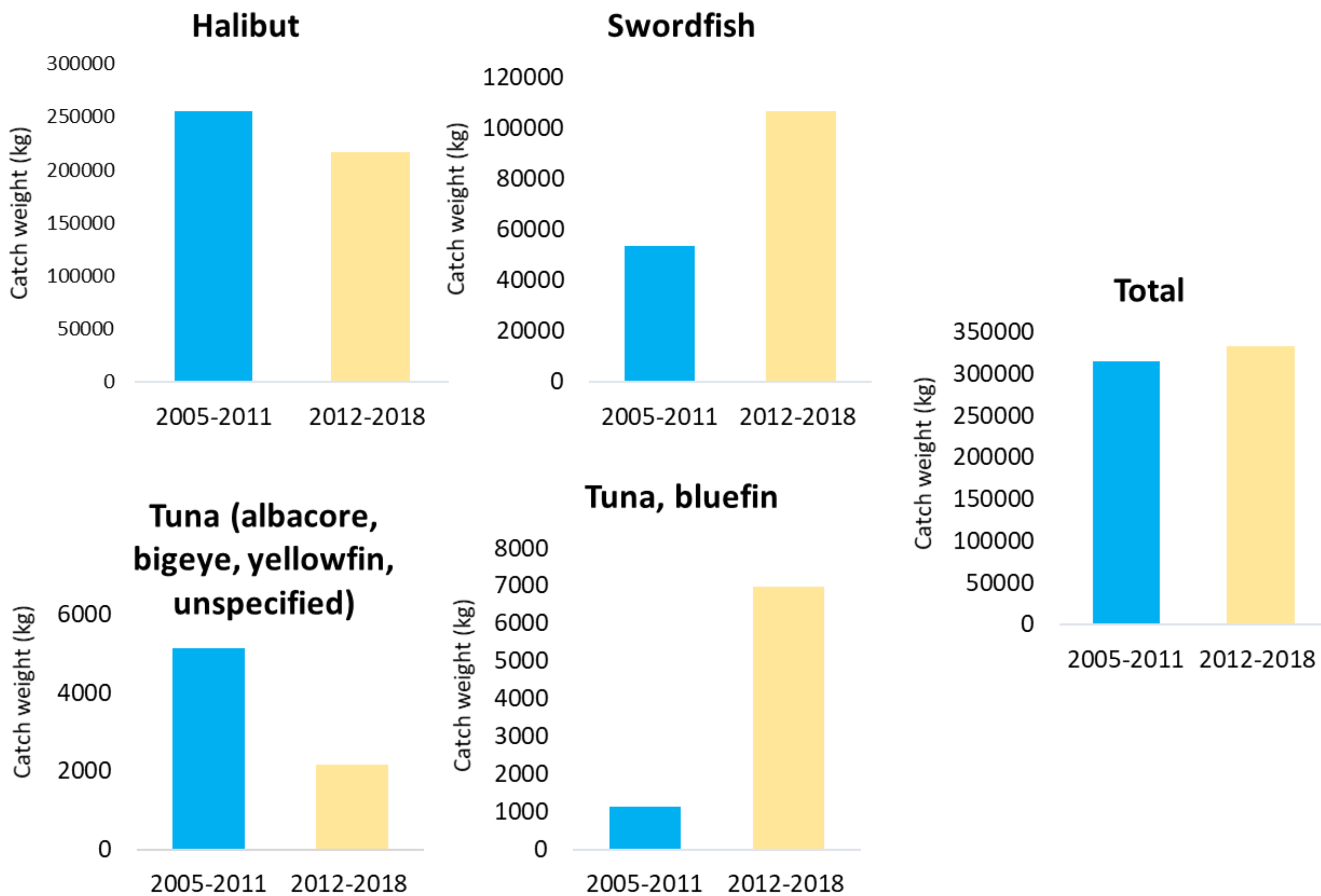


Figure 36-1: Catch weights (kg) for target species within the Gully MPA for 2005-2011 and 2012-2018, obtained from MARFIS.

Catch weights for bycatch species in the MPA (Tables 36-2 and 36-3, and Figure 36-2) have mostly declined in the second reporting period compared to the first. Overall bycatch in the demersal longline fishery constituted 19.2% of the overall catch within the MPA between 2005-2011, whereas it decreased to 10.4% of the overall catch in the MPA between 2012-2018. The pelagic longline fishery recorded slightly more bycatch in the second reporting period, increasing from 4.3% of the overall catch in 2005-2011 to 5% in 2012-2018. Mako Shark and Pollock are the only bycatch species where catch weights were higher in 2012-2018 than in 2005-2011.

Table 36-2: Catch weights in kg (MARFIS) for bycatch species from the demersal longline fishery in the MPA for 2005–2011 and 2012-2018.

Bycatch Species	2005-2011 (kg)	% of Demersal Fishery, 2005-2011 by weight	2012-2018 (kg)	% of Demersal Fishery, 2012-2018 by weight
Cusk	28,751.6	9.1	13,382.1	5.5
White Hake	13,023.5	4.1	7,768.8	3.2

Cod	12,565.1	4.0	2,171.7	0.9
Redfish	2,900.2	0.9	1,442.1	0.6
Haddock	304.2	0.1	258.3	0.1
Greenland Halibut	996.0	0.3	230.8	0.1
Porbeagle Shark	1,506.0	0.5	131.6	0.1
Monkfish	39.4	0.01	33.9	0.01
Pollock	15.3	0.005	15.7	0.01
Alewives/Gaspereau	151.5	0.05	0	0
American Plaice	17.8	0.01	0	0
Catfish	1.7	0.001	0	0
Dogfish	55.6	0.02	0	0
Fins, Fish unspecified	10.0	0.003	0	0
Groundfish, unspecified	57.5	0.02	0	0
Roundnose Grenadier	45.7	0.01	0	0
Mako Shark	71.3	0.02	0	0
Shark, unspecified	180.9	0.1	0	0
Total	**60,693.5**	**19.2**	**25,435.0**	**10.4**

Table 36-3: Catch weights in kg (MARFIS) for bycatch species from the pelagic longline fishery in the MPA in 2005–2011 and 2012-2018.

Bycatch Species	2005-2011 (kg)	% of Pelagic Fishery in the MPA, 2005-2011 by weight	2012-2018 (kg)	% of Pelagic Fishery in the MPA, 2012-2018 by weight
Mako Shark	2,243.1	3.6	5,932.8	4.9
Mahi mahi	69.2	0.1	138.0	0.1
Porbeagle Shark	350.8	0.6	37.5	0.03
Fins, Fish unspecified	0.4	0.001	19.5	0.02
White Marlin	32.7	0.1	0	0
Total	**2,696.1**	**4.3**	**6,127.7**	**5.0**

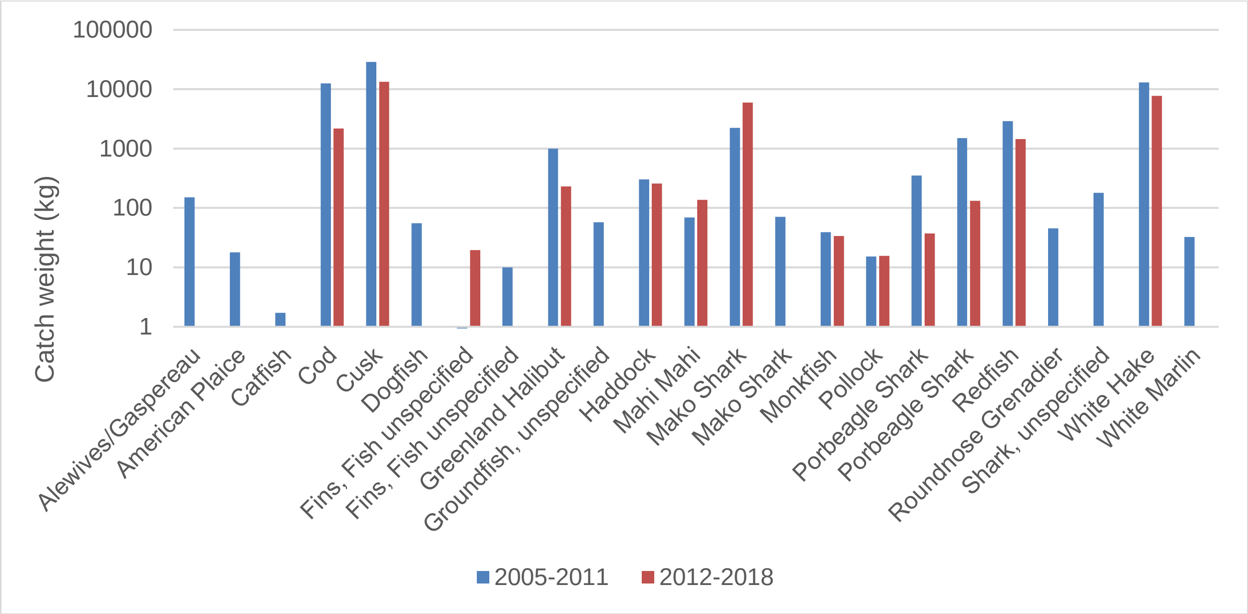


Figure 36-2: Catch weights (kg) for bycatch species in both demersal and pelagic longline fisheries in the MPA between 2005-2011 and 2012-2018 (MARFIS) using a logarithmic scale.

During 2005-2011, 12 longline trips in the Gully MPA had At-Sea Observers on board, for a total of 104 observed sets. In 2012-2018, there were a total of 23 observed trips, for a total of 69 observed sets (Table 36-4). For the current reporting period, the locations of observed trips were mapped, including the number of demersal and pelagic trips (Figure 36-3). At-Sea Observer data for longline sets includes four sets of coordinates: the location the first hook enters the water (P1); the location the last hook enters the water (P2); the start location for the recovery of the longline (P3); and the location where the last hook was removed from the water (P4) (Butler et al., 2019). Figure 36-3 illustrates lines drawn between P1 and P2. Sets that had any of the four points within the boundaries of the MPA are included in Figure 36-3 and Table 36-6. Therefore, some of the lines in Figure 36-3 appear to be outside of the MPA but would have been inside the MPA at some point during the fishing trip.

Tables 36-5 and 36-6 show At-Sea Observer records for catches within the Gully MPA between 2005-2011 (Table 36-5) and 2012-2018 (Table 36-6, Figures 36-4 and 36-5). In the first reporting period, At-Sea Observers recorded observed catches but did not record whether the catches were landed or discarded. To determine the fate of the catch, the observer records were compared to the MARFIS records and any observed species that were not listed in the MARFIS records were classed as suspected discards. In the current reporting period, landed and discarded estimated weights were recorded by the observers.

Between 2012-2018, approximately 5% of demersal sets in the MPA were observed (18 observed sets out of 386 total sets) and approximately 41% of pelagic sets were observed (51 observed sets out of 127 total sets). However, these approximates may be overestimates, particularly for the pelagic fishery due to the length of the longlines and differences in recording coordinates between the Observer program and MARFIS data.

Between 2005-2011, 12 fishing trips had At-Sea Observers on board, with 104 observed sets. Between 2012-2018, 23 trips were observed, with 69 observed sets. To facilitate comparison, catch weight per set was calculated for both reporting periods. This was done by dividing the catch weight by the number of sets observed for a given type of longline (pelagic vs. demersal).

Overall, the catch weight per set was fairly similar across both reporting periods, with 1,906 kg recorded per set in 2005-2011, and 2,112 kg recorded per set in 2012-2018. Some species had marked increases in the catch weights per set in the second reporting period, including Swordfish, Cusk, White Hake, and Porbeagle Shark. Species that had marked decreases in the catch weight per set in the second reporting period compared to the first include Atlantic Cod, Bluefin Tuna, and Black Dogfish. It is worth noting that while Blue Shark catch weight per set remained similar across both reporting periods, it is very high compared to other species. On average, 700 kg of Blue Shark, a bycatch species, are caught per set, which is higher than all other species except Swordfish, a commercially landed species. Other shark species caught as bycatch in the Gully include Porbeagle, Mako, Thresher, and Tiger sharks.

Table 36-4. Number of observed trips for demersal and pelagic longline to the Gully MPA and the number of sets observed within the MPA (2005–2018). A dash (-) indicates no value.

Year	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**All Years**
Trips	1	-	-	-	7	3	1	12
Sets	7	-	-	-	47	15	35	104

Year	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**All Years**
Trips	2	3	3	5	4	2	4	23
Sets	4	7	6	29	10	8	5	69

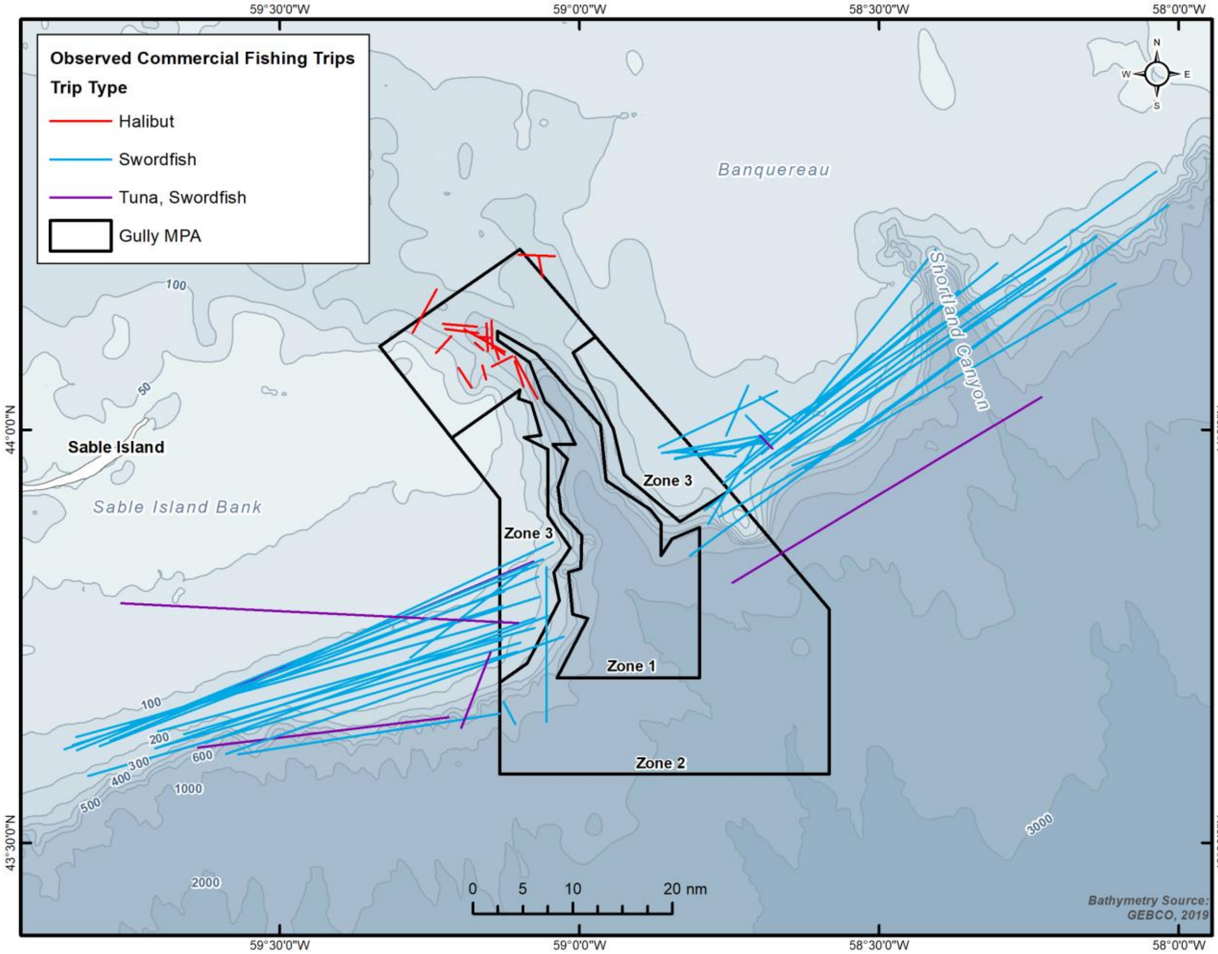


Figure 36-3: Observed trips for Atlantic Halibut (number of trips = 3, number of sets = 18), Swordfish (number of trips = 15, number of sets = 45) and Tuna (number of trips = 5, number of sets = 6) in the Gully MPA for 2012-2018.

Table 36-5: Catch weights in kilograms (kg) reported within the Gully for all observed trips to the MPA (2005–2011). Suspected discards were listed as caught in observer reports, but not recorded as landings by MARFIS records. Observed trips = 12.

Status	Species	Catch weights (kg)*	Catch weights per set (kg)
Suspected discards	Blue Shark	705	705
	Black Dogfish	328	3.2
	Thorny Skate	302	2.9
	Winter Skate	133	1.3
	Northern Wolffish	73	0.7
	Little Skate	63	0.6
	Spotted Wolffish	11	0.1
	Striped Atlantic Wolffish	9	0.1
	Skates (Not specified)	9	0.1
	Conger Eel	2	0.02
	Atlantic Rock crab	1	0.01
Total suspected discards		**1,636**	**714.03**
Landed species	Halibut (Atlantic)	16,440	159.6
	White hake	1,149	11.2
	Cod (Atlantic)	637	6.2
	Swordfish	580	580
	Cusk	445	4.3
	Bluefin Tuna	428	428
	Porbeagle Shark	186	1.8
	Redfish (unseparated)	78	0.8
	Spiny Dogfish	35	0.3
	Haddock	17	0.2
	Turbot, Greenland Halibut	12	0.1
	Pollock	10	0.1
	Snow Crab (Queen)	4	0.04
Total landed species		**20,021**	**1,192.64**
Grand Total		**21,657**	**1,906.67**

*Catch weights were originally recorded as metric tonnes in the previous report but were converted to kilograms for this report for comparison purposes.

Table 36-6: Catch weights in kilograms (kg) reported within the Gully for all Observed trips to the MPA (2012–2018) in (a) demersal longline commercial fishery and (b) pelagic longline commercial fishery. Observed trips = 23 (Demersal trips = 3; Pelagic trips = 20). Observed sets = 69 (Demersal sets = 18; Pelagic sets = 51).

a) *Demersal longline fishery*

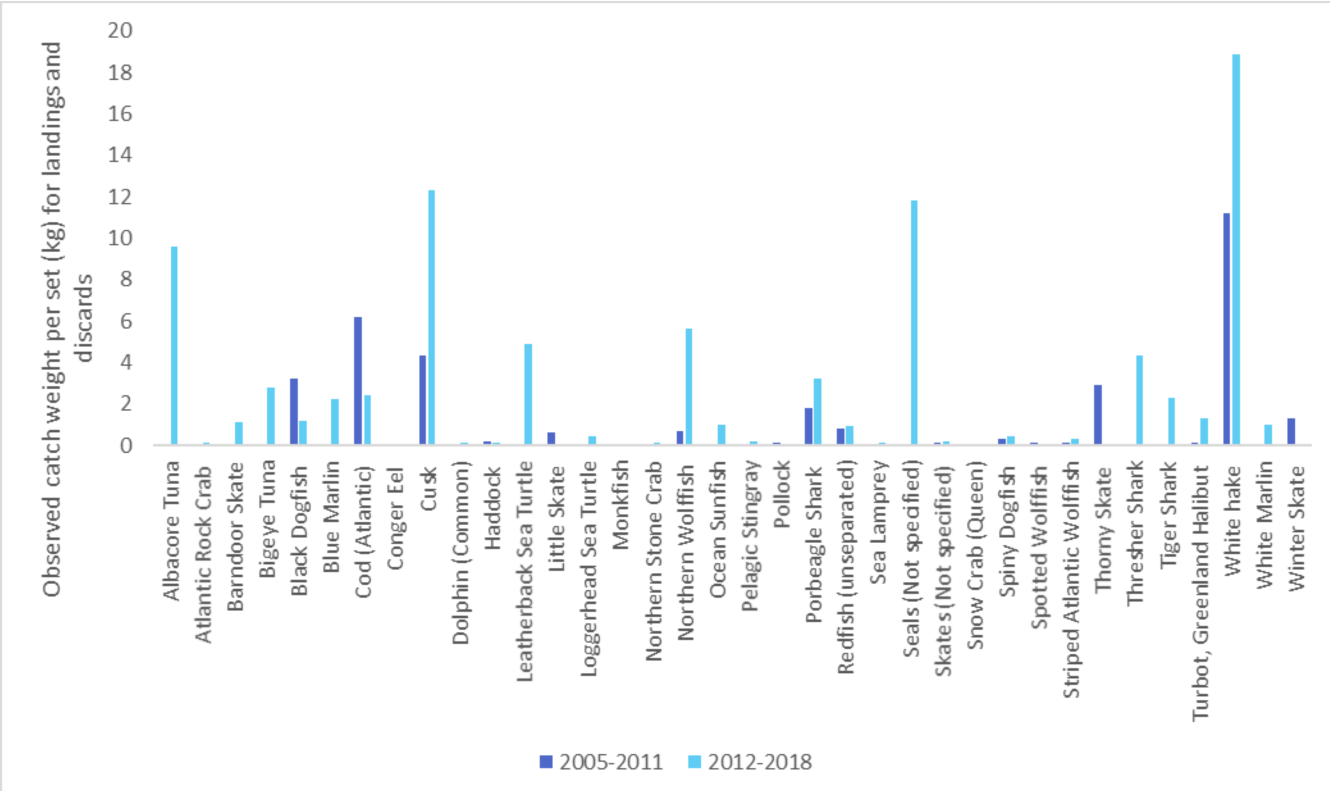
Species	Kept Weight (kg)	Discard Weight (kg)	Total Weight (kg)	Kept Weight	Discard Weight Per Set (kg)	Total Weight

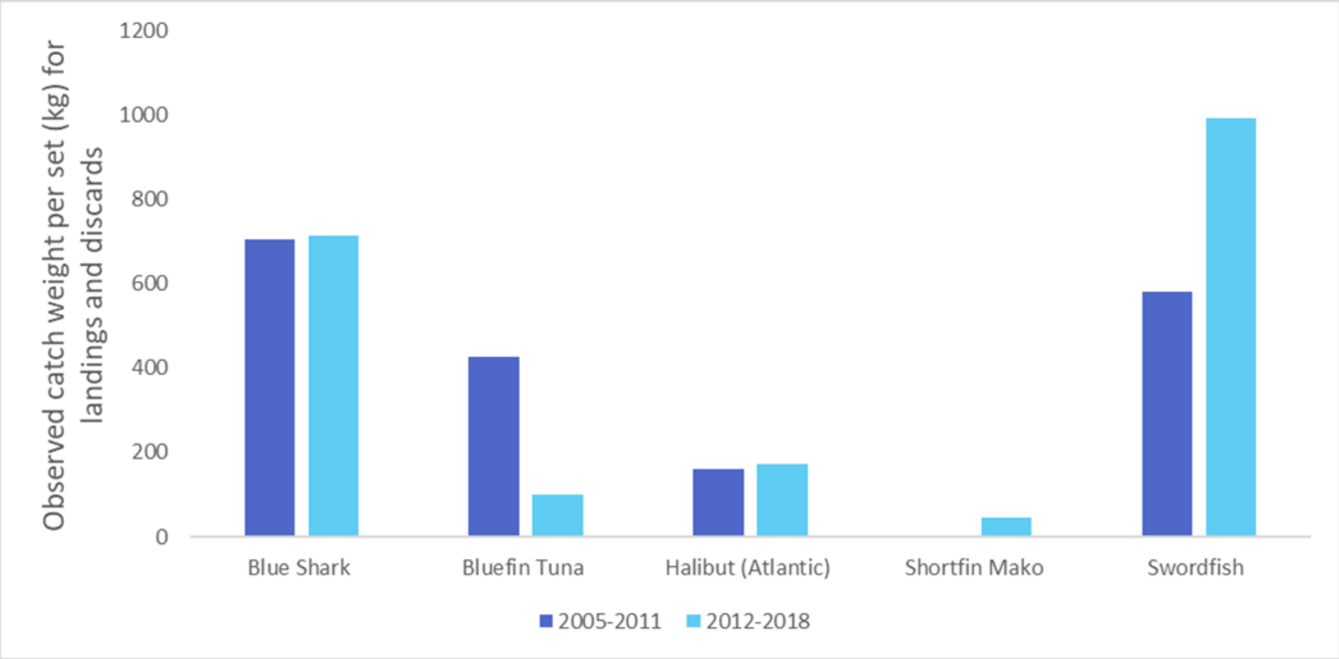
				Per Set (kg)		Per Set (kg)
Atlantic Rock Crab	0	1	1	0	0.1	0.1
Barndoor Skate	10	9	19	0.6	0.5	1.1
Black Dogfish	0	22	22	0	1.2	1.2
Cod (Atlantic)	44	0	44	2.4	0	2.4
Cusk	221	0	221	12.3	0	12.3
Haddock	2	0	2	0.1	0	0.1
Halibut (Atlantic)	2,897	227	3,124	160.9	12.6	173.6
Northern Stone Crab	0	1	1	0	0.1	0.1
Northern Wolffish	0	100	100	0	5.6	5.6
Redfish (Unseparated)	13	3	16	0.7	0.2	0.9
Skates (Not specified)	0	3	3	0	0.2	0.2
Spiny Dogfish	0	7	7	0	0.4	0.4
Striped Atlantic Wolffish	0	5	5	0	0.3	0.3
Turbot, Greenland Halibut	23	0	23	1.3	0	1.3
White Hake	340	0	340	18.9	0	18.9
Total	**3,550**	**378**	**3,928**	**197.2**	**21.0**	**218.2**

b) Pelagic longline fishery

Species	**Kept Weight (kg)**	**Discard Weight (kg)**	**Total Weight (kg)**	**Kept Weight Per Set (kg)**	**Discard Weight Per Set (kg)**	**Total Weight Per Set (kg)**
Albacore Tuna	477	12	489	9.4	0.2	9.6
Bigeye Tuna	143	0	143	2.8	0.0	2.8
Blue Marlin	110	0	110	2.2	0.0	2.2
Blue Shark	2,028	34,362	36,390	39.8	673.8	713.5
Bluefin Tuna	4,810	258	5,068	94.3	5.1	99.4
Dolphin (Common)	3	0	3	0.1	0.	0.1
Leatherback Sea Turtle	0	250	250	0	4.9	4.9
Loggerhead Sea Turtle	0	20	20	0	0.4	0.4
Monkfish	0	1	1	0	0.1	0.1
Ocean Sunfish	0	50	50	0	1.0	1.0
Pelagic Stingray	0	10	10	0	0.2	0.2
Porbeagle Shark	0	163	163	0	3.2	3.2
Sea Lamprey	0	3	3	0	0.1	0.1
Seals (Not specified)	0	600	600	0	11.8	11.8
Shortfin Mako	1,869	425	2,294	36.6	8.3	45.0
Swordfish	50,090	529	50,619	982.2	10.4	992.5
Thresher Shark	0	220	220	0	4.3	4.3

Tiger Shark	0	115	115	0	2.3	2.3
White Marlin	0	50	50	0	1.0	1.0
Total	**59,530**	**37,068**	**96,598**	**1,167.3**	**726.8**	**1,894.1**





Figures 36-4 and 36-5: Observed catch weights (kg) for landings and discards per set for At-Sea Observer trips to the Gully MPA for 2005-2011 (observed trips = 12) and 2012-2018 (observed trips = 23).

Catch records in the 10 nm buffer around the Gully MPA (Table 36-7) show the top five most landed species by weight (kg). This table was originally included with Indicator 33 in the previous report (Allard et al., 2015), however, it has been moved to this indicator because it is reporting on removals from the area around the MPA.

Snow crab was the species with the highest catch rate in the first reporting period and then declined in the second reporting period to approximately one quarter of the previous periods' catch. Hagfish, which was only recorded as catch in 2005 (privacy screened) during the first period, was the highest caught by weight in the second reporting period.

Table 36-7: Catch records by weight (kg) for target species in the 10 nm buffer around the Gully MPA between 2005 and 2018 (MARFIS). Dashes (--) indicate records that do not pass privacy screening.

Species	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**
Snow crab	272,480.9	--	--	--	267,410.8	202,363.4	--
Halibut	31,884.9	33,379.5	32,374.7	33,610.1	42,672.0	88,160.2	46,452.6
Sea Cucumber	0.0	0.0	0.0	0.0	0.0	--	--
Swordfish	56,069.3	--	19,785.3	59,922.3	21,623.8	46,244.3	58,615.7
Redfish	313.3	77.7	211.1	6.2	347.4	29,597.7	283.0
Hagfish*	--	0.0	0.0	0.0	0.0	0.0	0.0

Species	2012	2013	2014	2015	2016	2017	2018
Snow crab	--	137,654.3	--	--	--	--	0.0
Halibut	46,320.0	57,237.5	57,148.6	71,238.9	36,778.3	40,771.7	38,096.2
Sea Cucumber	--	0.0	--	0.0	--	--	0.0
Swordfish	21,343.5	42,395.2	54,419.8	94,519.9	75,137.4	18,861.2	28,575.7
Redfish*	2,724.2	43.1	--	--	--	--	0.0
Hagfish	--	--	292,818.4	374,121.5	283,534.5	140,990.4	118,587.5

*Hagfish was among the top five landed species by weight during 2005-2011, but not during 2012-2018. Likewise, Redfish for 2012-2018 was in the top five landed species by weight during 2012-2018, but not 2005-2011. Those records were retained for comparison between time periods.

Evaluating of existing protocols and suggestions for future monitoring

If removals in the vicinity of the MPA (10 nm buffer) continue to be analyzed in this indicator, the indicator may need to be reworded to specify that it examines removals both within and around the MPA. For example:

Quantities of target organisms removed from or discarded within and surrounding the MPA, and bycatch organisms (other than corals) from the MPA by commercial fishing.

During an internal review of the document, it was suggested that MARFIS records should be calculated using a catch-per-unit effort metric. Due to time constraints and inconsistencies with the records this was not possible for this reporting period. However, this kind of metric would add to the understanding of biomass removals from the MPA over time and should be considered in the next report.

Additionally, a discussion around whether or not there should be thresholds for bycatch in the MPA, particularly for vulnerable or at-risk species, could be helpful to support MPA effectiveness.

INDICATOR 37: QUANTITIES OF ORGANISMS (OTHER THAN CORALS) REMOVED FROM OR DISCARDED WITHIN THE MPA BY RESEARCH ACTIVITIES

L. McConney

Description

Corals receive specific focus in the pressures indicators (e.g., Indicator 35) due to their importance to the Gully ecosystem and focus within the conservation objectives. For species other than corals, Indicator 37 aims to monitor all removals by research activities from the MPA, including both target organisms and bycatch species. Bycatch is used to encompass everything that is not a coral that is removed from the water, including both landed catch and discards. Since these removals are associated with research activities, additional information is usually collected such as size measurements and weight and in some cases, organisms are brought to shore for preservative and additional work in a laboratory setting. Research gear associated with these removals/discards is varied and includes bongo nets, grab samples, ROV grabs, demersal longline fixed stations, and a range of trawls.

Summary from previous reporting period

Data compilation and analysis focused on the three primary documents associated with Ministerial Approvals: 1) Activity Plans submitted under Section 5 of the *Gully Marine Protected Area Regulations*; 2) MPA Approvals issued under Section 6 of the *Gully Marine Protected Area Regulations*; and 3) cruise reports submitted post-activity that provide temporal, spatial and biological details of the operations conducted. Records associated with MPA Approvals from May 2004 to fall 2011 were analyzed.

This indicator was combined with Indicator 31 in the previous reporting period and no specific information was included pertaining to bycatch specific to research and monitoring activities. Despite the longstanding approval request to file research cruise reports containing details of operations conducted, only a limited number of these documents have been submitted to the MPA management team, although compliance has improved in recent years with the creation of a standard report form.

Available data, analysis, and results

For the purposes of this review, data compilation and analysis focused on the post-activity reports and cruise reports associated with approved activity plans for the Gully MPA. Generally, the research activities that result in bycatch are associated with fisheries surveys, such as the Multispecies Trawl Survey, the Joint Industry-DFO Atlantic Halibut Longline Survey[3], and the Snow Crab Survey. For this assessment, results were compiled from January 2013 to December 2019 (inclusive).

Calculations were conducted to derive weights and quantities of organisms collected in the MPA. Weight and number of individuals removed/discarded were categorized by most frequent and Committee on the Status of Endangered Wildlife in Canada (COSEWIC)/*Species at Risk Act* (SARA)-listed species.

Despite an improvement in post-activity reporting since the development of a standard report form, compliance has not been 100%, therefore these results would be better used as general trends opposed to definite amounts removed.

According to 12 post-activity reports submitted by researchers from January 2013 to December 2019[4], 92 species were removed or discarded within the Gully MPA. Appendix B contains the table of all species including quantities of individuals and total weight. Table 37-1 includes the top 10 species by weight, while Table 37-2 contains information about the top 10 species by number of individuals. Table 37-3 is focused on caught/discarded COSEWIC and/or *SARA* listed species.

Table 37-1: Top 10 species by weight caught/discarded in the Gully MPA by research activities from January 2013 to December 2019. Both White Hake and Atlantic Cod are COSEWIC-listed species.

Species Name	Weight (kg)
Atlantic Halibut	5,331.72
Barndoor Skate	617.40

[3] Only removals/discards associated with fixed sampling stations are analyzed in this indicator. The commercial index aspect of this survey is included in Indicator 32.

[4] Additional records associated with the Joint Industry-DFO Atlantic Halibut Longline Survey and the Snow Crab Trawl Survey were requested and incorporated in the results for this indicator.

Redfish (Unseparated)	433.07
White Hake	331.36
Haddock	297.25
Shortfin Squid	250.68
Silver Hake	241.120
Atlantic Cod	139.70
Longhorn Sculpin	74.34
Black Dogfish	70

Table 37-2: Top 10 species by quantity of individuals caught/discarded in the Gully MPA by research activities from January 2013 to December 2019.

Species Name	**No. of Individuals**
Shrimp (*Pandalus Montagui*)	3,150
Redfish (Unseparated)	1,667
Silver Hake	1,486
Shortfin Squid	1,474
Longhorn Sculpin	1,030
Haddock	597
Snow Crab	316
Witch Flounder	296
Atlantic Rock Crab	260
Yellowtail Flounder	207

Table 37-3: COSEWIC and/or SARA listed species caught/discarded in the Gully MPA by research activities from January 2013 to December 2020.

Species Name	**COSEWIC Status**	**SARA Status**	**Weight (kg)**	**No. of individuals**
American Plaice	Threatened	N/A	7.16	133
Atlantic Cod	Endangered	N/A	139.7	191
Cusk	Endangered	N/A	24	6
Northern Wolffish	Threatened	Threatened	50	3
Smooth Skate	Special Concern	N/A	5.25	13
Spotted Wolffish	Threatened	Threatened	3	1
Thorny Skate	Special Concern	N/A	31.85	9
White Hake	Threatened	N/A	331.36	112
Winter Skate	Threatened	N/A	1.4	2

COSEWIC and/or SARA listed species caught/discarded at the highest abundance from the Gully MPA included White Hake, American Plaice, and Atlantic Cod. Overfishing is a concern for these species (Government of Canada, 2019a; Government of Canada, 2019b; COSEWIC, 2010) but quantities removed by research activities in the Gully MPA are not expected to impact populations. The other COSEWIC and SARA-listed species are caught at much smaller quantities.

Evaluation of existing protocols and recommendations for the future

While the submission of post-activity reports has increased since the last reporting period, it is recommended that the template is updated to include the information needed for monitoring all relevant indicators. Additionally, the template should be more prescriptive to ensure a more consistent level of detail is provided by activity proponents going forward. Specific suggestions related to this indicator include a section for species, number of and weight of all organisms removed.

INDICATOR 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

L. McConney and G. Pardy

Description

Protecting coral and other benthic organisms, and the seabed habitats they depend upon, is a central pillar of the MPA. After designation in 2004, when mobile fishing gear was eliminated from the Gully (i.e., trawls, dredges), the only seabed pressures that remained were commercial longline fisheries for halibut and approved scientific programs (e.g., benthic studies, trawl surveys, moorings). These pressures comprise the largest remaining human-generated pressure on benthos and seabed habitat.

This indicator addresses the location and size of areas on the seabed that are contacted by mobile bottom-tending activities still permitted to occur in the MPA via Ministerial Approval as granted for individual scientific proposals. Some impacts from this activity are expected and although the likelihood of causing significant damage or disturbance to sensitive bottom has been minimized, the level of interaction requires ongoing monitoring to address potential cumulative impacts.

Summary from previous reporting period

During the last reporting period, it was recommended that Indicator 38 (Seabed area swept by bottom-tending mobile research and monitoring gear within the MPA, both as a total and subdivided) and Indicator 39 (Length of lines of, and seabed occupied by, bottomset fixed commercial fishing, research and monitoring gear set within the MPA, both as a total and subdivided by seabed habitat type) be combined into: “Potential seabed area impacted by bottom-tending gear from commercial fishing and scientific research and monitoring within the MPA.”

Data was acquired from the MPA activity approval documents and the Ecosystem Trawl Survey data. One ecosystem trawl survey station set that was 1.78 nm in length occurred in the MPA in 2005. Other research activities with benthic interactions were described in Indicator 35.

Although there are uncertainties regarding the amount of total seabed area research activities occupied, it was expected to be very low due to the expected length and area of the intended interaction.

When collecting information for this reporting period, it was determined that there was sufficient data to assess Indicators 38 and 39 separately, as originally proposed.

Available data, analysis, and results

The degree of contact with the seafloor of mobile bottom-contacting gear is dependent on the design of the gear and its rigging, the tow speed, and the characteristics of the seafloor (Benoit et al., 2020). Additionally, the amount the gear penetrates the seabed will influence the amount and diversity of organisms affected. The Multispecies Trawl Survey gear is not designed to penetrate the substrate and has rollers that are intended to keep the gear from snagging on benthic features (personal communication, Don Clarke DFO Science, February 15 2021). The clearance for the bobbins and the footgear is approximately 10 inches, therefore features shorter than 10 inches should be able to pass underneath the trawl gear while features taller than 10 inches would interact with the gear and have the potential of being cut down. By comparison, the Snow Crab Trawl utilizes a modified Bigouden nephrops trawl net (Zisserson, 2015). This is a “digging” net designed to penetrate into soft bottom sediment therefore this net lacks rollers or rock hoppers.

Multispecies Trawl Survey data was acquired for the 2012-2020 time period from DFO Science Population Ecology Division (PED). This data consisted of trawl survey tow lengths which were mapped relative to the Gully MPA boundaries and benthic habitat classification developed by Cameron et al., (2008) (see Figure 38-1). Note, while data was acquired from 2012, the only records within the Gully MPA are from 2015 to 2020.

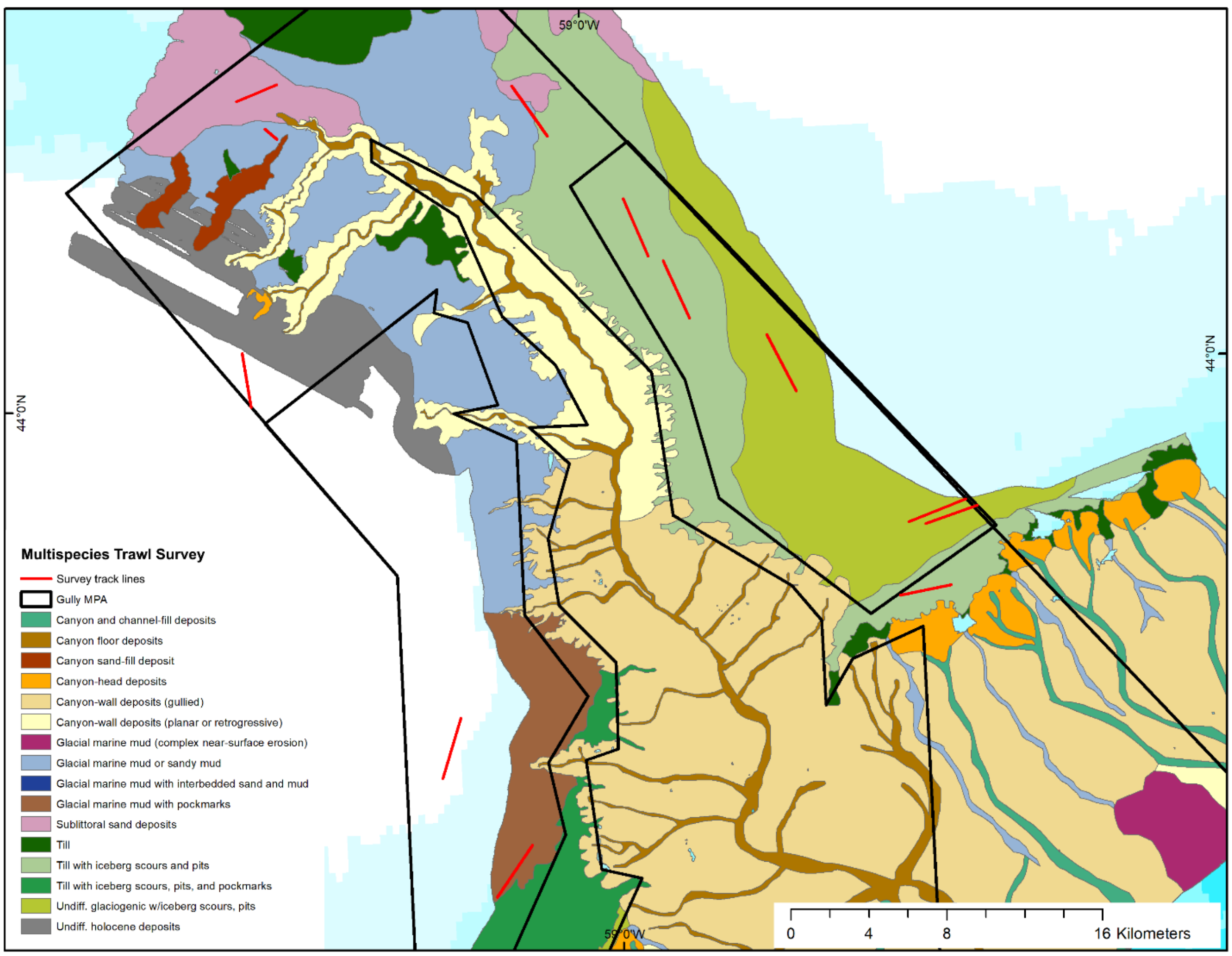


Figure 38-1: Multispecies Trawl Survey track lines from 2012-2020 on a bottom type classification dataset (Cameron et al. 2008).

Swept area was calculated using the methodology described in DFO (2018) and is summarized in Table 38-1. DFO (2018) provided the area swept by the average Ecosystem Trawl Survey which was multiplied by the length of the trawl track lines segments and then broken down by the various substrate classes intersected. DFO (2018) differentiates between the area swept by the trawl doors and the area swept by the net between the trawl doors. Additionally, the swept area was categorized by benthic type with five described benthic types being swept as well as the “unclassified substrate” category. In total, 1.935 km^2 of Zones 2 and 3 of the Gully MPA were swept by 12 trawls associated with the Ecosystem Trawl Survey from 2015 to 2020. The percentage of bottom type swept ranged from 0.042% of glacial marine mud or sandy mud to 0.553% of sublittoral sand deposits of the total of these bottom types within the Gully MPA. Note the trawl doors are calculated separately from the rest of the trawl gear because the potential impacts differ.

Table 38-1: Area of the Gully MPA swept by the Ecosystem Trawl Survey from 2015 to 2020 classified by the benthic type.

Bottom type	**Total area of bottom type in MPA (km^2)**	**Swept area between trawl doors (km^2)**	**Area swept by trawl doors (km^2)**	**Total area swept (km^2)**	**% of bottom type swept within the MPA**	**Number of survey trawls per bottom type[5]**
Glacial marine mud or sandy mud	253.964	0.024	0.082	0.106	0.042	2
Glacial marine mud with pockmarks	44.967	0.041	0.143	0.184	0.409	1
Sublittoral sand deposits	33.097	0.041	0.142	0.183	0.553	2
Till with iceberg scours and pits	149.493	0.132	0.458	0.59	0.395	4
Undiff. glaciogenic w/iceberg scours, pits	109.762	0.118	0.409	0.527	0.480	3
Unclassified substrate[6]	513.540	0.077	0.268	0.345	0.067	2
Total	**1,104.822**	**0.434**	**1.501**	**1.935**	**0.175**	**----**

[5] Note while 12 trawl surveys were conducted during the time period, some trawl track lines crossed over two or more substrate types.

[6] Likely Sable Island Bank sand according to an older dataset (Fader & King, 2003).

Data regarding the Snow Crab Survey locations within the Gully MPA during the 2012-2019 time period was obtained from DFO Science PED. The Snow Crab Survey consists of a fixed station survey design (Zisserson, 2015); therefore, it is expected that impacts of the survey will be consistent over time regarding locations and types of benthic environments trawled. PED provided track lines and the swept area calculations which were subdivided based on benthic type. Each survey trawl is five minutes in length at a speed of approximately two knots (Zisserson, 2015). Figure 38-2 displays the trawl track lines in relation to the Gully MPA boundaries and zones overlapping with the benthic type classification developed by Cameron et al., (2008) while Table 38-2 summarized the swept area by benthic type. A total of 0.103 km^2 of the Gully MPA was swept as a result of the Snow Crab Trawl Survey between 2012 and 2019. The percentage of bottom type swept ranged from 0.042% of glacial marine mud or sandy mud to 0.553% of sublittoral sand deposits.

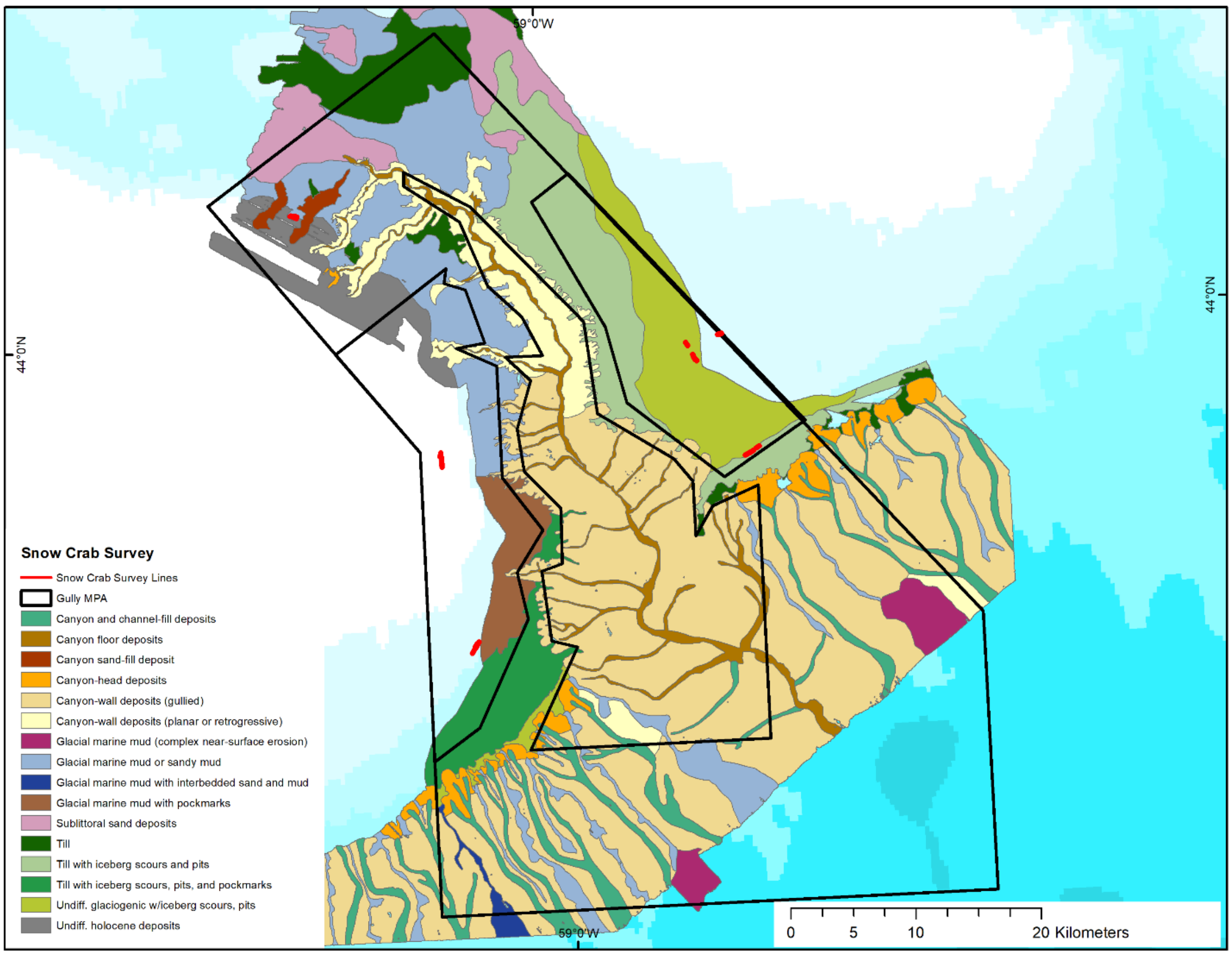


Figure 38-2: Snow Crab Trawl Survey track lines from 2012-2019 on a bottom type classification dataset (Cameron et al. 2008).

Table 38-2: Area of the Gully MPA swept by the Snow Crab Trawl Survey from 2012 to 2019 classified by the benthic type.

Bottom type	**Total area of benthic type in MPA (km²)**	**Area swept (km²)**	**% of benthic type swept within the MPA**
Glacial marine mud or sandy mud	253.964	0.002	0.001
Till with iceberg scours and pits	149.493	0.013	0.009
Undiff. glaciogenic w/iceberg scours, pits	109.762	0.029	0.027
Undiff. holocene deposits	62.521	0.015	0.024
Unclassified substrate[7]	513.540	0.044	0.009
Total	**1,089.279**	**0.103**	**0.068**

A much smaller swept area was calculated for the Snow Crab Trawl Survey compared to the Multispecies Trawl Survey over the same time period. A total of 2.038 km^2 of the Gully MPA was swept by survey trawls during the 2012-2020 time period. This is equivalent to 0.086% of the MPA. Comparisons with the previous reporting period are not possible due to the limited data previously available.

Evaluation of existing protocols and recommendations for the future

The data required for this indicator is regularly collected and communicated by DFO Science PED. No concerns with the existing protocols were identified, although further refinement of Gully MPA benthic classification would be beneficial. Additionally, future reporting on this indicator should consider a comparison of the Gully area sampled to the total area of each benthic class within the research survey strata.

INDICATOR 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

L. McConney and K. Rozalska

[7] Likely Sable Island Bank sand according to an older dataset (Fader & King, 2003).

Description

One of the key objectives of the Gully MPA is to protect coral and other benthic organisms, and the seabed habitats they depend upon. The only remaining seabed pressures are commercial longline fisheries for halibut, and approved scientific programs (e.g., benthic studies, trawl surveys, moorings).

This indicator addresses the location and size of areas on the seabed that are contacted by fishing activity by regulatory exception of Zones 2 and 3 fixed-gear fisheries and via Ministerial Approval as granted for scientific proposals. Impacts are inevitable and although the likelihood of causing significant damage or disturbance to sensitive benthic habitats and species has been minimized (i.e., by zoning <600 m depths for longline fisheries), the possibility for negative interactions remains, and hence the need for monitoring.

Summary from previous reporting period

It was recommended that Indicators 38 and 39 be combined into: "Potential seabed area impacted by bottom-tending gear from commercial fishing and scientific research and monitoring within the MPA." Details from the analysis are summarized in Indicator 38.

There is now sufficient data to address the two indicators separately as originally proposed, which was the approach taken for the current reporting period. During the data compilation and analysis for the current 2012-2018 period, it was noted that the previous report completed their analysis on a truncated dataset due to a technical error, therefore the complete dataset for 2005 to 2011 was re-analyzed and is described below.

Available data, analysis, and results

Commercial fishing

Calculations of the actual area swept by fishing gear are not feasible at this time due to the limitations of the Maritime Fishery Information System (MARFIS) data. Specifically, the fishing logbook entries only require one location per fishing set for the demersal longline fishery. While an average length of the fishing gear can be estimated, the direction in which the gear was laid is unknown, and therefore a calculation of actual area swept is not possible. Butler et al. (2019) estimated the footprint of the demersal longline fishery in the Maritimes Region using data from 2002 to 2017. During this study, four km transects were created in random directions originating at MARFIS landings points (Figure 39-1) and were overlaid with a two minute grid to depict general patterns of bottom longline gear. While this analysis was useful at the regional scale, the analysis was too coarse to provide meaningful information when viewed at a scale appropriate for Gully MPA monitoring.

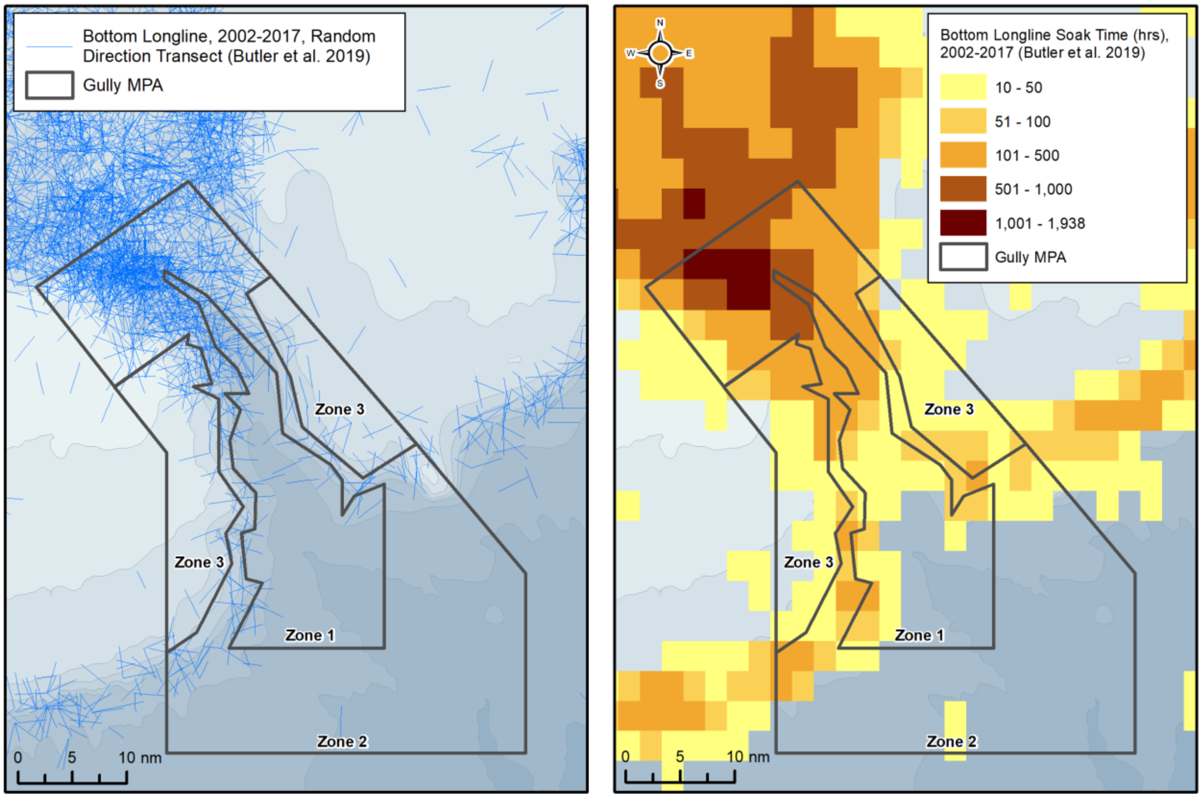


Figure 39-1: Randomly generated demersal longline transects and soak time (hours) based on logbook coordinates. Gully data for 2002-2017 extracted from products developed by Butler et al. (2019).

At-Sea Observer data provides more information regarding the location of fishing gear than data reported in MARFIS. Specifically, the At-Sea Observer data includes four coordinates: the location the first hook enters the water (P1); the location the last hook enters the water (P2); the start location for the recovery of the longline (P3); and the location where the last hook was removed from the water (P4) (Butler et al., 2019). Demersal longline fishing gear varies in length. Butler et al. (2019) used At-Sea Observer data from 1999 to 2017 determine the average distance between P1 and P2, essentially calculating the average length of the fishing gear. When targeting Atlantic Halibut, the average P1-P2 length value was 4.03 km. Where all other groundfish species were targeted, the average length was 2.38 km.

In accordance with the approach taken by Butler et al. (2019), the locations of P1 and P2 were plotted and joined by a straight line to estimate the footprint of the fishing gear from observed sets in the At-Sea Observer database from within and nearby the Gully MPA (Figure 39-2). From 2012 to 2018, there were 18 observed halibut longline fishing trips that included sets within the MPA. The length of the line drawn between P1 and P2 was compared with the reported longline length. Lines greater than 1.5 times or less than half of the reported length were removed as potential errors as was done by Butler et al. (2019). This resulted in the removal of three lines within the MPA that were less than half of the reported length. Additionally, based on DFO (2018), a lateral sweep of 0.1 km was added to better estimate the total swept area covered by the longline gear. Fixed fishing gear contacts the benthos during fishing but also laterally sweeps the ocean floor during gear deployment and retrieval (DFO, 2018b). This was done by creating a 50 m buffer on either side of each line. The total swept area of the MPA by observed fishing gear was 5.1 km^2. However, this calculation only includes the observed sets, therefore only a fraction of total fishing activity is included as approximately 5% of demersal longline sets in the MPA were observed from 2012-2018 (18 observed sets out of 386 total sets). This information provides additional context to the fished cell analysis conducted below.

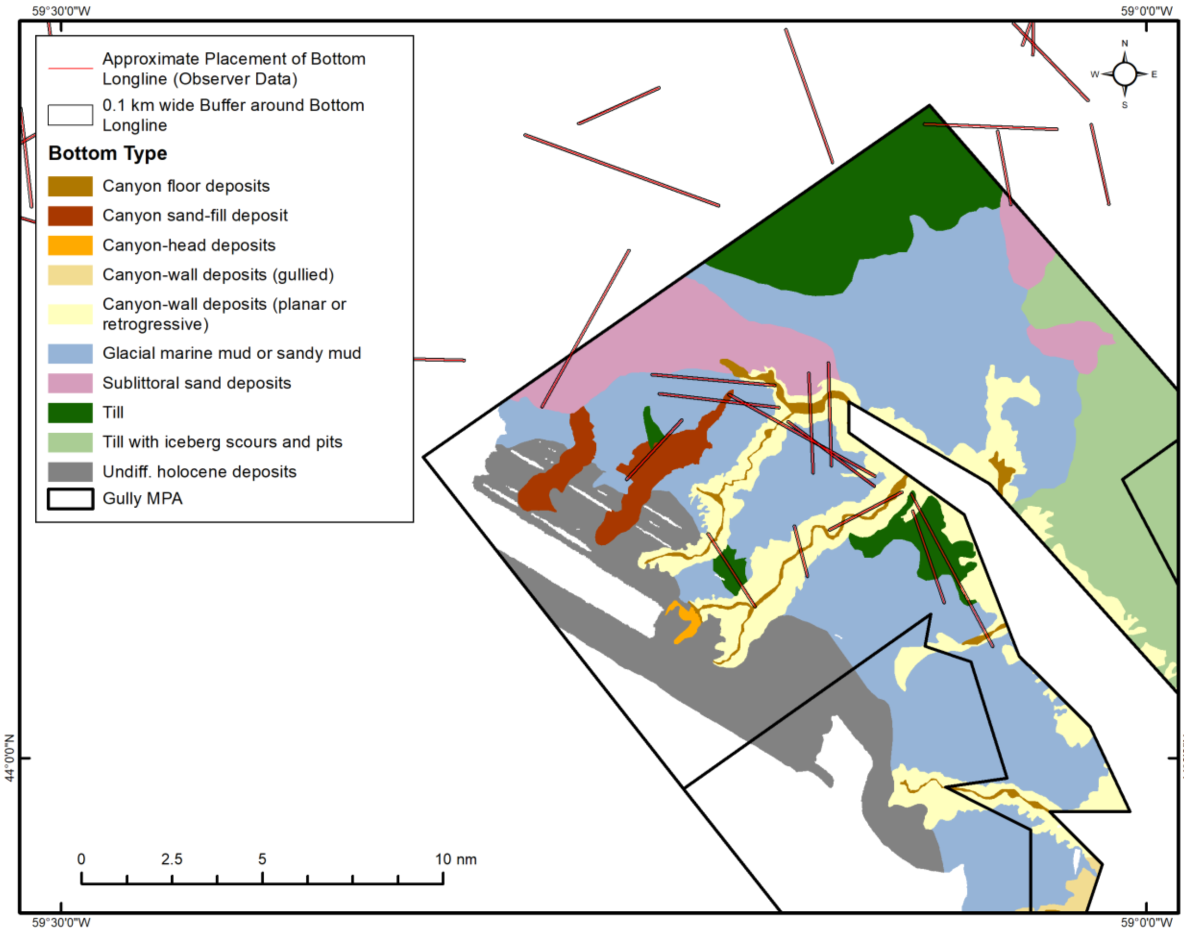


Figure 39-2: Approximate location of bottom longline fishing sets from 2012-2018 At-Sea Observer data. A 0.1 km lateral swept area has been added to account for movement of the fishing gear after it has been set and the gear locations have been overlaid on a bottom type classification dataset (Cameron et al., 2008).

Rather than using the entirety of Zones 2 and 3 as employed during the last reporting period, the maximum fishing depth of 1,000 m was used to identify the "fishable" area of the MPA. Zones 2 and 3 of the Gully contain 459 "fishable" 3 km^2 hexagonal grid cells (Figure 39-3), representing 1,103 km[8]. MARFIS data from 2005 to 2018 was acquired and the number of unique fishing sets for demersal longline were counted. Any MARFIS landings deeper than 1,000 m, or within Zone 1 of the Gully MPA were considered errors with respect to their location and were excluded from the data set. As a result, data from 47 of 942 fishing sets were removed from the analysis. During the study period (2012-2018), 122 of these cells contained at

[8] Note the number of cells includes those that touch Zone 2 and 3 and areas that are shallower than 1,000 m.

least one demersal longline set which is equivalent to approximately 26.6% of the "fishable" cells in the MPA having been fished by bottom-contacting fixed gear. The number of cells fished are broken down in Tables 39-1 and 39-2. The number of cells fished fluctuated annually from 2005 to 2018 with a general decreasing trend (Figure 39-4). As mentioned above, the 2005-2011 data was re-calculated because it was based on a truncated dataset and the current analysis only includes depths <1,000 m as "fishable" cells.

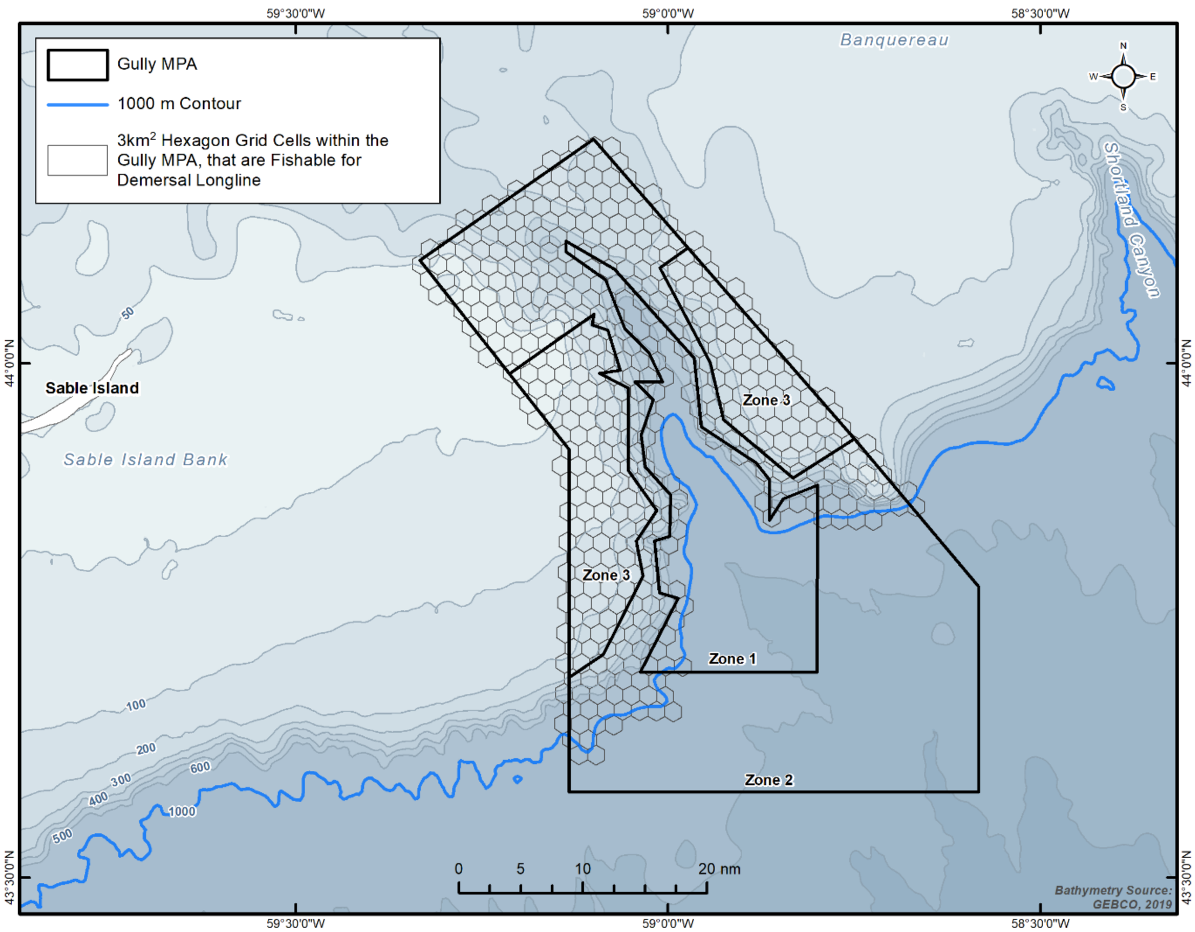


Figure 39-3: 3 km² hexagon cells within Zones 2 and 3 that are shallower than 1,000 m.

Table 39-1: Demersal longline fished cells from 2005 to 2011 in Zones 2 and 3 of the Gully MPA by number of cells and percent of fishable cells.

Year	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**Cumulative fished cells from 2005-2011[9]**
Number of fished cells	46	29	54	49	56	51	80	161
% of fishable cells	10.0	6.3	11.8	10.7	12.2	11.1	17.4	35.1

Table 39-2: Demersal longline fished cells from 2012 to 2018 in Zones 2 and 3 of the Gully MPA by number of cells and percent of fishable cells.

Year	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**Cumulative fished cells from 2012-2018[9]**
Number of fished cells	49	45	37	50	25	19	24	122
% of fishable cells	10.7	9.8	8.1	10.9	5.4	4.1	5.2	26.6

[9] Cumulative fished cells is not a sum of the fished cells for each year as many of the cells were fished in multiple years.

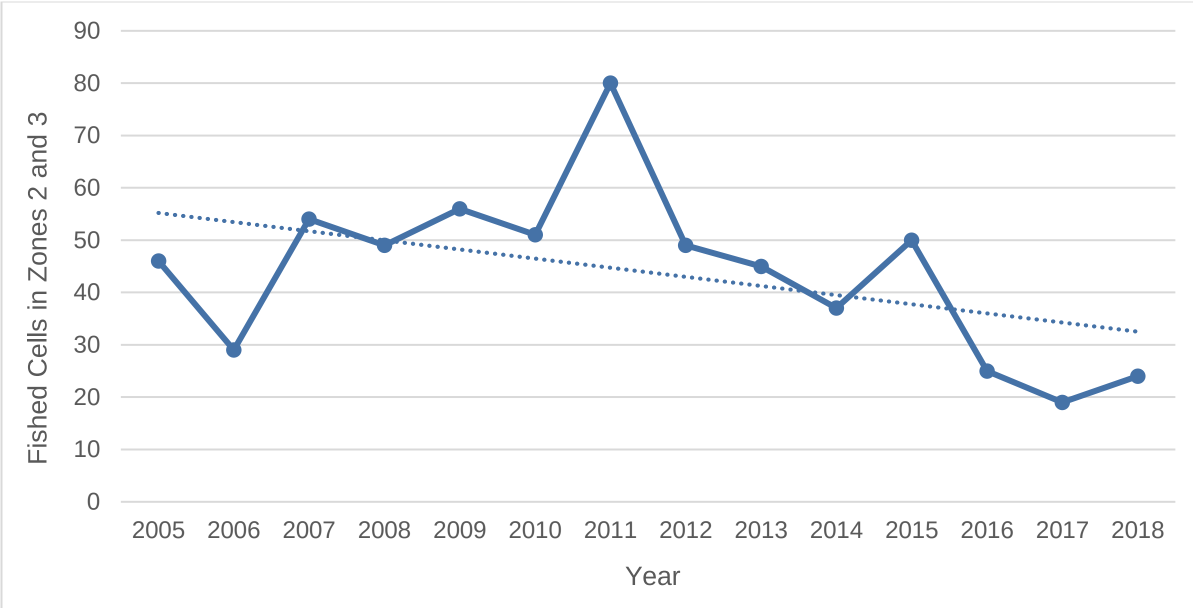


Figure 39-4. Demersal longline fished cells in Zone 2 and 3 of the Gully MPA from 2005 to 2018.

There were 386 demersal longline fishing sets from 2012-2018. Using the average longline length calculated by Butler et al. (2019) and the lateral swept area from DFO (2018):

386 fishing sets x 4.03 km longline length x 100 m lateral sweep = 156 km^2

156 km^2 is an approximation of the total swept area by bottom-tending commercial fishing gear in the Gully MPA from 2012-2018. This is approximately 14% of Zones 2 and 3 that are shallower than 1,000 m. Please note this calculation is based on an average longline length and does not take into consideration that swept areas likely overlap as the fishing effort is concentrated in different areas of the MPA.

One of the recommendations from the last reporting period was to include a consideration of benthic habitats in the analysis of data for this indicator. The demersal longline fishing data has been overlaid on top of the benthic classification data developed by Cameron et al. (2008) (Figure 39-5). The highest number of fished cells were associated with glacial marine mud or sandy mud. Till with iceberg scours and pits, till, canyon-wall deposits, and sublittoral sand deposits were also frequently fished. Table 39-3 summarizes the substrate of the fishable cells within the MPA. Every substrate type, except for one (glacial marine mud with interbedded sand and mud) had some fishing activity.

It is important to note that the following analysis is based on a data simplified approach to estimate coverage and should not be interpreted as an exact calculation of area swept. Since demersal longline fishing gear is often several kilometres long, it is likely that the fishing gear would cross over several benthic types and interact with a much longer area than described by the fished cells. However, since the lateral swept area for demersal longline is anticipated to be 100 m, the hexagons may exaggerate the area contacted since the hexagons are 3 km^2 whereas a single longline covers approximately 0.4 km^2.

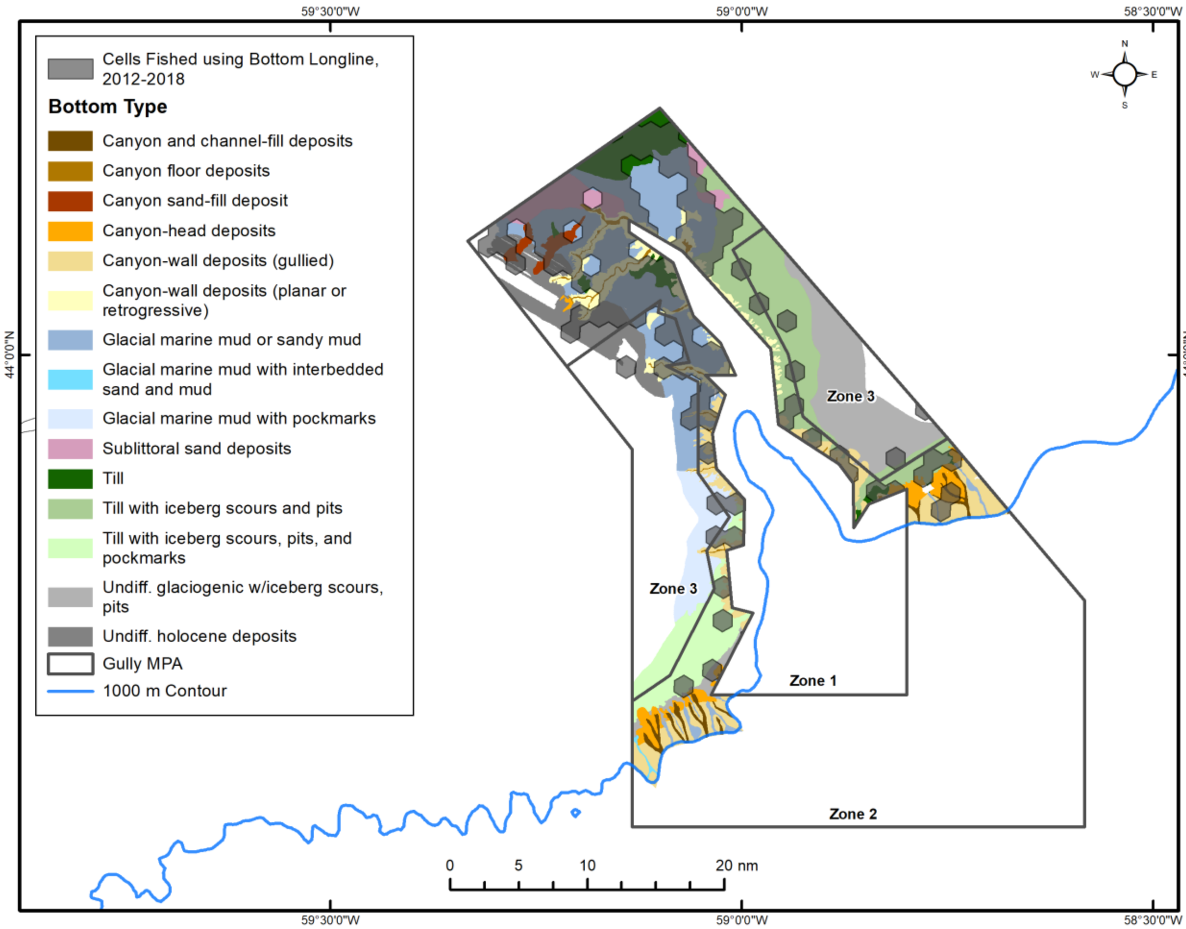


Figure 39-5: Demersal longline fished cells from 2012 to 2018 displaying bottom type classification (Cameron et al,. 2008) and the 1,000 m contour line used to differentiate "fishable" and "non-fishable" areas.

Table 39-3. Total and percentage of 'fishable' area (Zones 2 and 3 that are less than 1,000 m depth) of the Gully MPA broken down by bottom type.

Bottom Type	**Area (km^2)**	**%**
No Data	203.1	18.4
Glacial marine mud or sandy mud	193.9	17.6
Till with iceberg scours and pits	147.3	13.4
Undiff. glaciogenic w/iceberg scours, pits	109.4	9.9
Canyon-wall deposits (gullied)	80.5	7.3
Till with iceberg scours, pits, and pockmarks	68.6	6.2

Undiff. holocene deposits	62.5	5.7
Canyon-wall deposits (planar or retrogressive)	55.7	5.1
Till	45.6	4.1
Glacial marine mud with pockmarks	45.0	4.1
Sublittoral sand deposits	33.2	3.0
Canyon-head deposits	26.5	2.4
Canyon and channel-fill deposits	12.1	1.1
Canyon sand-fill deposit	10.7	1.0
Canyon floor deposits	7.6	0.7
Glacial marine mud with interbedded sand and mud	1.3	0.1
Total	**1,103.0**	**100**

In conclusion, while the exact seabed area impacted by bottom-tending commercial fishing is difficult to calculate due to data limitations, based on available information and the analyses described above, a best estimate of fishable area for the demersal longline fishery is 1,103 km^2 of the MPA, and approximately 156 km^2 was fished during the 2012-2018 time period. More detailed fisheries reporting would be required for a more accurate calculation as a source of error caused by the single MARFIS point is that many of the sets recorded inside the MPA spanned lengths that went outside of the MPA, conversely, there were likely many points recorded outside the MPA that had portions of longline inside the MPA.

Scientific research and monitoring

An Industry-DFO Joint Longline Halibut Survey was initiated on the Scotian Shelf in 1998 to improve estimates of adult Atlantic Halibut biomass (DFO, 2014). The Industry-DFO Longline Survey is completed by commercial fish harvesters and consists of two components: fixed survey stations and commercial index (Cox et al., 2018). The fixed stations are surveyed with onboard observers and while the survey originally consisted of a fixed station stratified design, it is in the process of transitioning to a randomly stratified design (personal communication, Peter Comeau DFO Science, September 21 2020). While participating in the survey, fish harvesters are asked to follow fishing protocols (e.g., minimum distance from station, hook size, number of hooks, and minimum soak times) but there is still some variation (DFO, 2014). Furthermore, while the longline survey is being conducted, fish harvesters also participate in a commercial index which is considered a proxy for commercial fishing. The commercial index allows fish harvesters to fish at the locations of their choosing with some variations from the survey protocol, including using more hooks, longer soak times, and variation in bait. Some commercial index trips have full observer coverage onboard while for other trips the observer collects the biological data when fish is brought to port (personal communication, Peter Comeau DFO Science, September 21 2020).

At-Sea Observer data from 2012 to 2018 was obtained and analyzed to determine the benthic area the Industry-DFO Joint Longline Halibut Survey equipment interacted with. Based on the methodology developed in DFO (2018), a lateral swept distance of 0.1 km was added to the length of the fishing gear (P1 to P2) to estimate the swept area associated with the survey. Lines greater than 1.5 times or less than half of the reported length were removed as potential errors as was done by Butler et al. (2019). This resulted in the removal of four out of a total of 61 lines. Figure 39-6 maps the approximate placement of the fixed station survey sets and the commercial index trips with full observer coverage from 2012-2018.

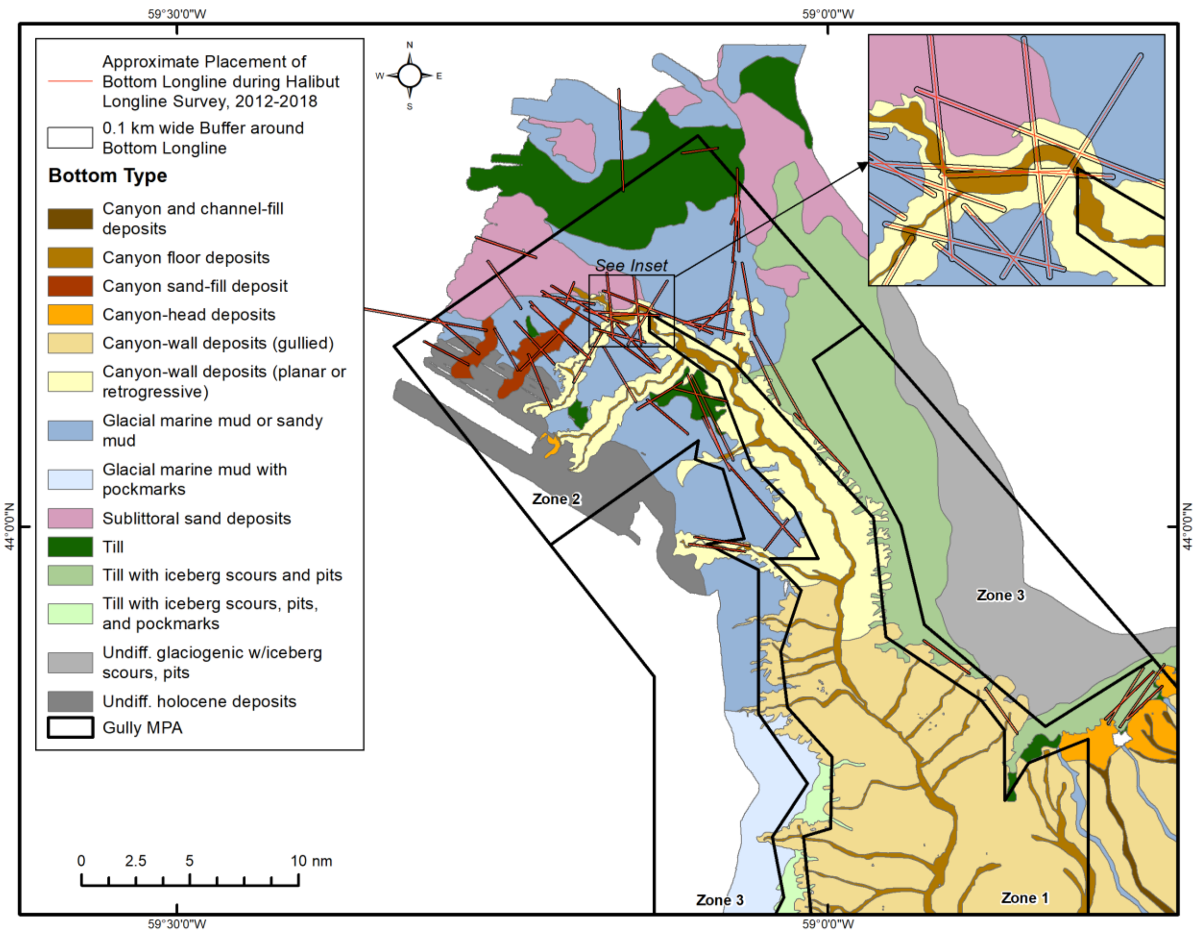


Figure 39-6: Approximate location of bottom longline fishing sets from 2012-2018 Industry-DFO Joint Longline Halibut Survey with At-Sea Observers on the vessels (fixed sampling stations and commercial index). A 0.1 km lateral swept area has been added to account for movement of the fishing gear after is has been set and the gear locations are depicted on a bottom type classification dataset (Cameron et al., 2008).

Based on the At-Sea Observer dataset, the Industry-DFO Joint Longline Halibut Survey (fixed stations and commercial index sets with At-Sea Observers onboard) interacted with approximately 20.04 km^2 of Zone 2 of the Gully MPA. Table 39-4 breaks down this area by bottom type, with the majority of the activity occurring in glacial marine mud or sandy mud, much like the commercial Atlantic Halibut fishery.

Table 39-4. Bottom area contacted by Industry-DFO Joint Longline Halibut Survey (fixed stations and commercial index sets with At-Sea Observers onboard) classified by bottom type and not duplicating the overlapping areas.

Bottom Type	Area (km^2)
Glacial marine mud or sandy mud	9.62
Till with iceberg scours and pits	2.82
Canyon-wall deposits (planar or retrogressive)	2.55
Till	1.49
Sublittoral sand deposits	0.98
Canyon sand-fill deposit	0.84
Canyon floor deposits	0.57
Undifferentiated holocene deposits	0.52
Canyon-wall deposits (gullied)	0.40
No Data	0.18
Canyon-head deposits	0.07
Total	**20.04**

Over the time period, some of the survey sets overlapped, therefore when quantifying the total area of the Gully that the survey interacted with (including areas that were swept multiple times), the area is 21.24 km^2.

Figure 39-7 demonstrates the one coordinate provided for the commercial index sets that were brought to port before being observed. Like the commercial fishing data, the port samples do not have the two coordinates necessary to approximate the swept area relative to bottom type but use the same calculation as above with the commercial fishing:

64 port samples x 0.1 km lateral sweep x 4.03 km average longline length = 25.8 km^2

25.8 km^2 is an estimate of the total swept area by port sampled fixed station survey sets and commercial index trips.

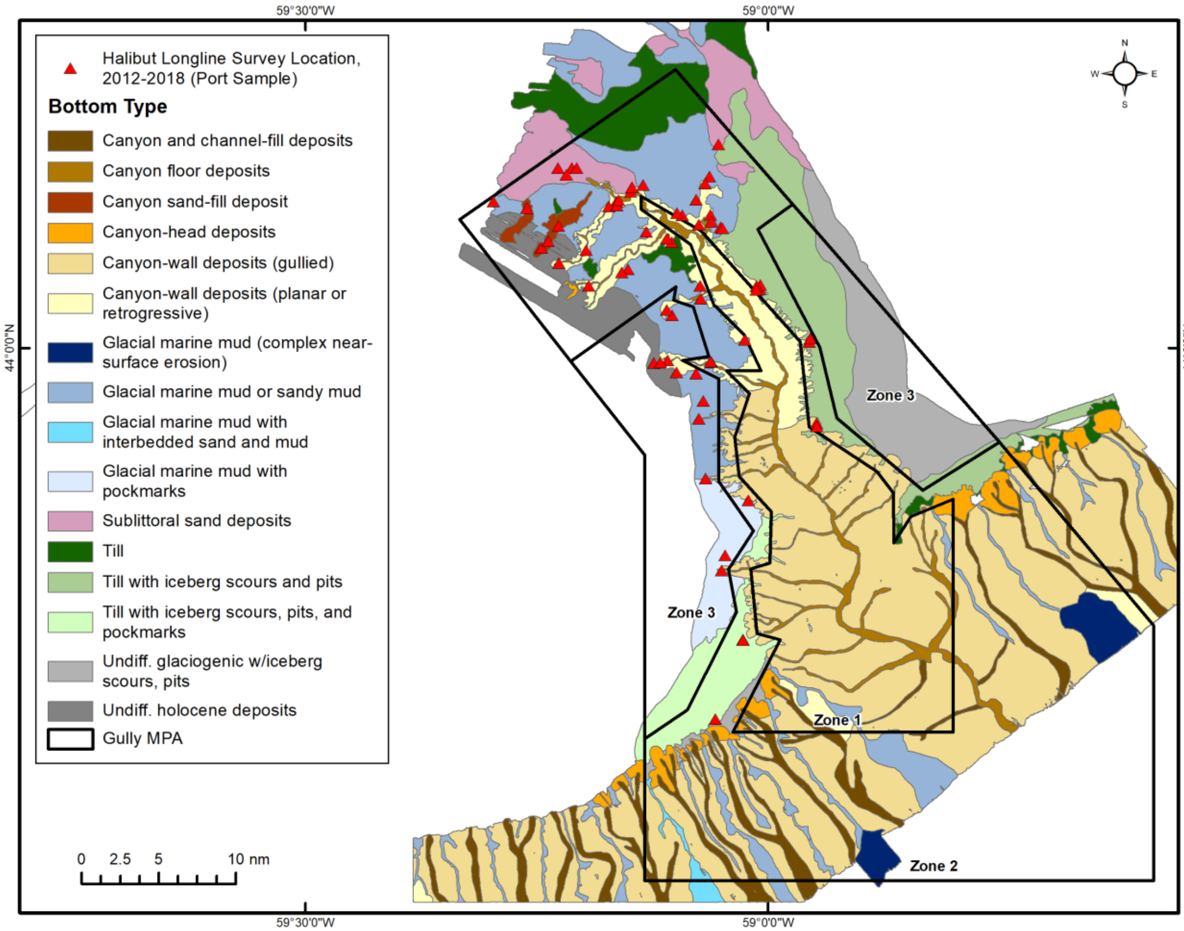


Figure 39-7: Approximate location of bottom longline fishing sets from 2012-2018 Industry-DFO Joint Longline Halibut Survey that are sampled at the port. The one coordinate associated with each sample is depicted on a bottom type classification dataset (Cameron et al., 2008).

Another bottom-set fixed research program is the passive acoustic monitoring (PAM) program conducted by DFO Science Team Whale. The program consists of PAM recorders attached to moorings deployed in the Bay of Fundy and along the Scotian Shelf to increase understanding of cetacean occurrence off Nova Scotia to better assess and mitigate potential threats to cetaceans in our waters. Figure 39-8 illustrates the mooring locations in the Gully MPA overlaying the benthic classification dataset (Cameron et al., 2008).

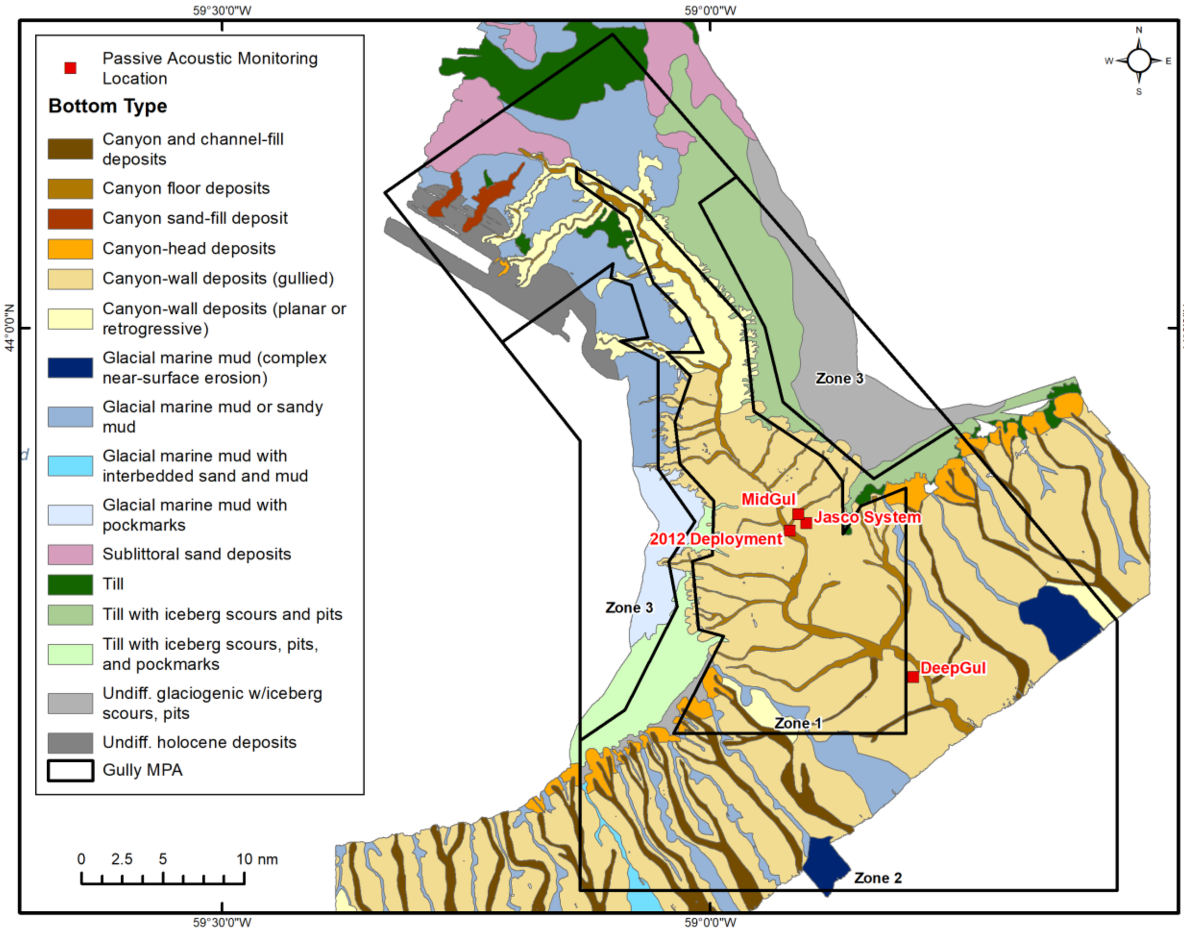


Figure 39-8: Approximate location of PAM moorings from 2012 to present. The one coordinate associated with each sample is depicted on a bottom type classification dataset (Cameron et al., 2008).

PAM moorings have been deployed at the "MidGul" location annually since 2012. While deployment is targeted at the exact same coordinates every year, exact deployment coordinates will vary year-to-year based on currents and weather but are generally within a few hundred meters of the targeted location. In 2013, a JASCO system was deployed in addition to the "MidGul" location. A mooring was placed at the "DeepGul" location in 2017.

The mooring system sits on the ocean floor for 11-14 months, but the ballast weight attached to the system is left on the ocean floor permanently. Each ballast weight affects an area of less than 1 m^2, therefore from 2012 to present, less than 11 m^2 of benthic habitat has been impacted by this activity. Mooring locations are within the canyon floor deposits and the canyon-wall deposits benthic type. It is noted that current changes around the weights may result in a broader footprint of impacts, but this is currently not quantifiable.

Evaluation of existing protocols and recommendations for the future

Fish harvesters are required by licence to submit data on fishing activity to DFO using fishery-specific monitoring documents (logbooks). As part of the reporting requirements for groundfish longline, one set of geographic coordinates must be provided for each set fished. Geographic coordinates provided in these reports are often rounded to the nearest arc minute. Logbook data are submitted by industry as a condition of licence and stored in MARFIS. The single coordinate per set poses a challenge as it does not allow for accurate calculations of area impacted by longline fishing gear.

Using a gridded approach of set locations is the most efficient way of determining overall fishing presence. However, more work is required to address the actual contact of fishing gear on the seafloor, subsequent movements and related seafloor impacts. Furthermore, an increase in observer coverage for fishing trips in the Gully MPA, and/or additional logbook reporting requirements (e.g., set deployment and retrieval coordinates) for fisheries active within the MPA would expand available datasets and improve approaches for monitoring the benthic impacts of bottom-tending commercial fishing gear.

INDICATOR 40: NUMBER AND TYPES OF OFFSHORE PETROLEUM EXPLORATION AND DEVELOPMENT ACTIVITIES (E.G., NUMBER OF WELLS, PLATFORMS, ETC.) ON THE EASTERN SCOTIAN SHELF

L. McConney and G. Pardy

Description

Exploration, development and production activities being conducted in the region surrounding the MPA include seismic surveys and reservoir assessment, geophysical hazard surveys, delineation wells, platform and pipeline construction, commercial extraction and vessel operations providing project support, standby, and resupply. Industry activities in adjacent waters pose uncertain and unquantified risks to the MPA. This indicator provides a general snapshot of activities for managers and scientists working on the MPA.

The Canada-Nova Scotia Offshore Petroleum Board (CNSOPB) is an independent joint agency created by the Governments of Canada and Nova Scotia (CNSOPB, 2020a). The CNSOPB ensures compliance with the *Canada-Nova Scotia Offshore Resources Accord Implementation Acts* (*Accord Acts*) and their supporting regulations. Responsibilities of the CNSOPB include protection of the environment, management and conservation of petroleum resources, and issuance of licences for exploration and development.

Summary from previous reporting period

Geospatial data was acquired from the CNSOPB and proximity mapping (within 10 km and 50 km of the Gully MPA) was conducted with data pre-MPA establishment (1967 to May 2004) and post-MPA establishment (May 2004 to present).

Seismic surveys: Seismic programs that occurred within 50 km of the Gully prior to MPA establishment (1999 to 2003) were mapped. At the time of report submission, DFO was working with CNSOPB to update the offshore petroleum data holdings, including any new seismic survey data.

Drilled wells: Since 1972, 37 wells have been drilled within 50 km of the Gully MPA, three of which are located within the MPA boundaries. Between May 2004 and September 2012, three gas wells were drilled within 50 km of the MPA.

Development and significant discovery licences: The Sable Offshore Energy Project was the only offshore petroleum development project with operations located within 50 km of the Gully MPA with two active fields within the assessment area. In 2012, there were three Call for Bids areas, one exploratory licence and 19 significant discovery licences within 50 km of the Gully MPA.

Available data, analysis, and results

DFO’s Marine Planning and Conservation (MPC) Program regularly receives offshore petroleum activity data from the CNSOPB and utilized data from October 2012 to March 2020 in this analysis.

The data allows for proximity mapping within 10 km and 50 km of the Gully to determine the nature and intensity of various offshore petroleum activities that have occurred in close proximity to the canyon. While the 50 km assessment area was initially chosen arbitrarily, the same assessment area was utilized for this reporting period for consistency.

Figure 40-1 depicts the locations of platforms, significant discovery licences, production licences and exploratory licences within 50 km of the Gully MPA. Figure 40-2 depicts the location of seismic surveys on the Scotian Shelf relative to the Gully MPA from 2012 to 2020.

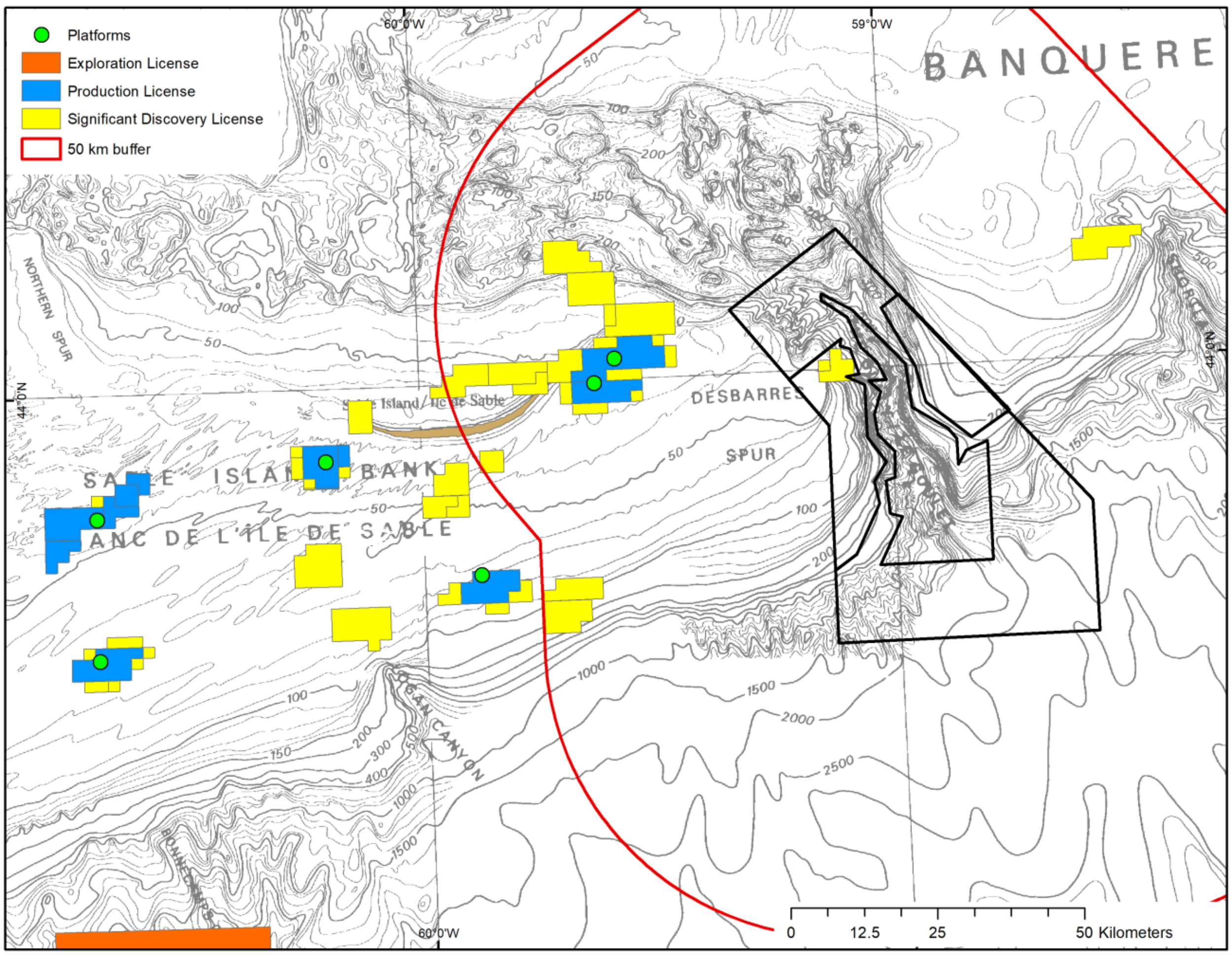


Figure 40-1: Locations of platforms, significant discovery licences, production licences and exploration licences relative to the Gully MPA.

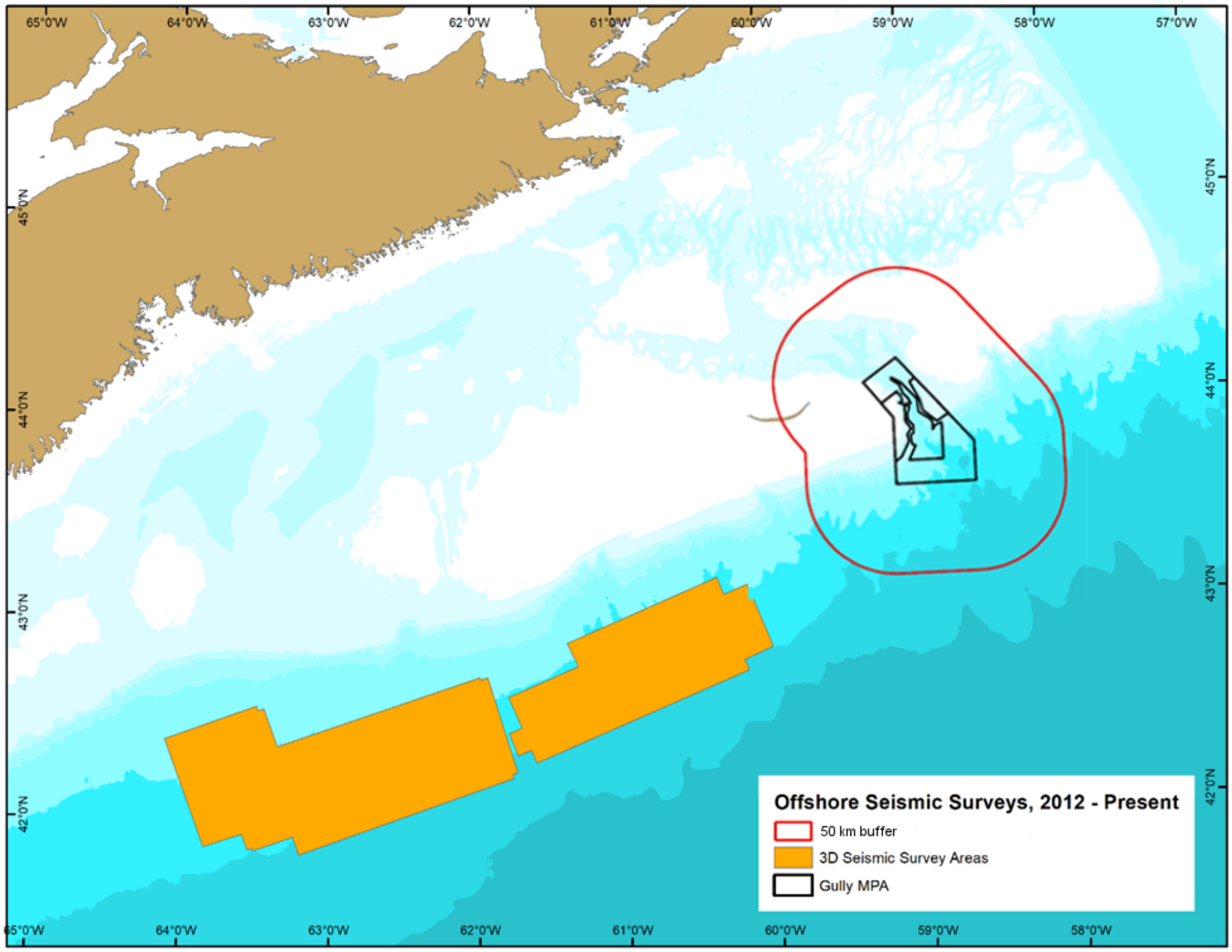


Figure 40-2: Location of seismic surveys conducted 2012-2020 on the Scotian Shelf relative to the Gully MPA.

Significant Discovery Licences: There are 20 licences within 50 km of the Gully, of which three are within 10 km of the site boundary and two licenses awarded in 1990 exist inside the Gully boundary. Significant discovery licences do not have an expiration date (CNSOPB, 2020b).

Production Licences: There are two licences within 50 km of the Gully MPA boundary, the closest being approximately 13 km from the site (Figure 40-1). A production licence has a term of 25 years but can be extended (CNSOPB, 2020b).

Seismic surveys: Two seismic programs have occurred on the Scotian Shelf since the last reporting period, but both were outside of the 50 km assessment area (Figure 40-2).

Drilled wells: Three wells have been drilled on the Scotian Shelf since 2012 but none of them are located within the 50 km assessment area (Figure 40-1).

Sable Offshore Energy Project: In 2017, ExxonMobil began plugging and abandonment of 21 production wells, and shutdown production in December 2018 (CNSOPB, 2020c). Decommissioning and removal of the offshore platforms located at each of the five offshore fields fully commenced in 2019 and all facilities were removed by November 2020 (Figure 40-1). This project is in permanent production shutdown.

Scotia Basin Exploration Drilling Project: In 2014, BP Canada completed 3D wide azimuth seismic surveys over their exploration licences (CNSOPB, 2020d). In 2018, BP Canada received authorization to drill an exploration well (Aspy D-11). BP Canada exploration licences expired January 14, 2022 (Figures 40-1 and 40-2).

Deep Panuke Offshore Gas Development Project: Operated by Ovintiv Canada (previously known as Encana), production began August 2013 (Figure 40-1) and operated seasonally until it was permanently shut down in May 2018 (CNSOPB, 2020e). The project was decommissioned by October 2020.

Evaluation of existing protocols and recommendations for future

The data required for this indicator is regularly collected and communicated from the CNSOPB to the MPC Program at DFO. No concerns with this data source were identified.

Due to the conservation priorities of the Gully MPA, specifically protecting whales and dolphins from the impacts of human activities, monitoring of seismic activities should continue and may be worthy of special attention in the future as knowledge surrounding the distance at which impacts to beaked whales improves.

INDICATOR 41: NUMBER, QUANTITIES AND TYPE OF DISCHARGES FROM OFFSHORE PETROLEUM INSTALLATIONS AND ACTIVITIES ON THE EASTERN SCOTIAN SHELF

L. McConney

Description

Industry activities in adjacent waters pose uncertain and unquantified transboundary risks to the MPA. This indicator is focused on spills, the class of industry-related discharges most likely to flow across the MPA boundary and contaminate the Gully.

Discharges associated with these offshore petroleum installations and activities include those typical of marine transportation as noted below for Indicators 42 and 43 (i.e., ballast water exchange and oily discharges) and those associated with wellhead operations (e.g., produced water, drill muds and cuttings).

Summary from previous reporting period

The previous reporting period analyzed spill data within 50 km of the Gully MPA from January 2000 to September 2012 during pre-MPA establishment and post-MPA establishment periods. From January 2000 to September 2012, discharges associated with offshore petroleum activities occurring within 50 km of the Gully have included accidental releases of diesel fuel, hydraulic oil, lubricating oil, other unclassified oils, condensate, and synthetic muds. The largest volumes released were diesel (385.5 L), hydraulic oil (194 L) and condensate (183 L, including one spill of 128 L in November 2011). There were a total of 797 L of spills since 2000, of which 304.2 L was spilled post-MPA establishment.

Available data, analysis, and results

Quality-controlled discharge data associated with offshore petroleum activities, including date, volume, location and source, is available from the Canada-Nova Scotia Offshore Petroleum Board (CNSOPB) website. In the 2012 reporting, data for spills located within 50 km of the Gully MPA from January 2000 to September 2012 were analyzed. This update focuses on discharges within 50 km of the Gully from October 2012 to April 2020.

Table 41-1: Spills within 50 km of the Gully MPA (January 2000 to March 2020)

Spill Substance	**Spill Volume Pre-MPA 2000-May 2004 (L)**	**Spill Volume Post-MPA May 2004-September 2012 (L)**	**Spill Volume October 2012 to April 2020 (L)**	**Total Spills (L)**
Diesel	385	0.5	2.00	**387.5**
Hydraulic oil	91	103	0.039	**194.039**
Lubricating oil	0.1	0	0.073	**0.173**
Condensate	1.9	181.1	0.02	**183.0232**
Oil (unclassified)	12.9	0.5	---	**13.4**
Synthetic-based muds	1.8	19.2	---	**21**
Hydrocarbon sheen	---	---	<0.001	**<0.001**
Methanol	---	---	---	**0**
Unknown hydrocarbon	---	---	---	**0**
Hydraulic fluid	---	---	0.002	**0.002**
Foam	---	---	---	**0**
Mono-ethylene Glycol (MEG)	---	---	---	**0**
Total spill volumes (L)	**492.7**	**304.3**	**2.14**	**799.135**

From October 2012 to April 2020 there were 8 spills within 50 km of the Gully MPA varying in size from <1 mL to 2 L.

No unauthorized discharge (e.g., incidental releases) occurred from April 1, 2018 to March 31, 2020 within 50 km of the Gully MPA[10]. This includes substances such as: oil-in-water, synthetic-based mud, and blowout preventer fluid.

Evaluation of existing protocols and recommendations for future

Operators are required to report environmental and health and safety incidents to the CNSOPB in accordance with criteria set out in regulation, as detailed in the Guideline for the Reporting and Investigation of Incidents (CNLOPB and CNSOPB, 2009).

[10] Note CNSOPB began posting this information publicly in November 2017, therefore information from the following two complete fiscal years were included.

There are no recommendations for improvement at this time.

INDICATOR 42: NUMBER AND QUALITY OF SHIPS' BALLAST-WATER EXCHANGES CONDUCTED WITHIN OR IN CLOSE PROXIMITY TO THE MPA

G. Pardy and E. Will

Description

Ballast water is carried in tanks onboard vessels and is taken up or discharged to ensure stability under varying loads and conditions at sea (Transport Canada, 2019). Ballast water may contain pollutants, bacteria and other microbes, micro-algae, and aquatic plant and animal species (eggs, larvae, adults) from source waters (Transport Canada, 2019). A major concern with ballast water is that its release may result in the accidental introduction of aquatic invasive species.

The International Convention for the Control and Management of Ships' Ballast Water and Sediments, 2004, is a treaty adopted by the International Maritime Organization (IMO) to help prevent the spread of potentially harmful aquatic organisms and pathogens from ships' ballast water (IMO, 2019). In 2010, Canada acceded to this convention, requiring all ships that travel internationally to manage their ballast water (Environment and Climate Change Canada [ECCC], 2020). The requirement for all ships to have on-board ballast water treatment systems under the Convention's ballast water management standards will be phased in by 2024. In the meantime, for vessels without ballast water treatment systems, lower salinity coastal waters taken up at port must be exchanged with higher salinity waters offshore. This will serve to reduce the spread of invasive species, as coastal species are unlikely to survive in the open ocean and vice-versa.

Canada is currently developing new Ballast Water Regulations under the *Canada Shipping Act, 2001* to bring the Convention into force in Canada (ECCC, 2020). Until the new regulations take effect, Canada will continue to apply the existing *Ballast Water Control and Management Regulations*, which prescribe acceptable management practices and reporting requirements, and lay out spatial rules and restrictions for ballast water exchange in Canadian waters. As per the *Ballast Water Control and Management Regulations*, vessels on transoceanic voyages cannot discharge ballast water taken onboard outside Canadian waters unless it has been exchanged with mid-ocean water at least 200 nm from shore where depths reach at least 2,000 m. For non-transoceanic voyages (e.g., international routes from the eastern seaboard of the United States), vessels may discharge ballast water sourced from outside Canadian jurisdiction in Canadian waters if the source water is taken from an area at least 50 nm from shore where water depth is at least 500 m. Alternative exchange areas may be used for vessels that cannot meet the above requirements due to circumstances that would compromise the stability or safety of the vessel or the safety of persons on board the vessel. The alternative exchange area nearest to the Gully MPA includes offshore waters south of 43°30' N latitude where the water is at least 1,000 m deep (shown in Figure 42-1).

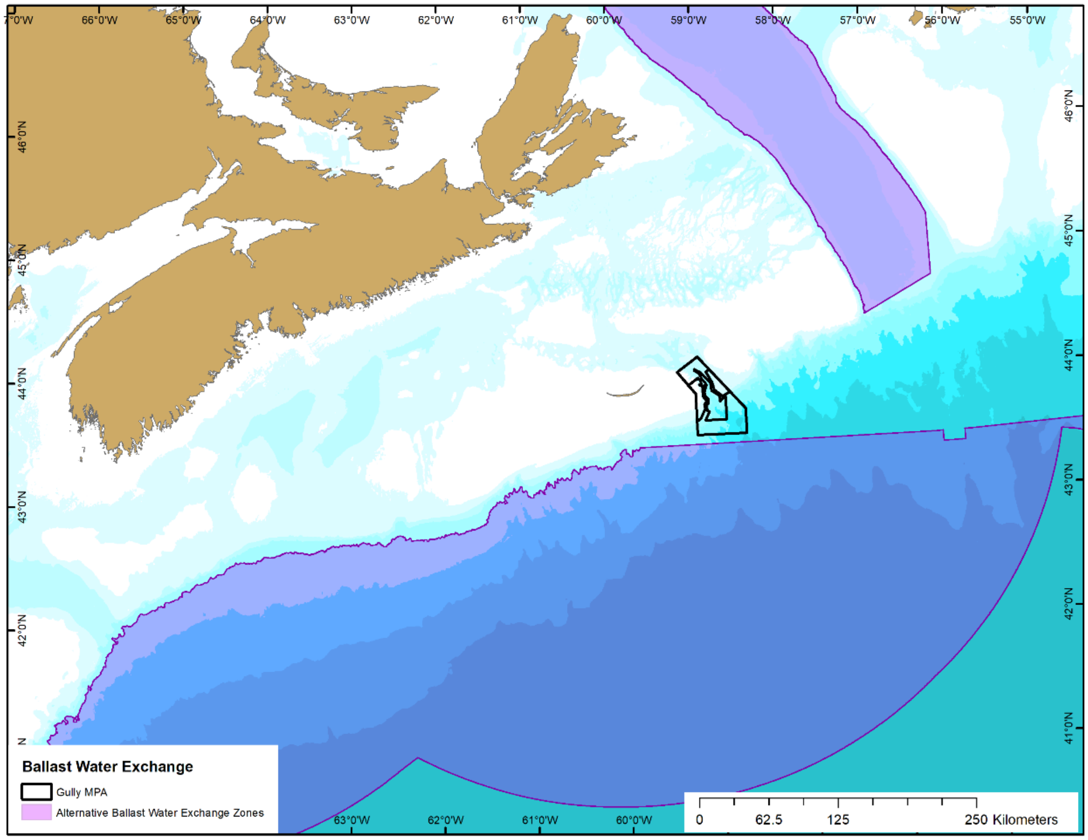


Figure 42-1. Alternative ballast water exchange zones nearest the Gully MPA, as described in the Ballast Water Control and Management Regulations (SOR/2011-237).

Summary from previous reporting period

Ballast exchange data from 2007 to 2009 were acquired from Transport Canada's Marine Safety Program. Ballast exchange track lines or points were mapped as compliant or anomalous based on spatial rules outlined in the *Ballast Water Control and Management Regulations*. This classification provides some indication of the quality of water undergoing exchange (e.g., an anomalous exchange within the Gully may represent an exchange of water sourced from a coastal port). In 2007, six vessels had exchange tracks that crossed or ended within the Gully MPA. In 2008, 11 vessels had exchange tracks that crossed the MPA boundaries. In 2009, 17 exchange tracks that crossed the MPA boundaries were reported. Most exchange tracks that passed through the Gully MPA in each of the three years were classified as anomalous. Compliant exchanges were those where ballast water was sourced from an acceptable distance offshore, or an otherwise acceptable location within Canadian waters as outlined in the *Ballast Water Control and Management Regulations*.

The majority of the exchanges within the Gully MPA from 2007-2009 were vessels originating from ports along the east coast of the United States destined for ports in Nova Scotia, Newfoundland or Quebec. Because the Gully is located just north of the Scotian Shelf alternative exchange zone, many of the track lines passing through the MPA began exchanging within an acceptable area but completed the exchange north and eastward along the shelf edge beyond the alternative exchange zone. It was determined that in these cases, vessels were most likely exchanging their ballast using the flow-through method, which involves pumping water through full ballast tanks (as opposed to completely emptying and refilling tanks). The

Ballast Water Control and Management Regulations require that vessels conducting flow-through exchanges must pump enough water through each tank so that three times the volume has been exchanged, therefore these exchanges can take a considerable amount of time over long distances. It was assumed that by the time the vessel had left the designated exchange zone and was passing through the MPA, the concentration of pollutants and non-indigenous species that was discharged from the ballast tanks would have likely been low compared to concentrations released at the start of the exchange. Furthermore, it was assumed that the Gully is not highly susceptible to the introduction of non-indigenous species from near shore environments given that it is primarily deep-water habitat. There are currently no reports of invasive species within the Gully MPA, but there are also no invasive species-related monitoring activities in the area (see Indicator 46).

Available data, analysis, and results

Vessels bound for Canadian ports must report the status of their ballast tanks and the management activities that have been conducted on their ballast and tanks to Transport Canada's Marine Safety Program. Data from these reports are entered into a central database housed within the Institute for Big Data Analytics at Dalhousie University. Atlantic ballast water exchange data from January 2010 to December 2019 were provided by Dalhousie University. All ballast records that included any activity within a 50 km buffer around the Gully MPA were pulled from the database. For the purposes of this analysis, the relevant information for each vessel's ballast exchange were the departure port, destination port, location of ballast source, date of ballast exchange, and start and stop coordinates of any exchange conducted.

Each ballast exchange in the dataset was mapped, assuming a straight course between the reported start and stop coordinates for the exchange. The majority of exchanges near the Gully MPA were conducted within an alternative exchange area described in the *Ballast Water Control and Management Regulations*, though many tracks can be seen outside of the designated exchange area, including some within the Gully (see Figure 42-2).

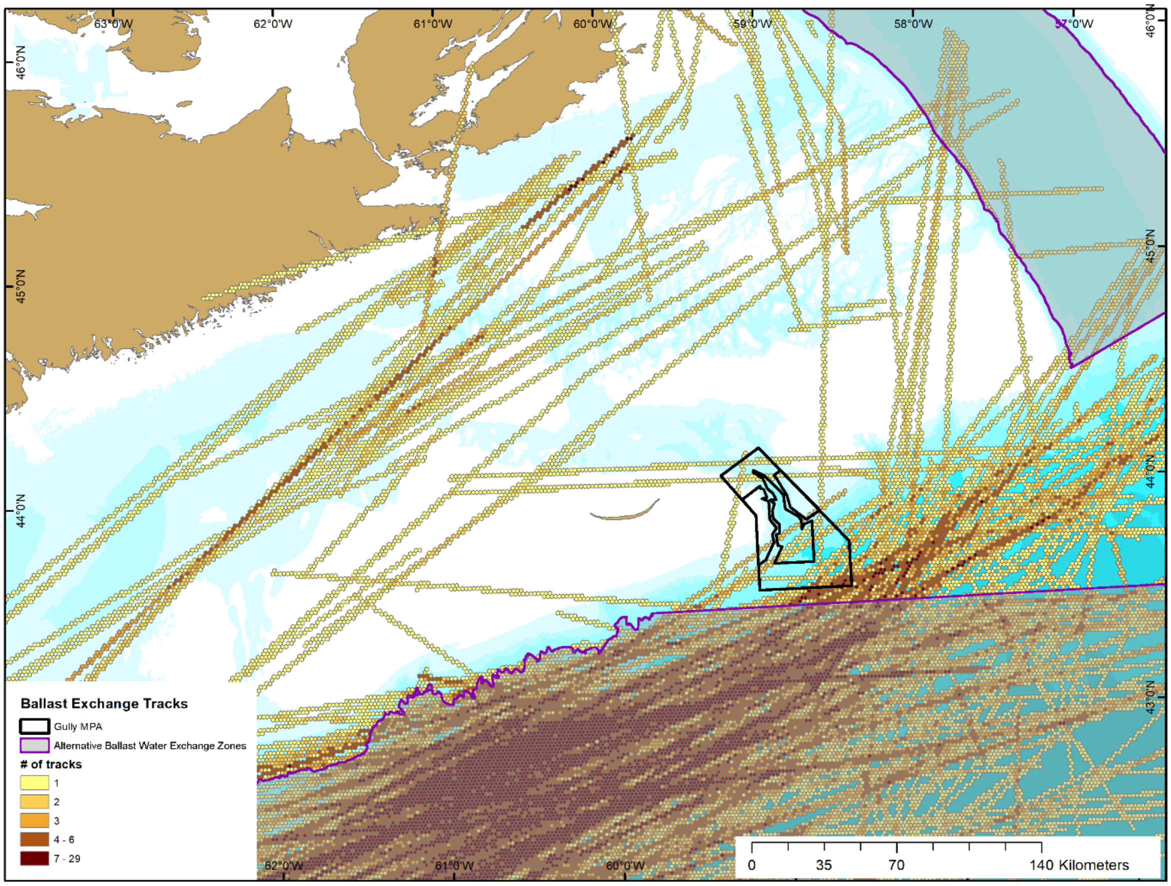


Figure 42-2. Ballast water exchange activity near the Gully MPA on the Scotian Shelf, from 2010 to 2019.

There were a total of 22 vessels with ballast exchange tracks that crossed through the Gully MPA between 2010 and 2019 (Table 42-1). As at least some part of these vessels' exchange was conducted outside of the designated alternative exchange zone, the exchanges were either classified as compliant or anomalous based on the ballast source location reported. Twenty out of 22 exchanges were considered anomalous. This averages out to two anomalous exchanges per year within the Gully MPA over the 10 year period.

All vessels departed from ports along the north-eastern coast of the United States except one, which departed from Gibraltar. In some cases, ballast source was not reported and these exchanges were assumed to be anomalous (e.g. ship number 11). For vessel 21, ballast was sourced from a location meeting the criteria in the *Ballast Water Control and Management Regulations* for some tanks onboard, and from port-sourced waters for other tanks. As not all of the tanks met the requirements for compliant exchange outside of a designated alternative exchange zone, the exchange for vessel 21 was characterized as anomalous. It should be noted that in early 2019, vessel 20 was issued a "Response to Contravention" letter from Transport Canada Marine Safety. This letter identified the three tanks of non-compliant ballast that were discharged contrary to section 7 of the *Ballast Water Control and Management Regulations*, and the potential consequences for any future violations.

Table 42-1. Vessels that exchanged ballast water within the Gully MPA from 2010 to 2019. A/C refers to anomalous (A) and compliant (C) exchanges.

Ship #	Year	Vessel Type	Ballast Source (# of tanks exchanged)	A/C	Departure Port	Arrival Port
1	2010	Oil tanker	Boston, MA (2)	A	Boston, MA	Come by Chance, NL
2	2010	Oil tanker	Portland, ME (2)	A	Portland, ME	Whiffen Head, NL
3	2010	Oil tanker	Boston, MA (1)	A	Boston, MA	Come by Chance, NL
4	2010	NLS tanker	Portland, ME (4)	A	Portland, ME	St Mary's Bay, NL
5	2010	Oil tanker	Port Reading, NJ (2)	A	Port Reading, NJ	Quebec
6	2010	NLS Tanker	Boston, MA (2)	A	NY and NJ	Come by Chance, NL
7	2010	NLS Tanker	NY and NJ (2)	A	NY and NJ	Come by Chance, NL
8	2011	Bulk Carrier	Portland, ME (4)	A	Portland, ME	Port Cartier, QC
9	2012	Oil tanker	NY and NJ (6)	A	Bayonne, NJ	Montreal, QC
10	2013	Oil tanker	Boston, MA (1)	A	Boston, MA	Come by Chance, NL
11	2015	Oil tanker	Not specified (1)	A*	New Haven, CT	Belledune, NB
12	2015	Chemical tanker	Not specified (6)	A*	Searsport, ME	Come by Chance, NL
13	2015	Chemical tanker	Quebec (4) Non-port waters (2)	A	Port Reading, NJ	Montreal, QC
14	2015	Bulk carrier	Non-port waters (1)	C	Boston, MA	Montreal, QC
15	2015	Oil tanker	Not specified (Not specified)	A*	Delaware City, DE	Come by Chance, NL
16	2016	Bulk carrier	Not specified (1)	A*	NY and NJ	Belledune, NB
17	2018	Oil tanker	NY and NJ (2)	A	NY and NJ	Come by Chance, NL
18	2018	General cargo/ multipurpose	Non-port waters (4)	C	Fairless Hills, PA	Sorel, QC
19	2018	General cargo/ multipurpose	Torre Annunziata, Italy (3)	A	Gibraltar	Sorel, QC
20	2019	Double hull oil and chemical carrier	Providence, RI	A	Providence, RI	Come by Chance, NL
21	2019	Oil and chemical tanker	Boston, MA (4) Non-port waters (3)	A	Boston, MA	Valleyfield, QC
22	2019	Oil tanker	New York, NY (2)	A	New York, NY	Come by Chance, NL

**Anomalous exchange assumed due to non-specified ballast source.*

Reported ballast water exchanges that crossed through the Gully MPA were mapped separately for each year (Figure 42-3). In some cases it appears that exchanges began within the alternative exchange zone and carried on outside of the zone and into the MPA. Flow-through exchanges can take a considerable amount of time over long distances as three times the volume for each tank must be exchanged. It is therefore likely that in some cases, the vessels were nearing the end of their exchanges while crossing through the Gully. In these instances, the concentration of viable organisms being discharged from the ballast tanks would likely be low. In other cases, such as in years 2011 and 2016, exchanges appeared to both stop and start outside of the exchange zone. These exchanges could have contained higher concentrations of coastally-sourced organisms.

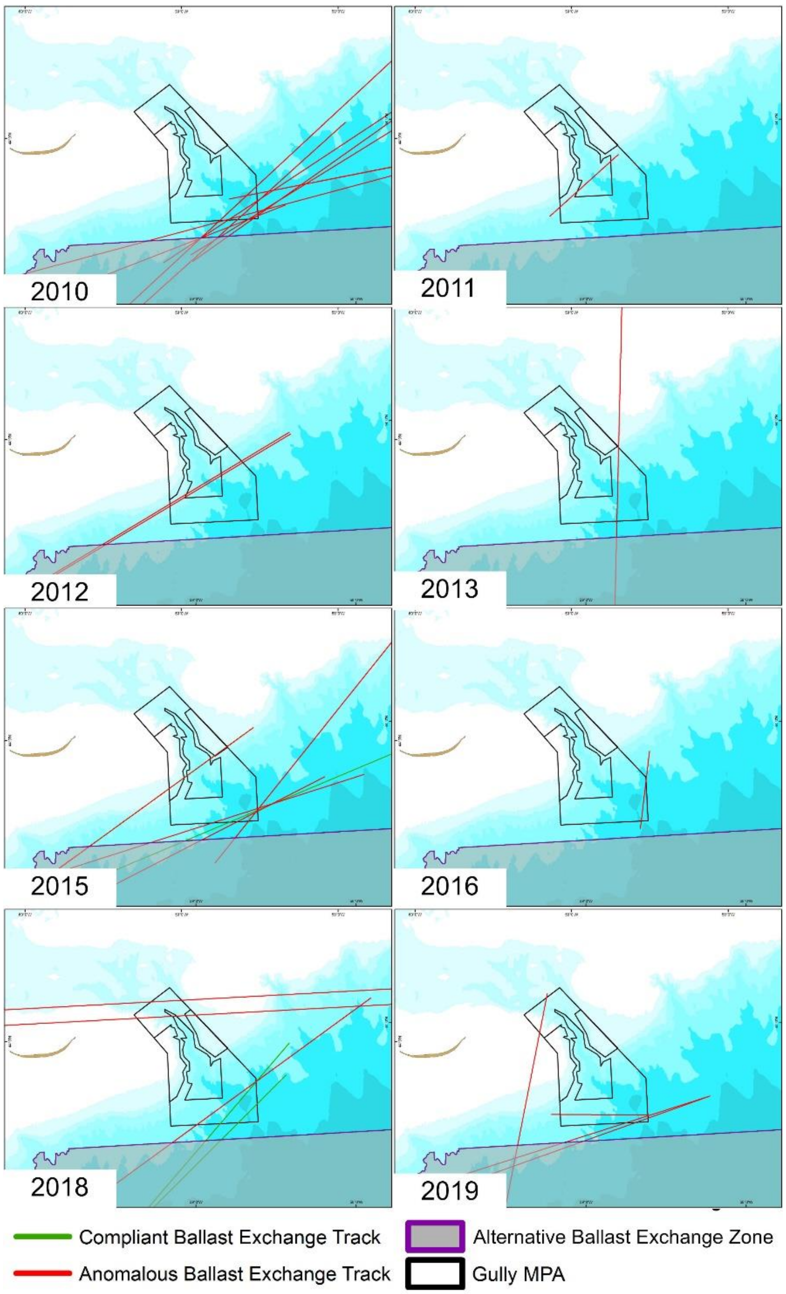


Figure 42-3. Ballast water exchanges within the Gully MPA from 2010 to 2019.

Evaluation of existing protocols and recommendations for future

There are exceptions within the *Ballast Water Control and Management Regulations* that allow for ballast exchange to be carried out under special circumstances, including if the uptake or release of ballast water is necessary for the purpose of ensuring the safety of the vessel in an emergency situation or safety of life at sea. Therefore, there could be exchanges carried out within the Gully MPA due to emergency circumstances that would not be explained within the dataset. There is also potential for errors in the data from either the vessels reporting the exchanges or from the entry of the reports into the Dalhousie University database. Prior to 2018, ballast reports were scanned from paper forms and then entered into the database, which may have increased the occurrence of errors. As well, because the exchange track lines represent an inferred, straight line route between ballast exchange start and end points rather than the actual path of each ballast exchange, it is possible that vessels took a longer route to avoid discharging their ballast within the MPA. In future analyses, AIS data could be used determine more precise locations of ballast exchanges.

Through a separate region wide inquiry, one 2018 ballast exchange record that crossed through the Gully MPA was identified that was not captured in the Gully monitoring ballast exchange records described above. This error could indicate potential for missing records in the original database queries. More detail on issues related to data access and recommendations for future access are described below.

The data required to perform the analyses described here are collected as part of a program led by another government department. Transport Canada provides monitoring and oversight of ballast water management activities to ensure compliance with the ballast water reporting and management requirements in the *Ballast Water Control and Management Regulations*. The development and ongoing maintenance of the ballast water database is supported by a collaborative agreement with Dalhousie University that is set to end by March 2023. DFO can access the reporting data, but that access is currently limited due to the ongoing development of the database analytics functions. It is recommended that DFO and Transport Canada develop a longer-term strategy for the support and maintenance of the database beyond 2023 that includes access to the data in real time. A second recommendation is to conduct a risk assessment to better understand the risk from species released in ballast water to the Gully ecosystems. A decision-support tool developed by DFO researchers in partnership with Transport Canada (Bradie and Bailey, 2020) can be used to develop risk estimates of non-indigenous species establishment.

INDICATOR 43: NUMBER, QUANTITY AND SOURCE OF OILY DISCHARGES FROM MARINE TRANSPORTATION WITHIN OR IN CLOSE PROXIMITY TO THE MPA

L. McConney and G. Pardy

Description

Impacts associated with oil spills are well understood and are a threat to the marine environmental quality of MPAs. Transport Canada and the Canadian Coast Guard manage oil spill incidence detections and reporting, respectively. Transport Canada is the lead agency for the National Aerial Surveillance Program (NASP), which is the principal surveillance mechanism for the detection of at-sea oil pollution. The NASP uses a range of tools to detect at-sea oil spills including side-looking airborne radar, infrared/ultraviolet line scanners, geo-coded digital cameras and electro-optical infrared cameras, and satellite-based vessel tracking. The Canadian Coast Guard manages the Marine Pollution Incident Reporting System (MPIRS), which tracks oil spill incident reports from a variety of sources including harbor authorities, surveillance personnel, self-reporting from the polluter, and reports from the general public.

Apart from accidental spills, discharges containing oil are an inevitable result of routine seagoing operations. Operational discharges containing oil can be a result of bilge water evacuation, slop tank releases, onboard sewage or waste treatment, and ballast water exchanges. Transport Canada's *Vessel Pollution and Dangerous Chemicals Regulations*, outlines provisions including acceptable concentrations of oil to be related as part of operational discharges to reduce and control vessel-sourced discharges.

Vessels of all types and sizes, including merchant marine and fishing boats are prone to system failures, inadequate containment and the leakage of fuels, lubricants, hydraulic fluids and related petrochemicals. A host of additional discharges, including ballast water as described in the preceding indicator, are a result of routine operations. This indicator is intended to detect, monitor and track oil spills and the oily components of other discharges.

Summary from previous reporting period

All of Transport Canada's NASP oil spill sightings in Atlantic Canada from April 1, 2007 to December 31, 2011 were mapped. During 2011, 31 flights passed over or in close proximity (within approx. 50 km) of the Gully MPA which equates on average, 2.6 flights per month. The nearest documented spills were over 100 km away from the Gully MPA.

Available data, analysis, and results

NASP pollution sightings data for Atlantic Canadian waters was obtained by request from Environment and Climate Change Canada. Variables in the dataset included detection date and time, location (latitude and longitude), estimated volume and spill source (if known). This program is ongoing and data holdings are updated in a central database on an annual basis. NASP sightings data were available from April 1, 2012 to November 27, 2017.

All NASP oil spill sightings from April 1, 2012 to November 27, 2017 were mapped. Figure 42-1 focusses on the area of the Scotian Shelf surrounding the Gully MPA. Graduated colours were used to indicate estimated spill volumes at each location.

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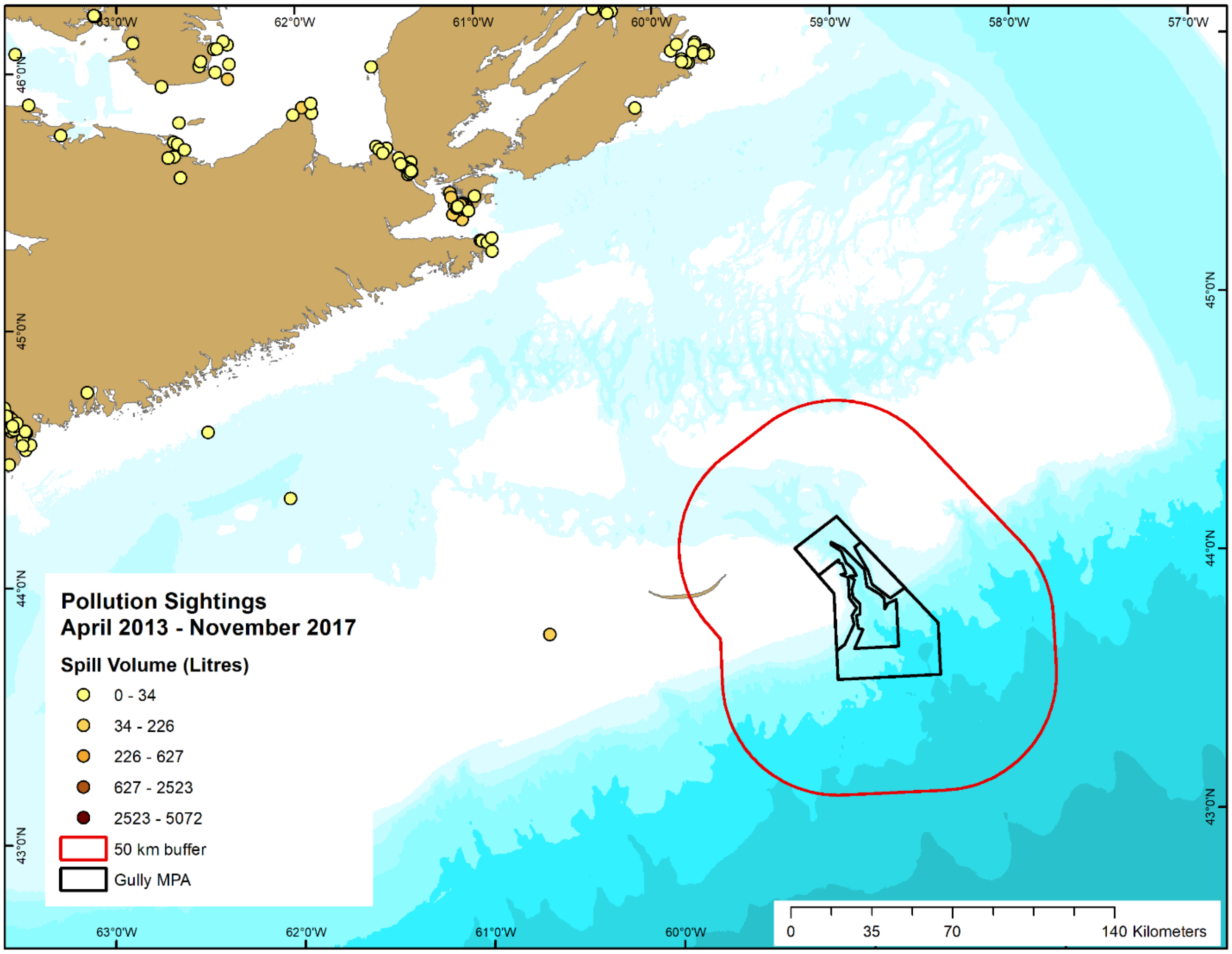

Figure 43-1: NASP pollution sightings from April 2012 to November 2017 in the vicinity of the Gully MPA. The red line denotes a 50 km buffer.

During 2019, 19 flights passed through or close to (within approximately 50 km) the MPA, which equates to 1.58 flights per month. The nearest documented spills were approximately 124 km away from the Gully MPA.

All the MPIRS sightings from 2013 to 2017 were mapped. Figure 42-2 focuses on the area of the Scotian Shelf surrounding the Gully MPA. Estimated spill volumes were occasionally provided.

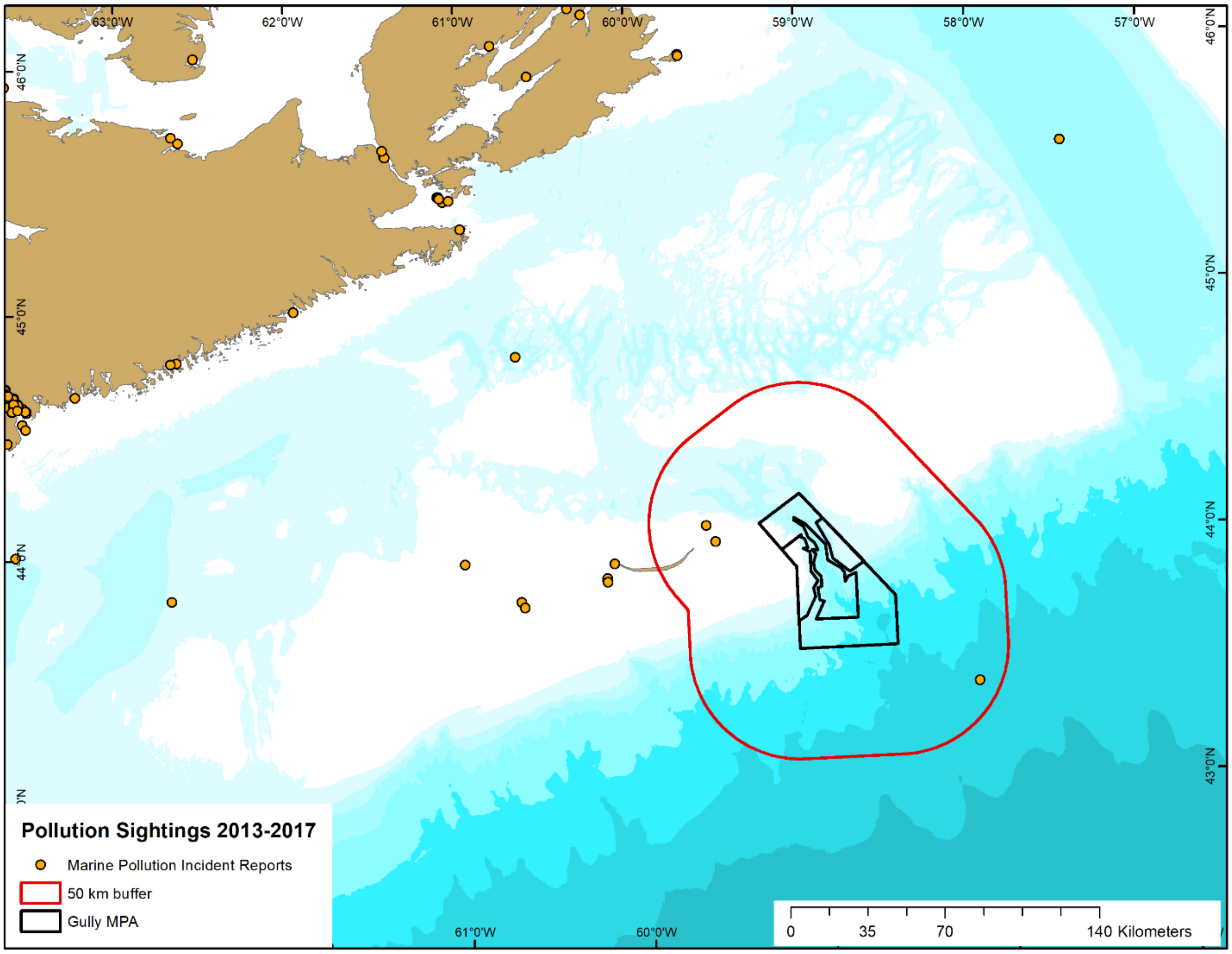

Figure 43-2: 2013-2017 MPIRS pollution sightings in the vicinity of the Gully MPA. The red line denotes a 50 km buffer.

Three sightings were observed within 50 km of the Gully MPA: approximately 1 L of crude oil; approximately 0.03 L of hydraulic oil; and an unknown volume of Bunker C fuel oil 6. There were no sightings reported within the MPA boundaries during this time.

Evaluation of existing protocols and recommendations for future

Data on operational vessel-sourced discharges are limited. While the NASP provides data for tracking oil spill detections, oil spill investigations are inherently limited by the vast territory covered by the single airplane based in Moncton, New Brunswick with a variety of department priorities – for example in the last few years, there has been an increased focus on aerial surveillance of the Gulf of St Lawrence to monitor North Atlantic Right Whales.

INDICATOR 44: QUANTITY OF FLOATING DEBRIS IN THE GULLY MPA

L. Feyrer, H. Whitehead, L. McConney, and G. Pardy

Description

Floating debris is a growing threat now recognized in the open ocean, especially in places where oceanographic features have the potential to retain and accumulate material. Plastic and other synthetic materials compromise water quality and pose an entanglement threat to both resident and transitory cetaceans in the MPA. Additionally, large plastic debris has been discovered in the digestive tracts of cetaceans where it can cause blockages and eventually result in starvation (Jacobsen et al., 2010). Other animals, including seabirds and at-risk turtles (Nelms et al., 2016) are particularly susceptible to the negative effects of plastic ingestion. Recording visual observations of debris coincident with cetacean surveys is a low-cost means of monitoring this pervasive threat.

Plastic degradation is minimal so large plastic items only degrade to increasingly smaller pieces, eventually becoming microplastics (<5 mm) and nanoplastics (Andrady, 2011). These smaller plastics also pose a risk to priority species in the MPA. Microplastics have been detected in the tissues of beaked whales (Lusher et al., 2018). Microplastics contain contaminants and additional contaminants can adhere to them while in the water column (Gallo et al., 2018) which can lead to chemical bioaccumulation in tissues and result in negative health impacts (Lusher et al., 2018).

Summary from previous reporting period

At the time of the last reporting, there was no ongoing monitoring program to collect information about floating debris in the Gully. However, work conducted in 1990 (Dufault and Whitehead, 1994) was examined as a case study and model for monitoring going forward. In Dufault and Whitehead (1994), 20 transects of varying length for large debris were conducted in the Gully and surrounding. 14 of the transects occurred at the mouth of the Gully and would have been within the current MPA boundaries. The average density of large debris was reported as 31.6 items/km^2 in the Gully region. Types of large debris included: plastic bags, nylon rope, and potato chip bags. Neuston net tows were used to survey for small debris, with 17 tows of approximately 1.8 km length conducted within the current Gully MPA boundaries. Debris was found in 80% of net tows and the average density of small debris was 1.20 x10^{-5} g/m^2. Types of small debris included: small pieces of polystyrene, textile fibres, fishing line and cellophane.

Available data, analysis, and results

Assessment of large debris

Surveys following the same protocols as Dufault and Whitehead (1994) were conducted in 1996, 1997, and 1999, and more recently in 2016 and 2019. The results of these debris surveys have been analysed for trends over time. Figure 44-1 shows the locations of the debris transects conducted in 2016-2019 and where incidental debris observations were made. Table 44-1 summarizes the survey results and describes the debris observed.

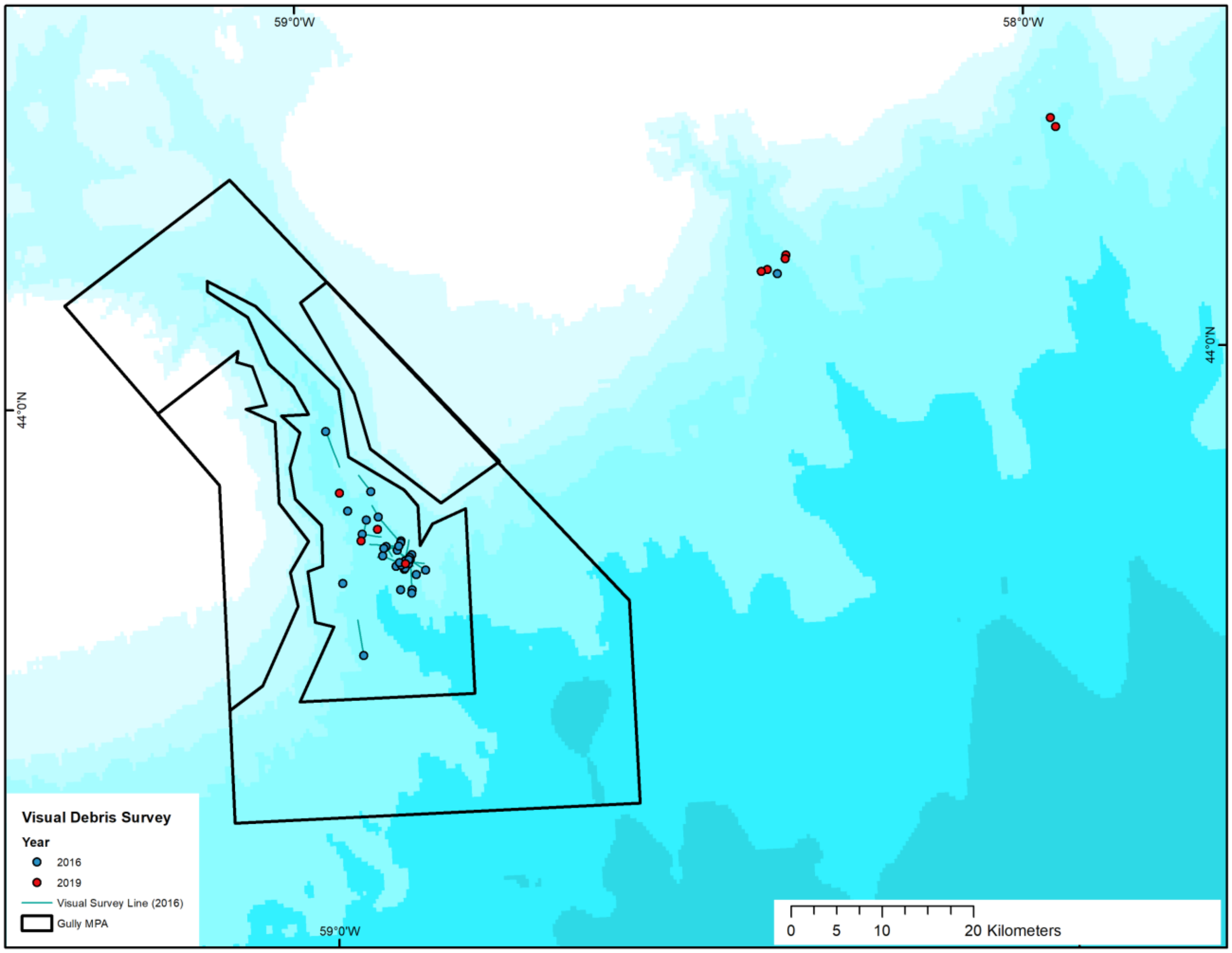

Figure 44-1: Locations of floating debris transects 2016 and 2019. Points illustrate the start location of the transects, each transect was approximately 1km long, at a bearing chosen at random from the start point.

Table 44-1: Summary of results of debris transects conducted in the Gully MPA in 2016 and 2019.

Date	Survey ID	Start Time	Stop Time	Debris(Y/N)	Debris Type
19-Aug-16	1	7:05	7:35	N	N/A
19-Aug-16	2	11:17	11:49	N	N/A
26-Aug-16	3	9:37	10:07	N	N/A
26-Aug-16	4	6:42	7:04	N	N/A

26-Aug-16	5	7:57	8:22	N	N/A
26-Aug-16	6	10:38	10:51	N	N/A
26-Aug-16	7	13:12	13:18	N	N/A
26-Aug-16	8	14:29	14:39	N	N/A
26-Aug-16	9	14:41	15:11	Y	Plastic sheet (15:00), Plastic Bag (15:03)
26-Aug-16	10	15:13	15:40	Y	Rectangular white (15:36)
26-Aug-16	11	8:04	8:23	N	N/A
29-Aug-16	12	9:00	9:30	Y	Plastic sheet (09:15)
29-Aug-16	13	10:18	10:31	Y	Small piece of plastic (10:27)
29-Aug-16	14	12:00	12:31	N	N/A
31-Aug-16	15	8:59	9:02	N	N/A
31-Aug-16	16	9:44	10:44	N	N/A
31-Aug-16	17	10:15	10:29	N	N/A
31-Aug-16	18	11:10	11:40	N	N/A
01-Sept-16	19	9:46	10:02	N	N/A
01-Sept-16	20	10:52	10:55	N	N/A
01-Sept-16	21	11:12	11:32	N	N/A

01-Sept-16	22	16:49	17:10	Y	Small white plastic wrapper (16:50)
01-Sept-16	23	17:48	17:59	N	N/A

Outside of survey transects, incidental debris observations from Dalhousie University researchers were also documented in 2015, 2016 and 2019. Debris included plastic bags, styrofoam wrapping, plastic water bottle, a balloon, and a candy wrapper.

Transect length and surface area were used to calculate densities of large debris and are summarized in Table 44-2. When considering the densities of large debris from visual surveys performed from 1990 to 2019, there is a decreasing trend over time.

Table 44-2: Summary of debris density calculations for 1990, 1996-7, 1999 and 2016-9.

Year	Number of Survey Transects	Area Surveyed (km^2)	Quantity of Debris Observed	Density (items/km^2)	SE (Density)
1990	14	0.87	76	87.7	10.1
1996-7	24	1.76	58	33.0	4.3
1999	10	0.45	9	20.2	6.7
2016-9	22	0.77	7	9.0	3.4

Assessment of small debris

An updated evaluation of microplastics is not available at this time. Since the last reporting period, researchers from Dalhousie University conducted 25 tows for microplastics in 2015 and 2019 (Figure 44-2) using methods described in Dufault and Whitehead (1994). Samples collected from the recent period are currently being processed but the results are not yet available.

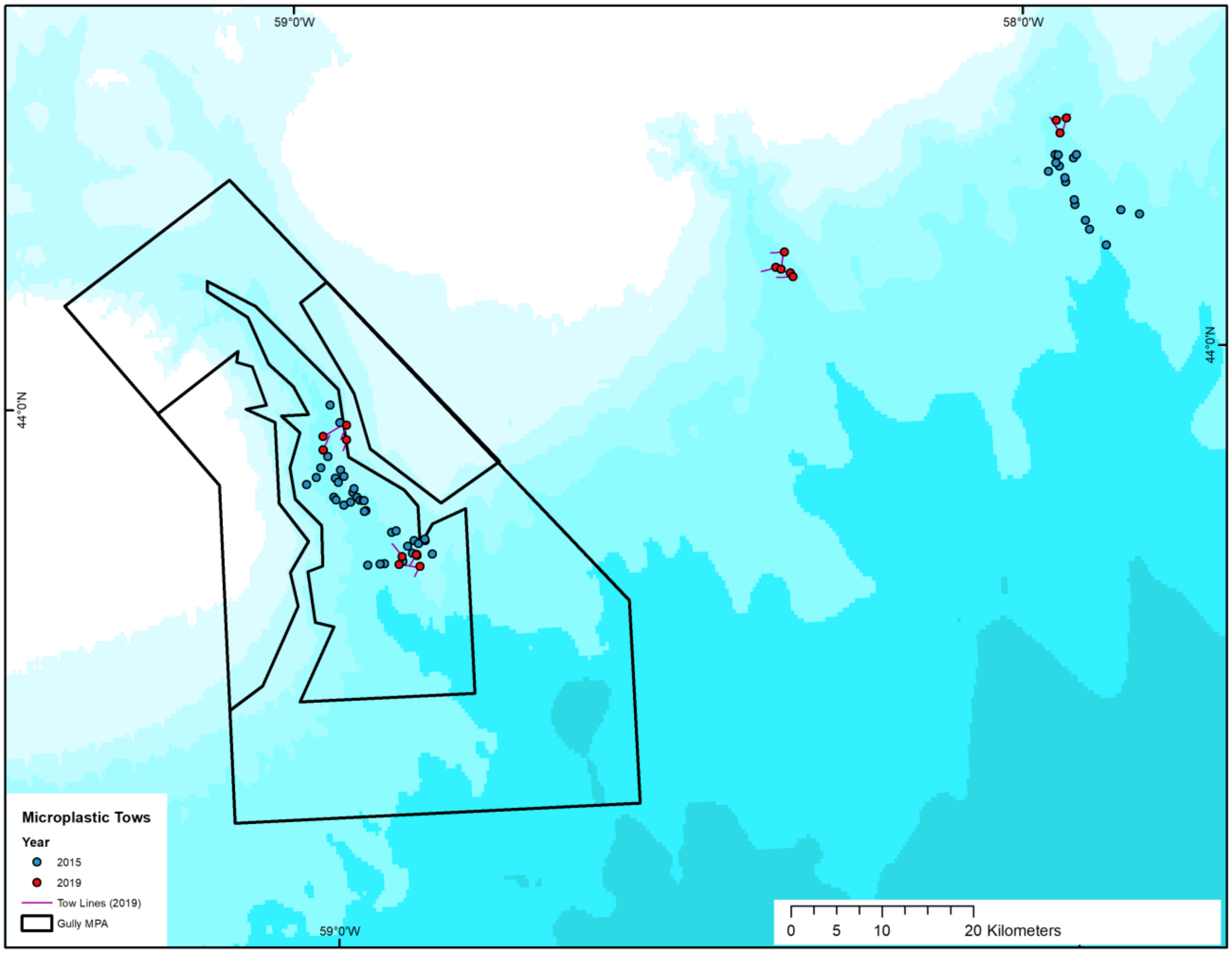

Figure 44-2: Locations of microplastic tows in 2015 and 2019. Points illustrate the start location of the tows, each tow was approximately 1km long, at a bearing chosen at random from the start point.

Evaluation of existing protocols and recommendations for future

It is recommended that both the large and small debris survey transects continue in the future with emphasis on activity within the Gully MPA. Every platform will be unique for visual sightings and may not be directly comparable to surveys conducted by other vessels, therefore it recommended to continue to work with Dalhousie University on collecting this data.

More recently, Kelly et al. (2023) published a paper on long term trends in floating plastic pollution within the Gully MPA, identifying threats for endangered Northern Bottlenose Whales.

INDICATOR 45: QUANTITY OF ANTHROPOGENIC DEBRIS AT SELECTED MONITORING SITES IN THE GULLY MPA

An evaluation of this indicator was not conducted.

INDICATOR 46: REPORTS OF KNOWN INVASIVE SPECIES IN THE GULLY MPA

L. McConney

Description

Marine aquatic invasive species are recognized as a growing threat to the planet's marine ecosystems and can have various effects including competition with native species for space, prey, and other resources, disruption of food webs, and introduction of parasites and pathogens (Lambert et al., 1992; Tan et al., 2002; Daniel & Therriault, 2007). Marine vessels can serve as a vector for the spread of non-indigenous aquatic species through hull fouling and ballast water releases (Klassen, 2012; Lacoursiere-Roussel et al., 2012). As described above for Indicator 42, ballast water discharges containing the eggs, larvae, and juveniles of non-local species are considered the primary vector for introduction. The *Vessel Pollution and Dangerous Chemicals* (SOR/2012-69) prescribes requirements for anti-fouling systems for vessels that engage in international voyages. Though catastrophic impacts on native species are possible, offshore effects of aquatic invasive species are far less prevalent than effects witnessed in colonized coastal embayments and commercial ports, though evidence of open ocean risk is mounting (Daniel & Therriault, 2007).

Summary from previous reporting period

An evaluation of this indicator was not conducted during the last reporting period.

Available data and analysis

Currently, there are no reports of known invasive species in the Gully MPA but there are also no known studies or monitoring activities specifically for invasive species detection in the area.

Based on the invasive species already detected in the region, *Didemnum vexilium,* also known as Pancake Batter Tunicate, poses the greatest risk of spread to the Gully based on current knowledge and barring new species introductions (personal communication, Remi Daigle DFO Ecosystem Management, April 2020). While originally found in Japan, in introduced habitats, these tunicates can smother the benthic habitat, overgrow other benthic species including corals and sponges, and can reduce habitat complexity, reduce prey availability for bottom feeders, and impact water quality (Bullard et al., 2007; Daniel & Therriault, 2007; Vercaemer et al., 2015). This tunicate tolerates a range of environmental conditions and has been observed in depths from the intertidal zone to 65 m (Daniel & Therriault, 2007). On Georges Bank, this tunicate has been found growing on hard substrates (e.g. pebble and cobble) at depths of 45-60 m. Figure 46-1 illustrates the areas of the Gully MPA that would be at risk for the establishment of *Didemnum vexilium* based on depth and displaying the surficial geology within the species' depth tolerance.

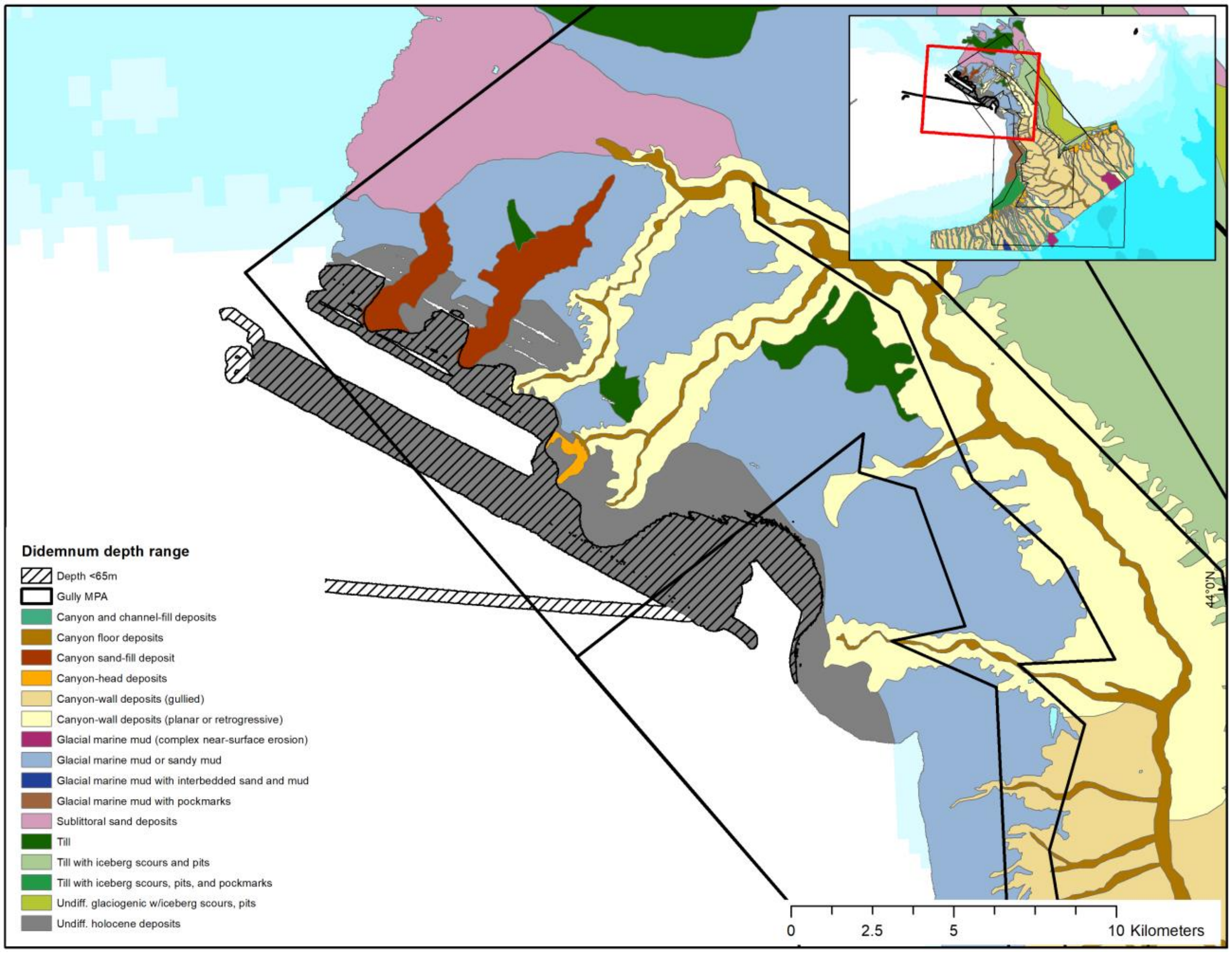

Figure 46-1: Regions of the Gully MPA with a depth less than 65 m deep, which may provide suitable habitat for the invasive tunicate Didemnum vexilium.

After the presence of *Didemnum vexilium* was confirmed in the Bay of Fundy near Parrsboro, NS in 2013, a rapid response survey was conducted at a number of sampling stations in the Bay of Fundy and on the Scotian Shelf (Vercaemer et al., 2015). However, none of these tows were conducted in or near the Gully MPA. A total of 236 scallop tows were conducted between German Bank, northern Browns Bank and eastern Georges Bank, and didemnid-like tissues were collected from hard substrates for further analysis. In total seven tissue samples were collected and all tested negative in the molecular screening test. Samples collected off Yarmouth and Digby tested positive for *D. vexillum.*

Suggestions for future monitoring

If an invasive species monitoring program were to be established for the Gully MPA, it would face several challenges. First would be determining if the species is native or non-native as there is no baseline/inventory of species that are present in this very deep and remote site. The next hurdle would be proving that the species was non-native and causing harm, thus qualifying as an invasive species. Due to a lack of natural predators, invasive species can spread rapidly (CCFAM Aquatic Invasive Species Task Group, 2004; Office of the Auditor General of Canada, 2019), and can cause environmental harm in several manners including the displacement of native species, habitat degradation and the introduction of disease.

As a complement to existing biodiversity survey efforts, monitoring of aquatic invasive species using environmental DNA (eDNA) is recommended as a non-destructive, sensitive detection method (Leblanc et al., 2020). This type of sampling could be added to existing monitoring and research activities to determine the presence/absence of species in the Gully, including potentially *D. vexillum.* Species specific primers can be developed to detect risk species, but eDNA metabarcoding could offer a broad scope solution for simultaneous biodiversity and invasive species monitoring (Stat et al., 2017). Water samples can be collected at depth during other scientific programs (e.g., Atlantic Zone Monitoring Program) and the water samples can be analyzed for presence of known invasive species (e.g., *D. vexillum*) via filtering, DNA extraction, and either metabarcoding or quantitative real-time PCR (qPCR).

INDICATOR 47: QUANTITATIVE CHARACTERIZATION OF ANTHROPOGENIC SOUND WITHIN THE MPA

An evaluation of this indicator was conducted and presented at the January 2021 CSAS workshop, but the results are not included here.

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ABBREVIATIONS

AIS	Automatic Identification System
CNLOPB	Canada-Newfoundland and Labrador Offshore Petroleum Board
CNSOPB	Canada-Nova Scotia Offshore Petroleum Board
COOGER	Centre for Offshore Oil and Gas Environmental Research
COSEWIC	Committee on the Status of Endangered Wildlife in Canada
C&P	Conservation and Protection
CSAS	Canadian Science Advisory Secretariat
DFO	Fisheries and Oceans Canada
DVS	Department Violations System
ECCC	Environment and Climate Change Canada
eDNA	Environmental DNA
IMO	International Maritime Organization
LRIT	Long-Range Identification and Tracking
MARFIS	Maritime Fishery Information System
MMSI	Maritime Mobile Service Identity
MPIRS	Marine Pollution Incident Reporting System
MPA	Marine Protected Area
MPC	Marine Planning and Conservation
MSOC	Marine Security Operation Centre
MSPV	Mid-Shore Patrol Vessels
NASP	National Aerial Surveillance Program
PED	Population Ecology Division
ROV	Remotely Operated Vehicle
SARA	Species at Risk Act
SOLAS	Convention for the Safety of Life at Sea
TAC	Total Allowable Catch
VMS	Vessel Monitoring System

APPENDIX A

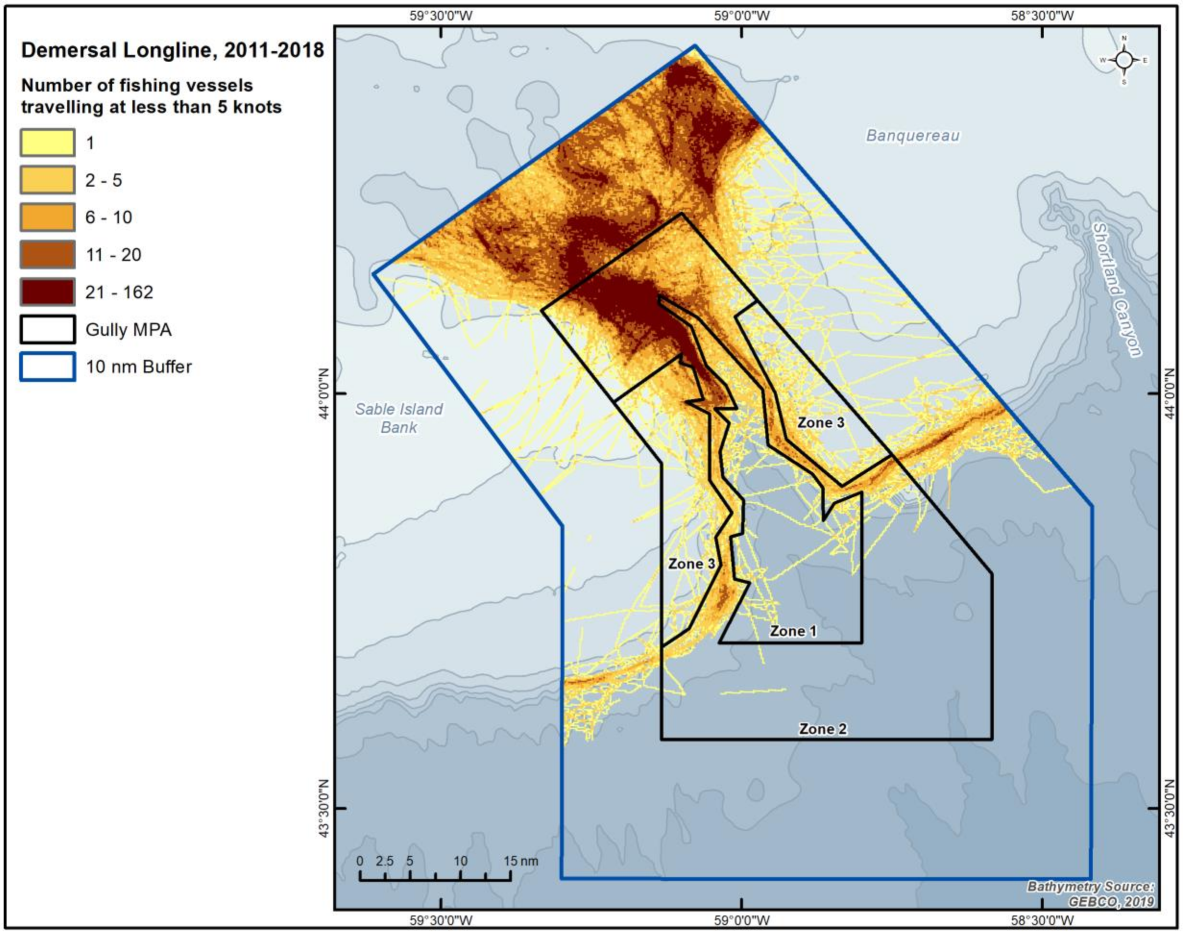

Figure A-1: Map of VMS records for vessels fishing using demersal longline in and surrounding the Gully MPA from 2011-2018.

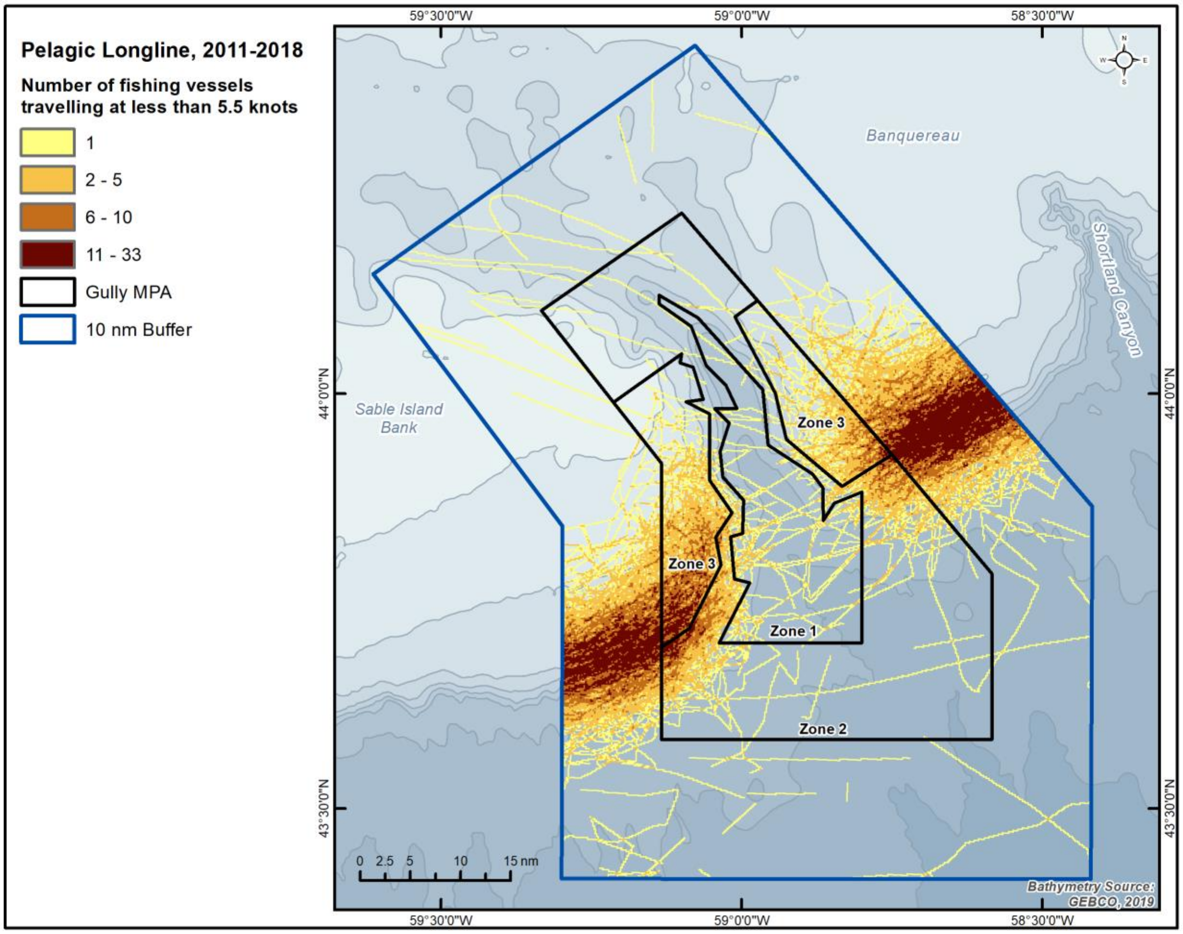

Figure A-2: Map of VMS records for vessels fishing using pelagic longline in and surrounding the Gully MPA from 2011-2018.

APPENDIX B

*Table B-1: Total weight for all species discarded/removed organisms associated with research activities from 2013-2019 in the Gully MPA. * signifies that some of the contributing surveys only collected counts of individuals not weights.*

Species	**Weight (kg)**				**Quantity of Individuals**			
	Halibut Longline	**Multispecies Trawl**	**Snow Crab Trawl**	**Total by Species (kg)**	**Halibut Longline**	**Multispecies Trawl**	**Snow Crab Trawl**	**Total by Species**
1840	0	0	0.1	0.1	0	0	4	4
Alewife	0	0	0.2	0.2	0	0	2	2
Alligatorfish	0	0	0.4	0.4	0	0	45	45
American Plaice	0	0.86	6.3	7.16	0	3	130	133
Anemone	0	0.002	0.5	0.502	0	1	6	7
Asterias Rubens	0	1.854	0.2	2.054	0	38	2	40
Asteroidea S.C.	0	0.111	0	0.111	0	4	0	4
Atlantic Argentine	0	0.062	0	0.062	0	3	0	3
Atlantic Cod	99	0.5	40.2	139.7	3	1	187	191
Atlantic Halibut	5291	36.322	4.4	5,331.722	74	7	6	87

Atlantic Herring	0	7.59	0.5	8.09	0	40	3	43
Atlantic Rock Crab	0	8.802	41.808	50.61	0	102	158	260
Atlantic Saury (Needlefish)	0	0.033	0	0.033	0	2	0	2
Barndoor Skate	609	0	8.4	617.4	46	0	2	48
Bivalvia	0	0.201	0	0.201	0	1	0	1
Black Belly Rosefish	0	0.288	2.3	2.588	0	62	36	98
Black Dogfish	70	0	0	70	0	0	0	0
Blood Star	0	0.027	0.2	0.227	0	1	4	5
Bobtail Squid	0	0.008	0	0.008	0	1	0	1
Brittle Star	0	0.002	0.1	0.102	0	1	1	2
Butterfish	0	0.441	0	0.441	0	3	0	3
Cusk	24	0	0	24	6	0	0	6
Eggs (NS)	0	0	0.1	0.1	0	0	2	2

Fourspot Flounder	0	0.4	1.2	1.6	0	1	9	10
Green Urchin	0	0.036	4.3	4.336	0	1	80	81
Greenland Halibut	10	0	0	10	1	0	0	1
Gulfstream Flounder	0	0.1	0.5	0.6	0	3	14	17
Haddock	0	186.648	110.6	297.248	0	344	253	597
Hatchetfish	0	0.008	0	0.008	0	4	0	4
Hermit Crab	0	0	0.8	0.8	0	0	22	22
Hippasteria Phrygiana	0	0.65	0	0.65	0	6	0	6
Horse Star	0	0	19.9	19.9	0	0	89	89
Jonah Crab	0	4.95	10.562	15.512	0	20	34	54
Lanternfish (NS)	0	0.86	0	0.86	0	135	0	135
Lesser Toad Crab*	0	0	0.261	0.261	0	0	2	2
Longfin Hake	0	4.764	1.1	5.864	0	63	13	76

Longhorn Sculpin	0	1.242	73.1	74.342	0	14	1016	1,030
Mackerel	0	0	0.5	0.5	0	0	1	1
Mailed Sculpin	0	0	0.2	0.2	0	0	2	2
Marlin-spike Grenadier	0	0.357	0.4	0.757	0	10	10	20
Monkfish	0	3.48	11.6	15.08	0	1	9	10
Muller's Pearlsides	0	0.002	0	0.002	0	3	0	3
Northern Hagfish	0	0.224	0	0.224	0	3	0	3
Northern Moonsnail	0	0.444	0	0.444	0	4	0	4
Northern Sand Lance	0	0.103	0	0.103	0	11	0	11
Northern Shrimp	0	0	0.1	0.1	0	0	4	4
Northern Stone Crab	0	1.662	10.108	11.77	0	4	14	18
Northern Wolffish	50	0	0	50	3	0	0	3

Pandalus Borealis	0	0.022	0	0.022	0	3	0	3
Pandalus Montagui	0	4.67	0	4.67	0	3150	0	3,150
Polar Sea Star	0	0	0.4	0.4	0	0	0	0
Pollock	0	4.124	42.8	46.924	0	8	54	62
Pontophilus Norvegicus	0	0.006	0	0.006	0	3	6	9
Psilaster Andromeda	0	0.043	0	0.043	0	10	0	10
Purple Sunstar	0	0	0.9	0.9	0	0	9	9
Red Hake	15	2.1	19.3	36.4	6	11	131	148
Red Isopod	0	0.005	0	0.005	0	2	0	2
Redfish (Unseparated)	97	239.965	96.1	433.065	8	1072	587	1,667
Ribbed Sculpin	0	0	0.1	0.1	0	0	1	1
Sand Dollar	0	0.084	1.2	1.284	0	4	29	33
Sand Shrimp	0	0	0.1	0.1	0	0	1	1

Sea Cauliflower	0	0.003	0	0.003	0	1	0	1
Sea Cucumber	0	0.206	6	6.206	0	2	26	28
Sea Mouse	0	0	0.3	0.3	0	0	2	2
Sea Pen (NS)	0	0	0.3	0.3	0	0	11	11
Sea Raven	0	0	2	2	0	0	5	5
Sea Scallop	0	0.06	2.6	2.66	0	1	46	47
Sea Slug	0	0	0.1	0.1	0	0	1	1
Seaweeds	0	0	0.3	0.3	0	0	3	3
Shortfin Squid	0	248.479	2.2	250.679	0	1464	10	1474
Shortnose Greeneye	0	0.001	0	0.001	0	1	0	1
Shrimps	0	0.003	0	0.003	0	5	0	5
Silver Hake	0	140.798	100.4	241.198	0	770	716	1,486
Smooth Skate*	0	0.348	4.9	5.248	0	2	11	13
Snow Crab	0	0	59	59	0	0	316	316

Spiny Dogfish	24	0	1.2	25.2	16	0	1	17
Spiny Sunstar	0	0	0.6	0.6	0	0	6	6
Spirontocaris Fabrici	0	0.002	0	0.002	0	3	0	3
Spirontocaris Norvegicus	0	0.001	0	0.001	0	1	0	1
Sponges	0	0	0.8	0.8	0	0	2	2
Spotted Wolffish	3	0	0	3	1	0	0	1
Squid (NS)	0	0.007	0	0.007	0	2	0	2
Squid Eggs	0	0.043	0	0.043	0	1	0	1
Star (NS)	0	0	1.4	1.4	0	0	15	15
Striped Shrimp	0	0	0.2	0.2	0	0	2	2
Thorny Skate	25	3.952	2.9	31.852	0	4	5	9
Whelks	0	0	0.5	0.5	0	0	8	8
White Barracudina	0	0.141	0	0.141	0	13	0	13

White Hake	275	40.058	16.3	331.358	8	59	45	112
Winter Skate	0	0	1.4	1.4	0	0	2	2
Witch Flounder	0	6.032	25.5	31.532	0	53	243	296
Yellowtail Flounder*	0	0.64	13.9	14.54	0	5	202	207
Total				**8,301.465**				**1,2375**