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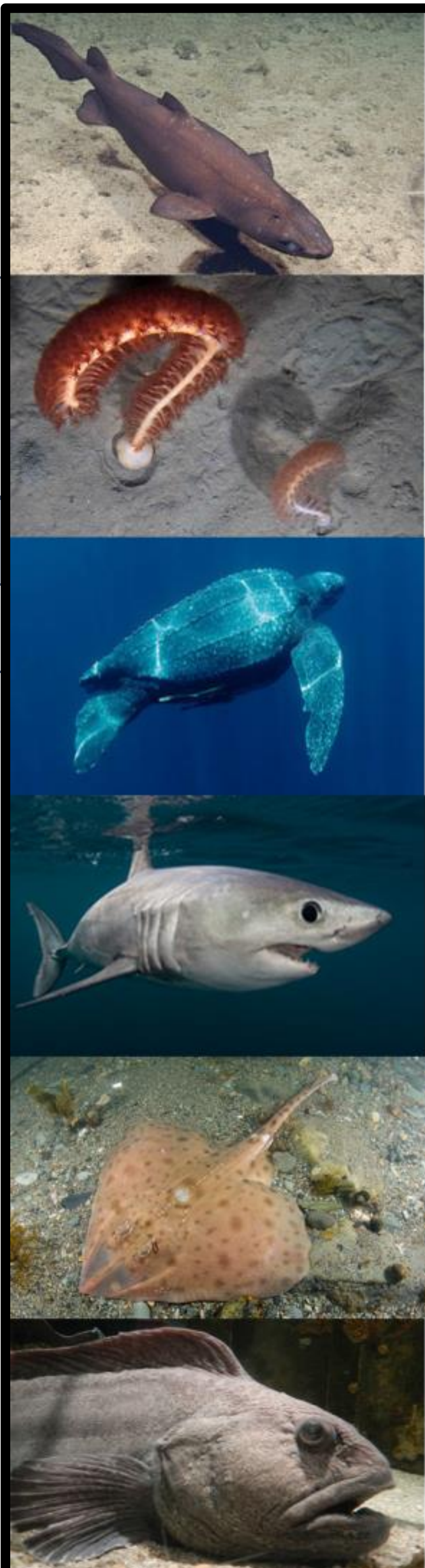

Assessment of the Laurentian Channel Area of Interest

A Risk Characterization

By DFO Oceans
Ecosystems Management Branch
Newfoundland and Labrador Region

EXECUTIVE SUMMARY

The overview and assessment of the Area of Interest (AOI) is a required step for all AOIs identified across Canada for potential designation as a Marine Protected Area (MPA) under the *Oceans Act*. The 'Assessment of the AOI' Report is the final of three documents completing the Laurentian Channel AOI Overview and Assessment. *The Biophysical Overview of the Laurentian Channel Area of Interest* summarizes the ecological importance of the AOI. *The Social, Cultural, and Economic Overview of the Laurentian Channel Area of Interest* outlines the socio-economic and cultural characteristics, human systems, and commercial/non-commercial activities relevant to the AOI. The Assessment Report identifies the impacts from multiple human activities on the significant ecological features within the AOI and the significance of those pressures.

To assist in meeting Canada's international commitments to protect marine biodiversity, the MPA goal is to 'To support the conservation of biodiversity in the Laurentian Channel MPA through protection of key species and habitats, ecosystem structure and function, and through scientific research'. To achieve this goal, conservation objectives (COs) have been developed with the advice of the Laurentian Channel AOI Advisory Committee and DFO Science. The COs were selected based on ecological significance, without reference to any level of threat from human activities. The analysis of the COs is based on a methodology used to characterize the level of risk from human activities and/or potential stressors on key marine ecosystem components, and provide information on cumulative effects. Human activities posing an actual or foreseeable risk to one or more of the COs are described in detail in terms of likelihood, severity, reversibility, and existing mitigation. The activities include commercial fishing (using bottom trawl and longline gear), oil and gas exploration (seismic surveys and drilling), vessel traffic (noise disturbance and ship strikes), and submarine cable installation.

The systematic analysis of each CO provides a means to quantify the significance of stressors from human activities, flagging activities that are incompatible with the planned MPA. The resulting scores are influenced by both the severity of harm and the number of key activities and stressors acting upon the COs. The numerical scores for each CO-activity interaction can be combined in a number of ways, allowing an examination of cumulative effects associated with each CO, or an activity-based analysis. The leatherback sea turtle had the highest score (highest risk) followed by corals/sea pens. Porbeagle shark had the lowest score of the COs. Black dogfish, smooth skate, and Northern wolffish had similar scores in the middle range. Bottom trawl was the activity which created the most risk of harm for all COs combined. The detailed assessments for each CO are provided in the Appendix. In conducting the Overview and Assessment Report, it has been determined that an *Oceans Act* MPA is the appropriate management tool to achieve the COs and address threats associated with the Laurentian Channel AOI.

For further information on this assessment of the Laurentian Channel AOI please contact Oceans Division, Ecosystems Management Branch of Fisheries and Oceans in the Newfoundland and Labrador Region:

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LIST OF ACRONYMS

AIS	Aquatic Invasive Species
ALDFG	Abandoned, lost, or discarded fishing gear
AOI	Area of Interest
CFIA	Canadian Food Inspection Agency
CCFAM	Canadian Council of Fisheries and Aquaculture Ministers
C-NLOPB	Canada-Newfoundland Offshore Petroleum Board
DFA	Department of Fisheries and Aquaculture
DFO	Fisheries and Oceans Canada
EA	Environmental Assessment
EC	Environment Canada
IFMP	Integrated Fisheries Management Plan
I-STOP	Integrated Satellite Tracking of Polluters
LOMA	Large Ocean Management Area
LRIT	Long Range Identification and Tracking
NAFO	Northwest Atlantic Fisheries Organization
NASP	National Aerial Surveillance Program
OWTG	Offshore Waste Treatment Guidelines
PBGB LOMA	Placentia Bay-Grand Banks Large Ocean Management Area
TC	Transport Canada
UN	United Nations
VME	Vulnerable Marine Ecosystem
WBM	Water Based Muds

INTRODUCTION

The overview and assessment of the Area of Interest (AOI) is a required step for all AOIs identified across Canada for potential designation as a Marine Protected Area (MPA) under the *Oceans Act*. It provides a focused description and analysis of both the biophysical and human components of the AOI, using ecological, social, economic and cultural information. It concludes with a recommendation on whether an *Oceans Act* MPA is the appropriate management tool to achieve the conservation objectives (COs) set for the area, thereby helping to determine whether to proceed with the regulatory stage of the MPA designation process.

The Assessment of the AOI is the final of three documents completing the 'Laurentian Channel AOI overview and assessment'. *The Biophysical Overview of the Laurentian Channel Area of Interest* (DFO 2010) summarizes the ecological importance of the AOI and can be found at the following link: http://www.dfo-mpo.gc.ca/csas-sccs/Publications/SAR-AS/2010/2010_076-eng.html. *The Social, Cultural and Economic Overview of the Laurentian Channel Area of Interest* (SEC Overview), outlines the socio-economic and cultural characteristics, human systems, and commercial/non-commercial activities relevant to the AOI. As the final document in the AOI overview, the Assessment Report identifies the impacts from individual or multiple human activities on the significant ecological features and functions within the AOI and identifies which pressures from human activities are impacting the ecological features or functions targeted for protection, and the significance of those pressures. As this information is compiled during the early stages of MPA development and designation, the information contained within identifies the key considerations for moving forward with next steps, including consultations; although it is recognized that specific information related to these considerations may require updating as the process progresses and as new information becomes available.

With consideration of the results of the overview and assessment and other regulatory tools available to protect resources in the area, it has been determined that an *Oceans Act* MPA is the most appropriate tool to protect the six COs set for the AOI in support of achieving the MPA goal.

SIGNIFICANT ECOLOGICAL FEATURES AND FUNCTIONS WITHIN THE AOI

To assist in meeting Canada's international commitments to protect marine biodiversity, the following MPA goal has been set:

> ***'To support the conservation of biodiversity in the Laurentian Channel MPA through protection of key species and habitats, ecosystem structure and function, and through scientific research'.***

To achieve this goal, conservation objectives (COs) have been developed with the advice of the Laurentian Channel AOI Advisory Committee and DFO Science. These objectives give clear direction to focus work and resources on common issues, provide benchmarks for measuring success, constrain the scope of work to be undertaken, delineate MPA boundaries, and set clear expectations for all involved.

The COs were selected based on ecological significance, without reference to any level of threat from human activities. COs for the proposed Laurentian Channel MPA include:

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

2. Ensure that human activities in the Laurentian Channel MPA do not impair the reproduction and survival, or disrupt important aggregations, of black dogfish.

3. Protect areas of juvenile smooth skate abundance and ensure that human activities in the Laurentian Channel do not impair the reproduction and survival of the species.

4. Ensure that human activities in the Laurentian Channel MPA do not impair the reproduction and survival of porbeagle shark.

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

6. Promote the survival and recovery of leatherback sea turtles by minimizing risk of harm from human activities in the Laurentian Channel MPA.

The analysis of COs (Section 4.0) characterizes and analyzes the degree of risk from human activities on key marine ecosystem components and/or properties within the Laurentian Channel AOI, and also provides information on cumulative effects (Park *et al*. 2010). The systematic analysis of each CO provides a means to quantify the significance of stressors from human activities, flagging activities that are incompatible with the planned MPA. The resulting scores are influenced by both the severity of harm and the number of key activities and stressors acting upon the COs. COs threatened by immediate or irreversible harm may be given higher priority for management action than those that appear to be relatively safe from harm.

HUMAN ACTIVITIES WITHIN THE LAURENTIAN CHANNEL AOI

Each human activity occurring within the Laurentian Channel AOI is described in the SEC Overview with information provided on past, current, and foreseeable economic uses; those posing a risk to COs are further detailed in Section 3 of this report.

The analysis in this report identifies the possible impacts from individual or multiple human activities on the significant ecological features within the AOI, also known as COs. Human activities posing an actual or foreseeable risk to one or more of the COs are described in detail. These include commercial fishing (using bottom trawl and longline gear), oil and gas exploration (seismic surveys and drilling), vessel traffic (noise disturbance and ship strikes), and submarine cable installation.

Information on oil pollution, aquatic invasive species, and marine debris is also included as these stressors pose a risk to numerous marine resources and the integrity of large ocean areas. However, for the time frame considered in this assessment, they do not have a substantial impact on the COs. The range and intensity of these activities should continue to be monitored, and the significance of their impact will be assessed throughout the MPA adaptive management process. The table below provides the linkages between human activities and resultant stressors.

Table 1: List of the main stressors resulting from human activities in the Laurentian Channel AOI (Templeman and Davis 2006).

Threat category	Activity	STRESSORS															
		Habitat destructions	Biomass removal	Spills	Wastes / sewage	Parasites / diseases	Invasive species	Nutrients/Org. Mat.	Dredging	Disposal at sea	Freshwater inputs	Collisions	Disturbance (sound, tresp)	Current obstruction	Contaminants	Produced waters	Meteorological Forcing	Currents / water masses
Fishing	Bottom trawl	X	X															
	Longline	X	X															
Disturbance and injury	Vessel traffic			X	X		X						X		X			
	Ship strikes											X						
	Seismic exploration												X					
Seabed alteration	Exploratory drilling	X		X	X								X					
	Submarine cables	X							X									
Marine pollution	Oil pollution	X		X											X	X		

COMMERCIAL FISHING

The Laurentian Channel AOI lies within NAFO subdivision 3P. From 1960 to 2009 the main species caught in 3P included Atlantic cod, redfish, and herring. Less substantial fisheries included American plaice, crab, haddock, witch flounder, sea scallop, pollock, and white hake. Historically, cod and redfish have been most significant in terms of landings and landed value. There are currently 15 species with directed fishery effort in the >40' fleet with over 28 species caught (some in small quantities).

The AOI is considered an offshore fishing area. Inshore harvesters with access to the AOI on their licences mostly choose to operate inshore due to distance, vessel capacity and water depths. Groundfish is the most consistently caught species group with redfish and Atlantic cod accounting for 98% of catch by weight (1991 to 2009 average).

There were 8 gear types utilized within the AOI during 1991 to 2009. More than 45% of the catch was caught utilizing a bottom Otter trawl, primarily in the redfish fishery. Midwater trawl (also targeting redfish) accounted for approximately 53% of the total catch. However, midwater trawl was not significantly utilized after 2001. Over the period 2005 to 2009, bottom trawl accounted for 89% of landings, while midwater trawl made up just 3% over the same period.

The remaining 6 gear types (dredge, gillnet, pot, longline, Scottish seine and Danish seine) accounted for, on average, less than 1% of the combined catch (1991 to 2009). Although gillnets were once the dominant gear used for cod in 3Ps, there has been relatively little directed cod fishing in the AOI in recent years. Total landings by dredge, gillnet, Danish seine, and crab pots are minimal; these gear types are not expected to be a key stressor to COs in the AOI, therefore are not included in the assessment. Midwater trawl was only utilized consistently up to 2001, and not expected to impact the COs identified for the AOI, as none of the fish are pelagic. Longline gear is used to a minimal extent for cod, Atlantic halibut, Greenland halibut, and white hake. Although landings and effort with this gear is low, it is the gear used to direct for porbeagle shark in the Maritimes fishery, and has therefore been included in the assessment.

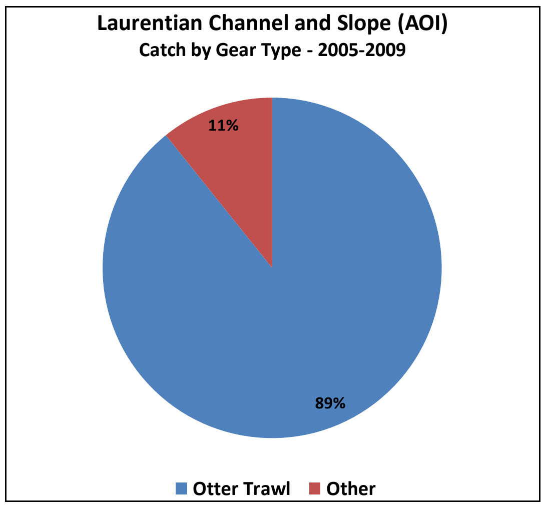


Figure 1: Catch by gear type for the period 2005 to 2009 (Policy and Economics Branch, DFO).

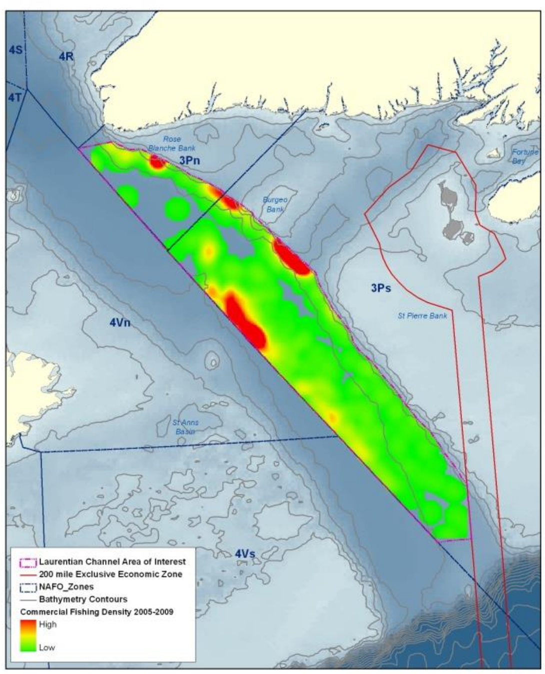


Figure 2: Density of commercial fishing activity in the AOI from 2005 to 2009.

BOTTOM (OTTER) TRAWL

Likelihood

There were eight gear types utilized within the AOI from 2005 to 2009. A little over 89% of the catch was caught utilizing a bottom trawl, primarily in the redfish fishery (Figure 1). Much of the catch occurred in the middle of the channel and along the slope (Figure 2).

Redfish has been most consistently caught from January to March, while in recent years an April to June spawning closure has been implemented for the redfish Unit II stock. In addition, area 3Psd is closed to mobile gear redfish fishing activity from November 15 to June 30 since 2007/08.

COD CLOSURES		
Mixing Closure	Nov 15 – May 15*	3Ps (d,e,g) western portion of 3Ps(a) closed to all fleets
Spawning Closure	March 1 – May 31*	All 3Ps closed
REDFISH CLOSURES		
Mixing Closure	Nov 15 – June 30	3Ps(d) closed to all bottom fishing
Spawning Closure	April 1 – June 30	Unit II closed

*****End date of these closures may vary a little from year to year as it is reviewed annually.

Severity

Bottom trawls are long wedge-shaped nets of synthetic webbing that narrow into a funnel shaped bag. The trawl is dragged along the seafloor and kept open during a tow with large, oval, metal doors. Footropes are often rigged with heavy steel rollers or chains to keep the net on the seafloor. Groundfish have a high likelihood of being caught in trawls, while cetaceans have a low likelihood. However, entanglement in nets and associated ropes can impact cetaceans and leatherback sea turtles. Bottom trawling is the most damaging gear type to benthic populations, communities, and habitats. Multi-year studies of the impacts of groundfish otter trawling carried out in the Atlantic by Fisheries and Oceans Canada (DFO) (DFO 2006) show short-term disruption of benthic communities, including reductions in the biomass and diversity of benthic organisms. The severity and longevity of the impact varies depending on factors such as depth, substrate, fishing intensity (i.e., the frequency of trawling), natural disturbance regime, and the life histories of the species being impacted. Bottom trawl was assigned an ecological damage rating of "high impact" (the highest of 5 categories) in relation to groundfish (Fuller *et al*. 2008).

Reversibility

Mobile bottom gear can damage or reduce structural biota and habitat complexity. For example, impacts to corals include immediate physical damage with subsequent slow recovery rates, as well as the potential for secondary effects due to sedimentation and alterations in associated benthic and fish communities (Templeman and Davis 2006). Some previously fished seafloor habitats showed recovery within one to three years but frequently trawled habitats remain in an altered state. Bycatch of non-target species is one of the main issues related to this gear type. Overall, trawl effort has decreased in Atlantic Canada, from a peak in the 1970s and 1980s, predominantly as a result of groundfish stock collapses (Kulka and Pitcher 2001).

Potential impacts of bottom trawling on species and habitats, in terms of duration of threat include:

- Removal of major habitat features (permanent)

- Reduction of structural biota (years to decades)
- Reduction of habitat complexity (days to several months)
- Changes in seafloor structure (days to several months)
- Reduction in geographic range (years to decades)
- Decrease in species with low turnover rates (years to decades)
- Fragmentation of species ranges (years to decades)
- Changes in relative abundance of species (days to many years)
- Fragile species more affected (unclear)
- Surface-living species more affected than burrowing species (weeks to a few years)
- Sub-lethal effects on individuals (weeks to a few years)
- Increase in species with high turnover rates (months to a few years)
- Increase in scavenger populations (days to months)

Mitigations

Canada is committed, under UN Resolution 61/105, to provide enhanced protection to marine habitats that are particularly sensitive. DFO's Policy for Managing the Impacts of Fishing on Sensitive Benthic Areas has been developed to help manage fisheries in such sensitive benthic areas. It describes how these areas are identified and the nature of the protection that will be given to them. Once a decision has been taken on appropriate management measures, the measures will be clearly identified in the management plan for the affected fishery (e.g. CHP, IFMP) and/or the fishing licence.

An April-June spawning closure has been instituted for the redfish Unit II stock. As well, area 3Psd is closed to the mobile gear redfish fishing activity from November 15 to June 30 since 2007/08. The redfish fishery in NAFO sub-division 3Pn occurs only in the month of July.

In general, measures that improve fishing efficiency can reduce fishing time and seabed impact in strictly enforced output-controlled fisheries. Also, alternative gears with less seabed contact could potentially be used instead of traditional bottom-tending gears in some fisheries (Rice 2006).

COs potentially impacted by fishing with bottom trawl:

1. corals
2. black dogfish
3. smooth skate
4. Northern wolffish

LONGLINE

Likelihood

Bottom longlines are fixed gear and consist of a single mainline to which shorter lines, armed with baited hooks, are attached (maximum of 6,000 hooks). Anchors attached to the longline secure the gear to the ocean floor. The directed fisheries using longlines in the AOI target Atlantic cod, Atlantic halibut, Greenland halibut, white hake, and Maritimes fishers target porbeagle shark in the AOI occasionally. Longlines are not commonly used in the AOI, making up less than 1% of landings from 1998-2009. Longline can be utilized from May 15 to February 28. Dredge, gillnet, pot, longline and Danish seine accounted for on average less than 4% of the combined catch, over the period 2005 to 2009.

Severity

This fishing gear is used minimally in the AOI. Longlines can hook or become entangled in corals, particularly structurally complex species, causing corals to become dislodged or broken. Habitat damage from bottom longlines depends on the gear configuration including weights, number of hooks and type of line as well as hauling speed and technique (Fuller *et al*. 2008). Habitat damage is also dependent on bottom type, with documentation of damage to corals and sponges. Bycatch of corals in longline fisheries can be high, with 35% of longline fishing sets in the Newfoundland and Labrador region containing corals based on the fisheries observer program in 2004/05 (Edinger *et al.* 2007). Longlines were also given a "high impact" rating in relation to groundfish (Fuller *et al*. 2008).

Reversibility

Longlines utilized in the AOI are considered to be fixed, bottom contact gear, however habitat damage is usually limited with this gear. Most impacts are likely to be on coral communities. Deep-sea corals are slow-growing and long-lived (Edinger *et al*. 2007). Due to low growth rates, anthropogenic impacts to corals include immediate physical damage with subsequent slow recovery rates, as well as the potential for secondary effects due to alterations in associated benthic and fish communities (Templeman & Davis 2006). Impacts to sea pens will likely be reversed in a shorter time than hard corals, as they have some flexibility and ability to reattach. Despite risk to some coral species, longline has not been included as a key stressor because solitary sea pens make up the majority of the coral CO.

COs potentially impacted by fishing with longline:

1. porbeagle shark
2. leatherback sea turtle

OIL AND GAS EXPLORATION

OIL AND GAS DRILLING

Likelihood

The current AOI boundary crosses two deep sedimentary basins: the Sydney Basin in the north and the Laurentian Basin in the south. Both have hydrocarbon potential and proven finds. There is no oil production in the AOI to date. Currently, there is one Exploration License issued by the Canada Newfoundland and Labrador Offshore Petroleum Board (C-NLOPB) in 2009 in the Sydney Basin. As of July 2012, there has been no drilling activity in the Sydney Basin. In order to keep their rights to the License, Husky may acquire more seismic data in the next few years and must drill a well by 2014. There are currently two Exploration Licenses in the Laurentian Basin, both of which are outside the AOI boundary. The most recent geophysical activity was a well site survey by ConocoPhillips in 2009. ConocoPhillips may acquire more seismic data including well site surveys, and must drill a well by 2015 in order to keep their rights to those licenses (DFO 2011).

It is difficult to speculate about future hydrocarbon production in these areas where both basins are relatively unexplored at this point. However, indications are that these areas are prone to natural gas resources and if resources are found in sufficient volumes to justify development then a potential natural gas project would result in increased seismic, drilling, production, and transportation activity (e.g. pipeline or tanker).

<u>Severity</u>
There is no oil production currently within the AOI, therefore drilling considered in this assessment will include exploratory drilling, not oil production drilling. Oil exploration and production involves a variety of activities with potential to impact the natural environment. The presence of vessels and drill rigs, the physical act of drilling, and the associated discharges and potential for oil spills can impact fish, cetaceans, benthos, corals, and habitat in a variety of ways.

Drilling:
Oil and gas drilling involves removal of bottom sediments and any associated benthic organisms, including corals. Impacts on habitat can be substantial as production wells are drilled in clusters inside of large excavated "glory holes" and the excavated material deposited outside on the glory hole is frequently dispersed over a wide area. Associated activity including placement of rigs and pipelines and the discharge of drilling mud and cuttings can damage habitat, benthos, and corals over a wider area by directly crushing them, or smothering them through the deposition of drill cuttings and muds.

Potential interactions between offshore drilling activities and **fish and fish habitat** relate primarily to:

- Attraction to subsurface structures and lights
- Avoidance due to noise or other disturbances
- Potential contamination due to wastewater discharges (e.g. deck drainage)
- Potential smothering, contamination and habitat alteration due to the discharge and deposition of drill muds and cuttings
- Well abandonment (structure removal, plugging of well, etc.)
- Contamination in the event of a spill or blowout (Jacques Whitford 2003).

Potential effects on **cetaceans and sea turtles** that may result from offshore drilling activities relate primarily to:

a) noise, that may cause
    - Avoidance of certain areas that would otherwise be used by the individuals affected
    - Interference with vocal communication between individuals
    - Attraction of some individuals to the sound source, putting them at risk of collision or contamination, and
    - Temporary impairment or permanent injury of hearing apparatus from extremely loud sounds
b) potential contamination of marine mammals and sea turtles and their food sources as a result of discharges; and
c) potential effects of accidental spills (Jacques Whitford 2003).

Discharges:
Species may be impacted by seafloor drilling and resulting discharges. Discharges associated with exploration and production activities may include: drill muds, bilge water, deck drainage, ballast water,

storage displacement water, cooling water, produced water, garbage, miscellaneous waste discharges (such as cement slurry), and air emissions. All discharges are required to comply with applicable limits as set forth in the Offshore Waste Treatment Guidelines (OWTG) (Jacques Whitford 2007). The primary issues related to the discharge and deposition of drill muds and cuttings include: deposition (smothering habitat, creation of piles); toxicity (based on chemical constituents of the mud); bioaccumulation (i.e. uptake of hydrocarbons by fish and the perception of taint); and physical effects (i.e. exposure of organisms to fine waste particles) (Jacques Whitford 2003).

Drilling Muds: Water Based Muds (WBM) have very small amounts of toxic components, and are directly discharged to the seafloor when drilling the initial sections of the hole, after which cuttings are discharged from the rig at surface. WBMs have been detected up to 3 km away from a drill site, but most trace metals were found between 250 to 500 m. Toxicity studies by Payne *et al*. (2001) on Hibernia drill cuttings found no acute toxicity in juvenile American plaice exposed for 30 days to Hibernia cuttings. Most likely, drilling muds elicit a startle response in fish resulting in these organisms moving away from the zone of influence (Payne *et al*. 2001).

Operational Discharge: Wastes and discharges from the drill rig include deck drainage, cooling water (semi-submersible only), sanitary and domestic waste (approximately 50 and 25 m^3/day of grey and black water, respectively), garbage and other solid waste, ballast water, bilge water, and produced fluids. All discharges must comply with the OWTG. In exploration drilling programs, produced water would only be discharged once the well is tested for production. However, if any produced water is encountered during the well test, it is likely that it will be atomized and flared during testing (Canada-Newfoundland and Labrador Offshore Petroleum Board 2007).

Reversibility

The effect of noise from oil exploration on fish, marine mammals and sea turtles is considered highly reversible; once the source is removed, individuals are expected to return to the area. The primary issue is the displacement of marine mammals and sea turtles from important spawning or feeding habitat during key periods (Jacques Whitford 2003).

Any benthos, corals, and sponges directly removed by drilling, excavation activity or buried under dredge spoils, drill cuttings or muds will be permanently destroyed. Associated activities may affect corals and benthic species over a broader area by increasing sedimentation in the water column via the re-suspension of naturally occurring bottom sediments, as well as potentially toxic drill cuttings and muds (Gass 2003). If enough drill cuttings are discharged to form piles that can be seen, then sessile, filter-feeding benthic organism, such as corals and sponges, will be smothered and killed (Gass 2003).

Mitigation

The C-NLOPB is responsible, on behalf of the Government of Canada and the Government of Newfoundland and Labrador, for petroleum resource management in the Newfoundland Offshore Area. The *Canada-Newfoundland Atlantic Accord Implementation Act* and the Canada-*Newfoundland and Labrador Atlantic Accord Implementation Newfoundland and Labrador Act* (the Accord Acts), administered by the C-NLOPB govern all petroleum operations in the Newfoundland and Labrador offshore area. The C-NLOPB's responsibilities under the Acts include: issuance and administration of petroleum and exploration and development rights; administration of statutory requirements regulating offshore exploration, development and production; ensuring activities are conducted in an environmentally prudent manner; and approval of Canada – Newfoundland and Labrador benefits and development plans.

All discharges will be required to comply with applicable limits as set forth in the OWTG by the National Energy Board (Jacques Whitford 2007).

Establishment of safety zones around drilling platforms are usually implemented as a mitigation measure, approximately 500 m from a drill rig with an exclusion zone of 0.8 km^2 in total area. Environmental compliance monitoring (including reporting on waste discharges, emissions, and treatment systems) is required to verify adherence to applicable legislation and any conditions of regulatory approval (Jacques Whitford 2003).

COs potentially impacted by oil and gas drilling include*:*

1. corals
2. smooth skate

VESSEL TRAFFIC – NOISE/DISTURBANCE AND SHIP STRIKES

Likelihood

The main shipping lanes between Newfoundland and the Maritime provinces pass through the AOI. The Laurentian Channel is the main route for ships entering and leaving the Gulf of St. Lawrence and the St. Lawrence seaway. The Laurentian Channel AOI has between 4800-12,299 total vessel transits in an average year (Pelot and Wootton 2004), which includes merchant, cruise, and fishing vessel traffic. The Cabot Strait sees approximately 6,400 commercial vessel transits annually, many of which would likely pass through some portion of the AOI.

Koropatnik *et al*.(2012) produced thirteen monthly maps and a 12-month (March 2010 to February 2011) composite of vessel track counts per 2 x 2-minute grid cell using long range identification and tracking (LRIT) data from 2010 to 2011. LRIT is a satellite-based system that tracks vessel identification and positional information for passenger and cargo vessels over 300 gross tonnes on international voyages. These maps serve to highlight commercial traffic patterns for vessels transiting within 1,000 nautical miles from Canada's Atlantic coast. The 12-month composite analysis shows the cumulative commercial vessel traffic for the entire study area. Annual vessel transits in this analysis show that the Laurentian Channel AOI in the range of 51 to 250 vessel transits (vessels >300 gross tonnes) between March 2010 and February 2011, which is the highest vessel traffic density around Newfoundland and Labrador.

Cetaceans and leatherback sea turtles in the AOI can be killed or injured by collisions with ships and ship propellers. Cetaceans and leatherback sea turtles tend to be most vulnerable because they breathe air and so tend to spend much of their time at the surface, often sleeping or resting. Both the size and speed of a vessel are the main determinants for ship strikes, particularly for cetaceans. Researchers (Jensen and Silber 2003) found that the range of speeds at which vessels were operating when a whale was hit was 2 to 51 knots, and the mean speed was 18.1 knots. The mean vessel speed which resulted in injury or mortality to the whale was 18.6 knots. Vessel traffic could also impact the AOI through pollution, aquatic invasive species, anti-fouling from hulls, and engine and propeller noise.

Severity

Researchers in 1992 studied the effects of pleasure craft on bottlenose dolphins and reported that the cetaceans exhibited negative responses to boat traffic, including changes in dive times and the avoidance of an approaching vessel at a distance of 150 to 300 m. Studies suggest that the 'areal extent' of impact can often be greater than the actual traffic route (The Whale and Dolphin Conservation Society 2004).

Vessel traffic could pose a risk to migration, especially for cetaceans, as it is a source of noise which impacts different species to varying degrees. In the northern hemisphere, shipping noise is the dominant source of background noise between 10 to 200 Hz (The Whale and Dolphin Conservation Society 2004). This chronic noise likely reduces the ability of large whales to maintain contact with others, potentially reducing mating and foraging opportunities. The noise from these vessels is at a frequency capable of masking blue whale calls (Payne 2004). The degree to which such acoustic pollution may, or already has, degraded habitat located near commercial shipping lanes has not been determined (DFO 2006b).

While no incidences of collisions with boats are documented in Atlantic Canada, they have been known to occur in some areas of the U.S. and may have an impact on the leatherback turtle population within Canadian waters. In areas where recreational boating, commercial fishing and ship traffic are concentrated, propeller and collision-related injuries may represent a source of mortality. However, in situations where there is evidence of a collision, it is difficult to infer whether the collision itself led to the death of the turtle in question, or if the turtle was hit after it died of other causes. Leatherback turtles are known to bask at the surface for extended periods of time when foraging in temperate waters and, therefore, are vulnerable to collisions with marine traffic (Atlantic Leatherback Turtle Recovery Team 2006).

Mitigation

Ship movements in coastal areas and within vessel traffic separation schemes are reasonably well known and readily captured by existing data collection streams (e.g., Automatic Identification Systems (AIS); Vessel Traffic Services (VTS) tracking systems). However, surveillance coverage of vessel traffic in the offshore has been limited, so less is known about the spatial and temporal patterns of commercial shipping beyond the coastal zone. LRIT is a new class of satellite enabled surveillance options. LRIT is a satellite-based system that tracks vessel identification and positional information for passenger and cargo vessels over 300 gross tonnes on international voyages. To date, surveillance technologies such as LRIT have been used almost exclusively for real-time maritime domain awareness in support of maritime safety and security.

An incomplete understanding of the distribution patterns of endangered species creates serious challenges for identifying areas where implementation of conservation efforts would be most effective. Conservation efforts largely remain focused on protecting leatherback nesting habitat and enhancing survivorship of eggs in southern regions. To promote leatherback recovery, there is an urgent need to identify critical leatherback foraging habitat and address anthropogenic hazards to turtles in those areas.

Aerial and shipboard surveys for sea turtles have not been conducted, and published accounts of leatherbacks in Canadian waters summarize observations of small numbers of turtles, typically found entangled in nearshore fishing gear. Information on sightings and tracking sea turtles is opportunistic. James *et al*. (2006) collected 851 geo-referenced records of leatherback turtles (1998 – 2005) from a

volunteer network of commercial fishers and tour boat operators in Atlantic Canada. Satellite telemetry provides a more independent means of addressing this issue, and has advanced understanding of the behaviour of leatherbacks in areas distant from nesting colonies (James *et al*. 2006). To enhance awareness and promote reporting of leatherbacks among commercial fishers and other mariners, public education and outreach initiatives targeting coastal communities in
Nova Scotia began in 1998 under the direction of the Nova Scotia Leatherback Turtle Working Group. A toll-free phone number was established for reporting leatherback sightings. Active recruitment of fishers as volunteer data collectors took place at wharves and fishing organization meetings. Fishers were asked to record the date, time, GPS location and condition (e.g., alive or dead, free-swimming or entangled) of each leatherback observed during the years 1998 to 2005. Canadian pelagic fisheries observer data can also aid in mitigation planning.

In Canada, aerial surveys are required to assess regional patterns and long-term trends in leatherback abundance, to help identify areas of turtle concentration at smaller scales, and to evaluate the spatial and temporal overlap between leatherbacks and the human activities that impact them. Finally, to enhance our ability to predict occurrence of this endangered species, systematic surveys for leatherbacks in their northern foraging areas should include simultaneous study of turtle behaviour and physical and biological oceanographic conditions, including prey distributions (James *et al*. 2006).

COs potentially impacted by vessel traffic include:

1. leatherback sea turtle

SUBMARINE CABLES

Likelihood

Persona Communications Corporation completed installation of a fibre optic cable in 2011 which is comprised of two parallel submarine cable segments linking Cape Breton (Sydney area) to Newfoundland (Port aux Basques area) as well as four additional submarine segments along the southern coast of Newfoundland. The Newfoundland portion of the system consists of two main cable lines: one is land-based and runs from Port aux Basques to St. John's following the TransCanada highway; the other will be a combination of land-based and submarine running along the south coast, with a land-based line from St. John's to Argentia and a series of submarine components running from Argentia to the Port aux Basques area. The cable is not powered, and is made of 24 single mode fibres; it will carry Internet, TV, and telephone signals. The only transmission through the cable is light. The cable has no magnetic field, nor does it vibrate. This cable crosses NAFO subdivision 3Pn and will not affect the AOI.

Hibernia Atlantic is Canada's largest trans-Atlantic submarine cable operator, and has planned installation of a submarine cable from Halifax to the United Kingdom. This 'Canadian Express' installation will provide service mainly to the financial industry, including banks, financial exchanges and trading firms. Installation of the cable is targeted for March - August 2012. A cableship will lay cable with a plough to achieve cable burial depth of at least 1 meter where possible throughout the Canadian continental shelf from the Halifax landfall near Herring Cove to north of Flemish Cap. Plough speed is 1 km/hr. The cable is also to be buried in the Laurentian Channel.

Severity

Once cables are laid, they cause no significant harm to the marine ecosystem, and may even be used as habitat or attachment sites for certain organisms. When crossing soft bottoms, the cable is typically buried by a cable vessel pulling an underwater plow. When crossing hard bottom areas, where burial is infeasible and anchoring or bottom-fishing gear is expected, typically "armored" cable is used. The cable itself is narrow, at 43mm for thicker parts and 28mm for thinner parts. The trench for the cable will also be narrow, at 20cm across and will fill in quickly in softer soils, and will take more time in harder soils. Evidence shows that such cables do not move laterally once placed. Natural sea-bed features are used to shelter cables in valleys and trenches to minimize possibility of iceberg contact or interaction with fishing activity. In order to do this, tunneling and rock trenching may be used. When crossing the deep ocean, where no anchoring or bottom-fishing gear is expected, the cable typically is just laid flat on the ocean bottom and has no known adverse effects (GlobalSecurity 2006). A typical cable installation may involve two or more corridors, each with a footprint of less than 5m in width (Nalcor Energy 2009).

Reversibility

Any excavation of the sea floor can result in direct mortality of corals and sponges as a result of breaking, crushing and burying. Excavation also increases sedimentation which can be hazardous to corals and sponges, congesting polyps and inhibiting feeding processes (Edinger *et al*. 2007), particularly for those that are buried or crushed onto the sediments. However, old cables are found encrusted with corals and other sea life.

Any corals and sponges that are directly removed by drilling, excavation activity or associated pipeline construction, or buried under dredge spoils, drill cuttings or muds will be permanently destroyed. Associated activities may affect corals over a broader area by increasing sedimentation in the water column via the re-suspension of naturally occurring bottom sediments (Gass 2003).

Exposure to disturbances, either physical or chemical, often results in the retraction of coral polyps. If these defense reactions persist for long periods of time because of continued exposure to a pollutant or physical disturbance, they can have various results: decreased nutrient assimilation and production, altered biochemical composition, depressed respiration and nitrogen excretion, partial or complete inhibition of growth and deposition of calcium carbonate skeleton, bacterial infection, and eventually death can result from chronic exposure to a pollutant (Gass 2003).

Deep-sea coral and sponge communities are considered one of the most biodiverse ecosystems in the ocean and are considered as core biological components for the identification on Vulnerable Marine Ecosystems (VMEs) by NAFO's working group on the ecosystem approach to fisheries management (Fuller *et al*. 2008). Corals and sponges play important ecological roles in the lifecycles of many species associated with them, providing feeding sites, nursery habitat, physical substrates for attachment and shelter from predators for invertebrates and fish, including both commercial and non-commercial species (Edinger *et al*. 2007; Fuller *et al.* 2008). Any activity or stressor that affects coral and sponge communities could potentially have a significant negative affect on other components in the ecosystem.

Mitigation

A desktop study was completed by Hibernia Atlantic from June to October 2010, and the proposed route is influenced by fishing, hydrocarbon developments, seabed geology and topology, ice, and geopolitical boundaries, among other things. The upcoming Environmental Assessment review process could last 8 months. Public Works in St. John's, NL will coordinate the EA review process as well as the distribution of the Project Description to federal and provincial (NS and NL) government departments to identify concerns and mitigations.

<u>COs potentially impacted by submarine cables include</u>:

1. corals

MARINE DEBRIS

<u>Likelihood</u>

Marine debris is a classic "tragedy of the commons" environmental problem. As the ocean is a vast commons, individuals can pollute without an immediate negative consequence. In the Atlantic Ocean, currents funnel debris towards the Gulf of Mexico from a huge area which includes the south eastern USA, Mexico, central and South America and Africa. These currents eventually form the Gulf Stream, a major current which carries debris north towards Atlantic Canada. In turn the North Atlantic Current carries debris from the northeast coast of Newfoundland and Labrador towards Europe and Africa.

Marine debris can be anything discarded or lost which makes its way to the marine environment. It ranges from large items such as tires, building materials, and abandoned vehicles, to smaller items like fast food containers, pop cans, plastic chip and candy bags, coffee cups, cigarette butts, motor oil bottles, rope, and fishing line. A report issued by the United Nations Environment Program states that plastics comprise 60 to 80 percent of the ocean's total trash, as well as 90 percent of all floating marine debris (UNEP 2009). Plastics contribute disproportionately to the overall impact of marine debris for a number of reasons. Due to their low cost they are readily discarded, and because they are lightweight they tend to float, remaining available to interact with marine organisms.

<u>Severity</u>

A recent study of over 400 individuals reported that one third of leatherback sea turtles had plastic in their digestive system (Discovery News 2009). Of even greater concern is the fact that plastics do not biodegrade, but instead go through a process called photo-degradation, where they are broken down by sunlight into smaller and smaller pieces, all of which are still plastic polymers, and consumed by marine life. Not all plastics are negatively buoyant, and plastic debris also accumulates on the sea floor, where it is available to interact with benthic organisms. Although 80 percent of marine debris is attributed to land-based sources, shipping is also a significant source of marine debris. Intentional discharge of solid waste contributes to the problem. Accidental loss of cargo and fishing gear are also major sources of concern. Plastics contribute disproportionately to the overall impact of marine debris for a number of reasons (Derriak 2002; Moore *et al*. 2001).

Marine debris also poses a serious danger to marine organisms through ingestion and entanglement. Common items including fishing line, strapping bands, and lost fishing nets can entangle fish, whales, turtles, and sea birds, preventing them from swimming, feeding and/or breathing, frequently with deadly results. A four-year study off the coast of Newfoundland estimated that over 100,000 animals were killed by entanglement from 1981 to 1984 (Environment Canada 2002). Abandoned, lost or otherwise discarded fishing gear (ALDFG) is a problem that is increasingly of concern. The impacts of ALDFG include: continued catching of target and non-target species (such as turtles, seabirds and marine mammals); alterations to the benthic environment; navigational hazards; introduction of synthetic material into the marine food web; introduction of alien species transported by ALDFG; and a variety of costs related to clean-up operations and impacts on business activities. In general, gillnets and pots/traps are most likely to “ghost fish” while other gear, such as trawls and longlines, are more likely to cause entanglement of marine organisms, including protected species, and habitat damage (Macfadyen *et al*. 2009).

Reversibility

Acute impacts leading to mortality include blockage of the throat or digestive tract and physical injury from ingestion of hard objects. Ingestion of such materials may interfere with metabolism or gut function and lead to blockages in the digestive tract, which could result in starvation or in the absorption of toxic byproducts (Atlantic Leatherback Turtle Recovery Team 2006). Ingestion and entanglement in marine debris or lost fishing gear will likely result in death, or decreased condition leading to vulnerability to predators, starvation, or drowning (i.e. leatherbacks). Lost pots and traps can continue to fish indefinitely. Some instances of entanglement may be reversible if the individual is able to free themselves.

A main concern regarding plastics, which make up the majority of marine debris, is the fact that plastics do not biodegrade, but instead go through a process called photo-degradation, where they are broken down by sunlight into smaller and smaller pieces, all of which are still plastic polymers. Plastic particles will continue to be released for hundreds of years from the slow breakdown of the millions of tons of plastic already circulating in the world’s oceans. Some scientists estimate that plastic can last 300-600 years. Others say it lasts forever, but we don’t really know yet. We do know that plastic cannot be digested, or used as a source of food by any living creature.

Mitigation

Marine debris is a chronic stressor that is difficult to target as litter can be carried thousands of miles from the original sources. The *Canada Shipping Act* prohibits the discharge of garbage into Canadian waters, and an International Convention bans the dumping of all forms of plastic into the sea. Although the world’s fishing fleets still dump thousands of tons of debris into the sea each year, increased awareness is making a difference and steadily reducing this practice. Technology can be used to reduce the impacts of abandoned, lost or discarded fishing gear, particularly through alterations to the gear itself to minimize the potential to ghost fish, but also through ways to better manage gear in the water. Reduced ghost catches can be achieved through the use of biodegradable nets and pots. In Newfoundland and Labrador, a biodegradable mesh piece is required in all crab pots as of 2012. Better reporting of lost gear, attempts to retrieve lost gear, and raising awareness of the problem will help to lessen the effects of lost fishing gear over time. Various United Nations General Assembly resolutions now provide a mandate for, and indeed require, action to reduce ALDFG and marine debris in general.

COs potentially impacted by marine debris include:

1. leatherback sea turtle

HUMAN ACTIVITIES NOT CONSIDERED KEY STRESSORS TO THE COS

SEISMIC SURVEYS (AND DRILLING NOISE)

A typical seismic survey lasts two to three weeks and covers a range of approximately 555 to 1110 km. Airguns, towed near the back of a ship, release compressed air every 6 to 10 seconds with duration of 10 to 30 milliseconds per shot (Jacques Whitford 2007). Each exploration licence area will be completely explored by seismic surveys, but this usually occurs when the licence is given, therefore is not repeated in most cases. Each new area in the C-NLOPB's 'Call for Bids' process may undergo seismic surveys. The Laurentian Basin south of St. Pierre Bank was subject to extensive seismic survey activity from 1995 to 1999 (DFO 2007a).

Seismic surveying involves sending sound waves from a vessel to the seafloor, and recording the echoes that bounce back off the various sedimentary layers. The shock waves are generated by a high pressure air gun towed near the back of the ship and cable is towed (500 m to 8 km in length) to record the reflected sound waves. Airgun arrays are usually audible over 50-75 km when used in water 25-50 m deep. Noise from just a single seismic survey can flood through a region of almost 300,000 km^2, raising noise levels 100 times higher, continuously for days at a time (Atlantic Whale Foundation 2010). Detection range can increase to over 100 km in deeper water or when propagation conditions are efficient (Hammill *et al.* 2001).

There is a concern with the noise produced by drilling activities on cetaceans as they depend on the underwater acoustic environment. The studies available suggests that seismic exploration may cause strong avoidance reactions in some species while still several kilometers away from seismic survey ships (Hammill *et al*. 2001). Not only can loud or persistent noise impact the auditory system of cetaceans, it may impact health by bringing about changes in immune function, as has been shown in other mammals. In addition, noise has been documented as causing displacement of cetaceans from preferred habitats. Avoidance reaction by cetaceans may occur within 1 km of the array and within 500 m of sea turtles (Canada-Newfoundland and Labrador Offshore Petroleum Board 2010).

Studies on sea turtles have shown that certain levels of exposure to low frequency sound may cause displacement from the area near the sound source and increased surfacing behaviour. This raised the concern that turtles may be displaced from preferred foraging areas. Concerning the exposure to seismic airguns used in exploration, studies to date describe behavioural responses such as: increased swimming speed, increased activity, change in swimming direction, and avoidance (DFO 2004). Startle responses and erratic swimming behaviour was also observed by McCauley *et al*. (2000). Overall, based on the available information, it is considered unlikely that sea turtles are more sensitive to seismic operations associated with oil and gas exploration than cetaceans or some fish (Atlantic Leatherback Turtle Recovery Team 2006).

Behavioural effects of seismic activity on marine fish may include avoidance behaviour (a startle response, a change in swimming direction and speed, or a change in vertical distribution), increased swimming speeds, disruption of reproductive behaviour, and alteration of migration routes. If a seismic survey overlaps with the presence of migrating fish species, startle responses and temporary changes in swimming direction and speed could be expected, but schooling behavior is not expected to be affected. Any temporary change in behavior is not expected to interrupt the natural migration instinct to a spawning or feeding area (Jacques Whitford 2007). However, long term impacts to migration routes could have severe consequences, but there is little evidence to prove that this would occur. No mass fish kills associated with the operation of airguns have been recorded to date (Jacques Whitford 2003).

A review of scientific information on impacts of seismic sound on a range of marine animals concluded that, "from available evidence, seismic sounds in the marine environment are neither completely without consequences nor are they certain to result in serious and irreversible harm to the environment" (Fisheries and Ocean Canada 2004). Potential acute effects range from induction of the bends, physical damage to body tissues including ears, temporary shift in hearing threshold, interference in ability to communicate or interpret other important sounds within the environment, interruption of key activities such as feeding, and displacement from area (The Whale and Dolphin Conservation Society 2004).

Potential chronic effects range from permanent shift in hearing threshold, decreased viability, increased vulnerability to disease, increased potential for impacts from negative cumulative effects (e.g. chemical pollution combined with noise-induced stress), sensitization to noise causing animals to remain close to damaging noise sources, reduced availability of prey, and increased vulnerability to predation or other hazards, such as collisions with fishing gear, strandings, etc. (The Whale and Dolphin Conservation Society 2004). The behavioural and physiological impacts of seismic surveys are better studied and more obvious. Few chronic impacts have been discovered for fish or cetaceans. Long term impacts to migration routes could have severe consequences, but there is little evidence to prove that this would occur. As cetaceans have been identified as a research priority for the Laurentian Channel AOI further study is warranted.

Mitigation

In February 2005, the Government of Canada and the provinces of Newfoundland and Labrador, Nova Scotia, and British Columbia proposed a *Statement of Canadian Practice for the mitigation of seismic noise in the marine environment*. The *Statement* aims to formalize and standardize the mitigation measures used in Canada for the conduct of seismic surveys in the marine environment. It is based on a DFO-sponsored peer review by Canadian and international experts. It specifies the mitigation requirements that must be met during the planning and conduct of marine seismic surveys, in order to minimize impacts on life in the oceans. These requirements are set out as minimum standards, which will apply in all non-ice covered marine waters in Canada. The document incorporates many of the mitigation measures currently being employed in Newfoundland and Labrador waters. The *Statement* sets out mitigation requirements for:

- Planning of seismic surveys
- Establishment and monitoring of a safety zone
- Prescribed marine mammal observation and detection measures
- Prescribed start-up
- Prescribed shut-down

OIL POLLUTION

A number of major shipping routes cross the AOI, resulting in a high density of vessel traffic due to ships moving from Newfoundland to Nova Scotia and the US eastern seaboard, as well as international traffic to and from the St. Lawrence seaway and the Gulf region. Vessel traffic may result in chronic oil release and the risk of large and small spills. Chronic ship-source oil pollution, or mystery spills, result largely from intentional oily bilge or ballast water releases at sea from large vessels. Offshore oil exploration is ongoing within the AOI, with associated oil releases in produced water and accidental spills an ongoing possibility. An oil spill may result from a surface or subsea blow-out or an accidental discharge from the drilling platform or associated vessel.

The effects of oils and hydrocarbons on marine life vary with the composition of the oil, the environmental characteristics of the area, and the species' sensitivity. The nature and severity of such an interaction would depend on the magnitude, timing, and location of the spill (Jacques Whitford 2003). Oils may be toxic to aquatic life when ingested or absorbed through the skin or gills and can interfere with respiratory systems. Oils can also taint seafood and smother benthic communities. Reported physiological effects on fish included abnormal gill function, increased liver enzyme activity, decreased growth, organ damage and increased disease or parasite loads. The fish and invertebrate life stages most sensitive to oil exposure are the egg and larval stages. Planktonic eggs and larvae that occur near the surface are moved by the same physical forces (wind, current) that move the oil slick (Transport Canada 2007), and are not able to actively avoid water that contains oil. Species whose larval forms are found in the first few meters of the water column for a number of months, would be at higher risk (Carew 2001).

For the Sydney Basin drilling program, the probability of a blowout during the drilling of an exploration well is estimated to be 1 in 19,500 for spills greater than 150,000 bbl, 1 in 6,500 for spills greater than 10,000 bbl, and 1 in 4,875 for spills greater than 1,000 bbl (Canada-Newfoundland and Labrador Offshore Petroleum Board 2007).

Although cetaceans and leatherback turtles spend much of their time at the sea surface, it is likely that these highly mobile species are frequently able to avoid significant impacts. They may experience irritation or ulceration of the skin, eyes, mouth or airways/lungs from direct contact with oil and suffer from chronic impacts through direct ingestion or food chain effects. Benthic species such as smooth skate, which spend much of their time in contact with bottom sediments, may be negatively impacted by chronic exposure to contaminated sediments. Risks to fish stock recruitment are generally viewed as being higher for spills in shallow and enclosed inshore waters as opposed to more open and deep waters in the offshore (Carew 2001).

Open ocean environments recover much more rapidly from oil spills as oils tend to remain at the sea surface where biodegradation is most active, and slicks are rapidly dispersed by wind and wave action, resulting in improved biodegradation and a rapid reduction in harmful effects. The weathering process can result in the formation of tar balls which may fall to the bottom, but even following a large spill, tar balls would be widely dispersed.

Mitigation

Transport Canada (TC) takes the lead role in regulating and managing marine traffic within Canadian waters. The responsibility for ship inspection falls under TC's Marine Safety Directorate, which regulates marine transportation as well as the inspection of both domestic and foreign vessels in Canadian waters. The nearest Marine Safety Offices are located in Corner Brook and Marystown (Intervale 2006).

Vessels are regularly inspected for compliance with shipping regulations, which includes salinity tests on ballast water in the tanks and review of on board documentation. Pollution from oil cargo residues is mitigated through surveillance, and various inspections. Ballast water is mitigated by reporting, vetting of reports, monitoring discharge, and onboard compliance inspections and sampling.

Transport Canada keeps a watchful eye over ships transiting Canadian waters through its National Aerial Surveillance Program (NASP). The NASP is the primary tool for detecting ship-source pollution in waters under Canadian jurisdiction. Evidence gathered by NASP crews is used by TC and Environment Canada (EC) to enforce the provisions of all Canadian legislation applicable to illegal discharges from ships, including the *Canada Shipping Act* and the *Migratory Birds Convention Act*. Additionally, through an agreement with the Department of Fisheries and Oceans, TC uses Provincial Airlines Limited aircraft for pollution patrols and validation of Radarsat imagery as part of the Integrated Satellite Tracking of Polluters (I-STOP) project, in waters off Newfoundland and Labrador. Aerial surveillance can be an effective tool in combating ship-source marine pollution by detecting oil spills and gathering evidence to prosecute polluters. TC is also a strong partner in the I-STOP project, which uses earth observation technology (Radarsat imagery) to look for oil-like signatures (anomalies) on the ocean's surface that could be indicative of an oil spill. To supplement ongoing NASP pollution surveillance flights, TC uses Radarsat as an early warning system to direct pollution surveillance flights to the locations of potential pollution incidents.

AQUATIC INVASIVE SPECIES

Aquatic invasive species (AIS) are widely recognized as a major threat to marine biodiversity and have transformed marine habitats around the world, displacing native species, changing community structure and food webs, and altering fundamental processes such as nutrient cycling and sedimentation. Marine industries and infrastructure are also affected. AIS are generally characterized by rapid population growth which displaces or kills native and farmed species, fouls boats, wharves, fishing and aquaculture gear, and damages benthic habitats. It is difficult to predict the behavior of AIS in a new environment and species that exhibit explosive population growth in one area may not thrive to the same extent in others.

To date, five AIS have been detected within the Placentia Bay-Grand Banks Large Ocean Management Area (LOMA), including the European Green crab (*Carcinus maenas*), the golden star tunicate (*Botryllus schlosseri)*, the violet tunicate *(Botrylloides violaceus),* coffin box bryozoan *(Membranipora membranacea)*, and the Japanese skeleton shrimp *(Caprella mutica)*. AIS are a priority for action in the PBGB LOMA Integrated Management Plan (2012) and DFO Oceans intends to engage further on this issue in the future.

The key activities or stressors are the vectors associated with the non-authorized introduction of the harmful species. Vessel related introductions, particularly ballast water, are a major focus of concern. Any water that enters a vessel during operation (ballast, bilge water, sea chests, live wells, and engine cooling systems, etc.) may contain unwanted organisms, while hulls, anchors, ropes, and related equipment and gear provide attachment sites for marine hitchhikers. Although the risk of primary introductions from overseas ports may have been reduced through open-ocean exchange of ballast water, secondary introductions from previously invaded ports in North America may be the primary threat to Canadian aquatic ecosystems (Humphrey 2008), since open-ocean exchange is not mandatory for ships traveling within the northwest Atlantic north of Cape Cod.

Other vectors for introduction and spread of AIS may include transfer of wild and cultured seafood, movement of fishing or aquaculture gear, buoys, moorings, cables, dredging equipment, and drill rigs. Environmental changes such as temperature rise, increased nutrients, and increased storm events can also promote the growth and spread of invasive species and/or intensify their negative impacts.

Mitigation

The regulatory framework governing AIS is complex, and multi-jurisdictional, with some level of uncertainty due to the wide range of potential pathways for introduction and spread of AIS, and the scope of potential impacts. Numerous regulatory authorities and stakeholders are involved, from local to international levels, and national efforts to address the issue have involved both *federal and provincial governments,* led by the *Canadian Council of Fisheries and Aquaculture Ministers (CCFAM).*

Within the federal government, primary responsibility and authority rests with DFO and EC, but depending on the species and its pathway into Canadian waters, management actions can involve a number of other agencies including TC, Canadian Food Inspection Agency (CFIA) and provincial Fisheries and Aquaculture (DFA).

Efforts to coordinate laws and regulations with a bearing on aquatic invasive species are in their early stages, and have focused largely on ballast water management. In many cases, broad regulatory mechanisms already exist to control the intentional and unintentional introduction of AIS, but where resources will come from and who will bear enforcement responsibility still needs to be adequately addressed. In order to be effective, legislation and regulations must be coordinated within and between governments.

DFO

- Lead federal agency for AIS
- Bill C-32, the new Fisheries Act, proposes authority to develop AIS regulations
- Aquaculture, Science Branch maintains the National Registry on Introductions and Transfers, Coordinate annual report for CCFAM (Canadian Council of Fisheries and Aquaculture Ministers)
- *National Code on Introductions and Transfers of Aquatic Organism* developed by DFO and provinces at the request of CCFAM. The Code does not cover accidental introductions and transfers, where the transfer of an aquatic organism (and its eventual release into natural waters) is not intentional.

ASSESSMENT OF POTENTIAL STRESSORS ON CONSERVATION OBJECTIVES

The Laurentian Channel AOI COs were identified based on the ecological significance of ecosystem components and properties, without reference to the associated level of risk resulting from human activities. Clearly, elements that are at risk of immediate and irreversible harm must be given a higher priority for management action than those that appear to be relatively safe from harm for the foreseeable future.

The analysis of the COs is based on a three-phase methodology (Park *et al.* 2010) used to characterize and analyze the level of risk from human activities and/or potential stressors on key marine ecosystem components and/or properties, and provide information on cumulative effects. Details on the assessment methodology are available at http://www.dfo-mpo.gc.ca/Library/340905.pdf. The level of activity or intensity for each stressor is considered for an average year.

The COs and potential stressors resulting from human activities included in the analysis include the following:

1. Protect corals, particularly significant concentrations of sea pens, from harm due to human activities in the Laurentian Channel MPA.
    - Commercial fishing – bottom trawl
    - Oil and gas exploratory drilling
    - Submarine cables

2. Ensure that human activities in the Laurentian Channel MPA do not impair the reproduction and survival or disrupt important aggregations of black dogfish.
    - Commercial fishing – bottom trawl

3. Protect areas of juvenile smooth skate abundance and ensure that human activities in the Laurentian Channel do not impair the reproduction and survival of the species.
    - Commercial fishing – bottom trawl
    - Oil and gas exploratory drilling

4. Ensure that human activities in the Laurentian Channel MPA do not impair the reproduction and survival of porbeagle shark.
    - Commercial fishing – longline

5. Promote the survival and recovery of Northern wolffish by minimizing risk of harm from human activities in the Laurentian Channel MPA.
    - Commercial fishing – bottom trawl

6. Promote the survival and recovery of leatherback sea turtles by minimizing risk of harm from human activities in the Laurentian Channel MPA.
    - Commercial fishing – longline (entanglement)
    - Ship strikes
    - Marine debris

RESULTS

This assessment followed a phased methodology which identifies key activity/stressors for each CO, and produces a numerical score for the interaction between each key activity and the CO. This allows the COs to be ranked based on a relative analysis of cumulative risk of harm from human activities and associated stressors. The final ranking is presented here, with the individual assessments for each CO available in Appendix A.

The numerical scores for each CO-activity/stressor interaction (Table 3) can be combined in a number of ways, allowing an examination of cumulative effects associated with each CO, or an activity-based analysis. The ranking process allows a planning initiative, such as the Laurentian Channel MPA Advisory Committee, to focus efforts on managing activities that pose the greatest risk of harm to the COs.

Table 2: Prioritization ranking for Laurentian Channel AOI conservation objectives.

Conservation Objective	Assessment Score	Rank
Leatherback sea turtle	18.5	1
Corals, particularly sea pens	15.1	2
Black dogfish aggregations	7.8	3
Smooth skate	6.9	4
Northern wolffish	6.5	5
Porbeagle shark	1.7	6

Table 3: Results of individual CO assessment.

Human Activity/ Stressor	Corals, sea pens	Black dogfish	Smooth skate	Porbeagle shark	Northern wolffish	Leatherback sea turtle	TOTAL
Fishing- Bottom trawl	11.6	7.8	6.0		6.5		31.9
Fishing - Longline				1.7		1.3	3.0
Oil and gas exploratory drilling	3.5		0.9				4.4
Submarine cables							0
Ship strikes						10.4	10.4
Marine debris						6.8	6.8
TOTAL	**15.1**	**7.8**	**6.9**	**1.7**	**6.5**	**18.5**	

The scores reflect the risk of harm from human activities or associated stressors, based on a detailed review of available literature, including primary scientific literature, data collected by government and non-government agencies, consultants, and personal communication with relevant experts. The leatherback sea turtle had the highest score, followed by corals (sea pens). Porbeagle shark had the lowest score of the COs. Black dogfish, smooth skate, and Northern wolffish had similar scores in the middle range (results graphed in Figure 3). Bottom trawl was the activity which came out as creating the most risk of harm for all COs combined (see Figure 4).

The detailed assessments for each CO are provided in Appendix A.

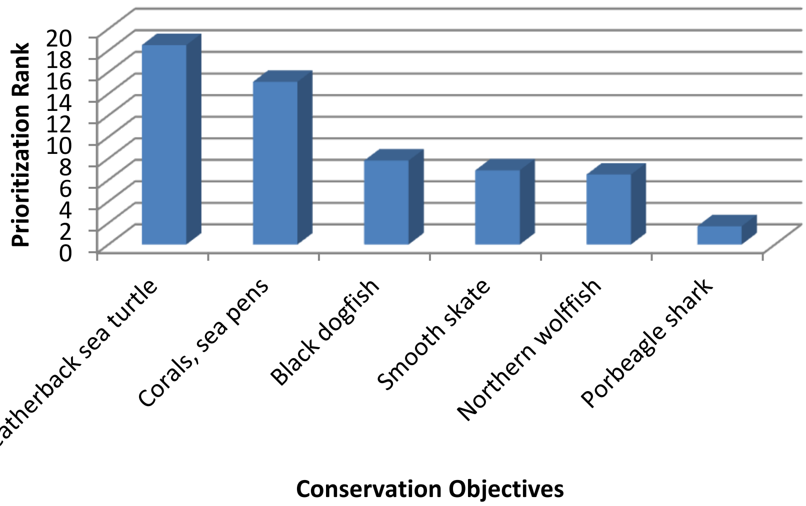


Figure 3: Relative prioritization ranking, based on impacts from human activities.

Scores for each activity/stressor were combined to allow a ranking of key human activities which require priority action. The relative scores provide a measure of each activity/stressor's contribution to the risk of harm and help guide MPA planning by providing an understanding of which activities may be incompatible with the COs.

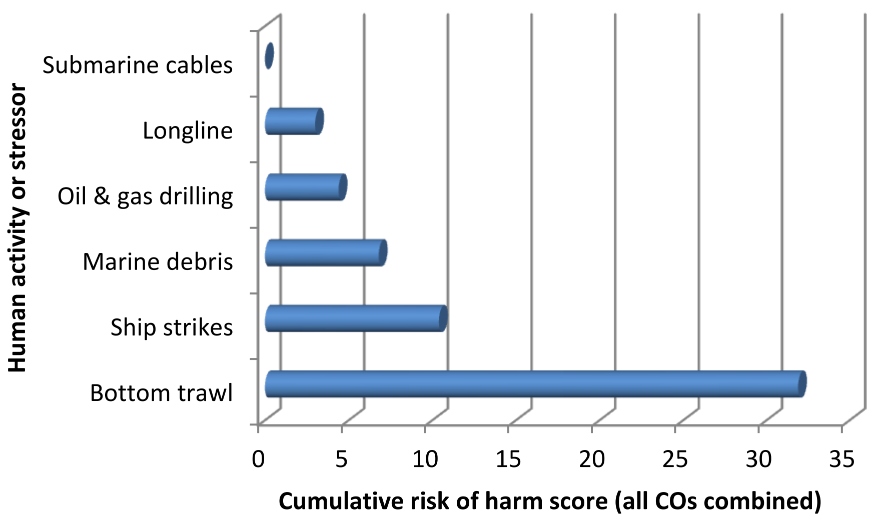


Figure 4: Cumulative risk of harm score for each human activity/stressor.

CUMULATIVE IMPACTS

Concerns are often raised about the long-term changes that may occur not only as a result of a single action but the combined effects of each successive action on the environment. These incremental effects may be significant even though the effects of each action, when independently assessed, are considered insignificant. Cumulative effects are changes to the environment that are caused by an action in combination with other past, present and future human actions. Cumulative effects can be additive or synergistic. One of the goals of ecosystem-based management is to reduce cumulative impacts. MPAs cannot be isolated from many of the activities and impacts occurring outside their boundaries. Thus, MPAs will be most successful at meeting goals when there is some degree of coordination among the management entities responsible for fisheries, coastal development, offshore oil and gas extraction, shipping, and other human activities (Halpern *et al*. 2010).

One of the main obstacles to assessing the state of the oceans and in planning for the conservation, protection and sustainable management/use of the marine environment is the slow response of the seas to pressures. Many processes and changes in the oceans take place below the surface, silently, on large scales and over long time periods, and are not on the ‘radar screen’ of human perception. Many marine areas and species may be exposed and impacted simultaneously by all or several stressors, often acting in synergy and thereby amplifying their effects and impacts. This is called cumulative effects. For example, climate change will provide numerous changes in the oceans. It will affect physical parameters such as temperature, strength of currents and the chemistry of the oceans, which, in turn, will invariably impact fisheries.

There is presently no measurement system in place for many ecosystem attributes that are fundamental to the provision of ecosystem services, such as biodiversity, on scales large enough to be relevant to management. In the context of ecosystem-based management, interaction terms and cumulative impacts will inherently include high levels of uncertainty, but it may be clear that an interaction is occurring and is substantial. In this case, management that accounts for the interaction should move ahead even if the precision of specific parameters is low (precautionary approach). Such protections should not wait for the development of detailed studies on effects if there is even nominal evidence such an impact may be important (Agardy 2005). There is also an urgent need for a more complete understanding of cumulative impacts. While it is possible to estimate the impacts of a particular fishery on an individual ecosystem service such as the biomass of a certain fish stock, understanding the cumulative impacts of all activities on the valued ecosystem components of the Laurentian Channel is more challenging.

Cumulative effects are difficult to quantify and even predict. The methodology used for the CO analysis provides a workable approach to cumulative effects assessment, and one that is open to scientific scrutiny and review. This is very important both in terms of documenting the information on which decisions are based and for moving cumulative effects assessment beyond the expert opinion approach. It is recognized that these interactions are complex and in some cases nonlinear, and that some activities/stressors will have more than an additive effect while others may diminish the impacts of another. However, it is believed that adding the individual activities/stressors scores will provide a reasonable indication of the overall level of threat to an ecosystem component (Table 2) despite inherent inaccuracies, and can contribute to the development of effective MPA planning (Park *et al*. 2010).

RECOMMENDATION

The 'Overview and Assessment of the AOI' (consisting of the Biophysical Overview, SEC Overview, and this Assessment Report) underpins the decisions leading to the establishment of an MPA. The intent of these documents has been to focus on those ecological features for which the AOI has been selected (COs), as well as the social, economic and cultural characteristics that impact these ecological features. It is important to distinguish between assessing the impacts of human activities on the components of an ecosystem and assessing the socio-economic effects of establishing the MPA. The latter will be accomplished through the Cost-Benefit Analysis in the regulatory documents.

The goal of the Assessment of the AOI Report is to help identify the regulatory and management measures necessary to achieve the objectives, referred to as the 'regulatory intent' of the proposed MPA. The Assessment provides this information through identification of the impacts from individual or multiple human activities on the significant ecological features and functions within the AOI. The types of human activities which may impact the COs and overall goal of the MPA have been acknowledged. Also, the risk of harm due to these activities has been quantified through a systematic and transparent analysis. The final step of the 'Overview and Assessment of the AOI' is to use the Assessment results to determine which activities are compatible with the AOI COs, and how they should be managed or mitigated.

Based on the potential impacts of human activities and risks identified in the Assessment, ecosystem features needing protection in the Laurentian Channel AOI include the following:

- Leatherback sea turtle is listed as Endangered under Schedule 1 of the *Species at Risk Act.* Although a national recovery plan has been drafted, there are no specific regional plans to alleviate threats in the Laurentian Channel, which is one of the most highly frequented foraging areas in Atlantic Canada, and regularly supports one of the highest summer and fall densities of leatherbacks in the North Atlantic. The Action Plan is still being developed (led by Maritimes Region) in which critical habitat will be identified.

- Corals, particularly sea pens, are known to be sensitive benthic habitat and provide habitat complexity. Scientific study and research on deep-water corals is ongoing within the Newfoundland and Labrador region, and the highest regional concentrations of sea pens occur within the Laurentian Channel. The potential importance of soft corals and sea pens as potentially habitat-forming organisms, particularly for juvenile fish and invertebrates such as redfish, shrimp and crab must not be overlooked at this early stage of investigation.

- Black dogfish are highly concentrated in the Laurentian Channel, and this area is the only known pupping ground in the Northwest Atlantic. This non-commercial shark species is not well studied, but is ten times more densely concentrated in the Laurentian Channel than other Canadian waters. Species that are the most abundant within the AOI are likely to be more influential within the ecosystem.

- Smooth skate are common catch in the skate fishery, targeting thorny skate, and therefore overlooked in the management of the fishery. The Laurentian Channel is an important young juvenile ground. Knowledge of the life history of the species is limited, but we do know that they produce only about 50 large eggs (purses) on the bottom each year, therefore have limited reproductive potential, and higher vulnerability.

- Northern wolffish is listed as Threatened under Schedule 1 of the *Species at Risk Act*. The Newfoundland Region is the lead developing the Action Plan, in which critical habitat will be identified. Northern wolffish are concentrated in the Laurentian Channel, and have limited range with no migrations.

- Porbeagle shark is the only directed commercial shark fishery in Atlantic Canada, mainly taken by Maritime region pelagic longliners. The Laurentian Channel is one of only two mating grounds for this Northwest Atlantic population. Juveniles stay in the region up to 13 years, until mature. Shark conservation has been highlighted by governments and ENGO's as a conservation priority.

Based on the potential impacts of human activities and risks identified in the Assessment, activities incompatible with AOI conservation objectives include:

- **Commercial fishing (bottom trawl)** – This activity contributed the highest risk of harm score for four of the COs. It has potential to impact corals, black dogfish, smooth skate, and Northern wolffish. Although fisheries utilizing bottom trawl are managed by Fisheries and Aquaculture Management (DFO), they are concerned only with commercial species and not those identified as COs for the Laurentian Channel. Adequate protection is not provided to the AOI's valued ecosystem components through standard fisheries management practices, which are specific to commercial species using Conservation Harvesting Plans, specific to vessel sizes and stock management areas.

- **Oil and gas exploratory drilling** – Although this activity poses a key risk to only two COs (corals and smooth skate), it would be incompatible with coral and sea pen conservation efforts. Corals, unlike fish or shark species, are not mobile and provide important aspects of habitat complexity to a variety of species. It is recommended that the significant sea pen fields outlined in the coral analysis be exempt from exploratory or production drilling.

Ship strikes and marine debris will necessitate a different management approach that will require input from the Laurentian Channel AOI Advisory Committee members, and an agreement towards best practices. With further research and observation in the AOI over time, these stressors will be addressed as mitigation strategies are identified and become feasible.

FINAL RECOMMENDATION

In conducting the Biophysical Overview, the Social, Economic, and Cultural Overview, as well as the Assessment of the Laurentian Channel AOI Report, it has been determined that an *Oceans Act* MPA is the appropriate management tool to achieve the conservation objectives and address threats associated with the Laurentian Channel AOI.

APPENDIX A – CONSERVATION OBJECTIVE ANALYSIS

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

- Commercial fishing – bottom trawl
- Seabed alteration – oil and gas exploratory drilling
- Seabed alteration – submarine cables

Corals – bottom trawl

MAGNITUDE OF INTERACTION:

Areal extent

- This CO refers to “corals, particularly sea pens”. From DFO research trawl surveys, 3 Orders (*Alcyonaceans, Scleractinians,* and *Pennatulaceans*), including 14 species, of corals have been documented through 229 coral specimens from the Laurentian Channel AOI. These include 2 species of gorgonians, 5 species of soft corals, 1 species of solitary cup coral, and 6 species of sea pens (DFO 2010).

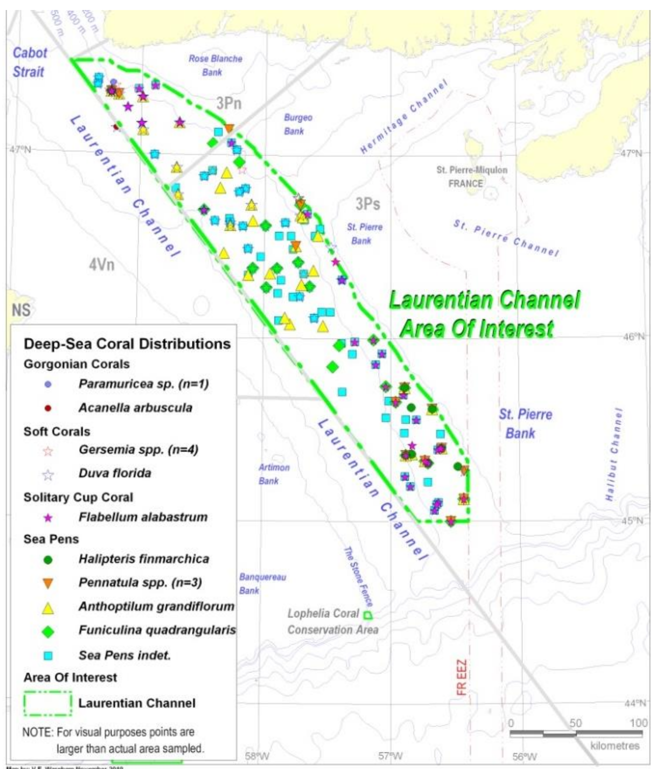


Figure A1. Deep sea coral distribution in the Laurentian Channel AOI (Wareham, Biophysical RAP 2011).

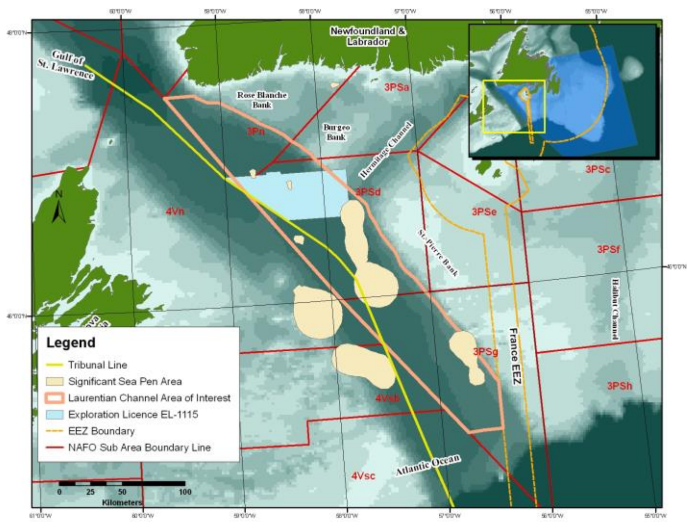


Figure A2. Significant sea pen areas (DFO Oceans).

- Sensitive habitats occurring in the AOI are represented by various species of corals. However, of the corals occurring in the AOI, sea pens have been recorded in the greatest numbers and with the greatest diversity; and have also been described as having their highest regional concentrations within the Laurentian Channel (DFO 2010).
- The CO refers to "corals, particularly significant concentrations of sea pens". Therefore the areal extent will consider the areas outlined in Figure 2 for sea pens, as well as the areas where coral diversity and richness is high (Figure 1).

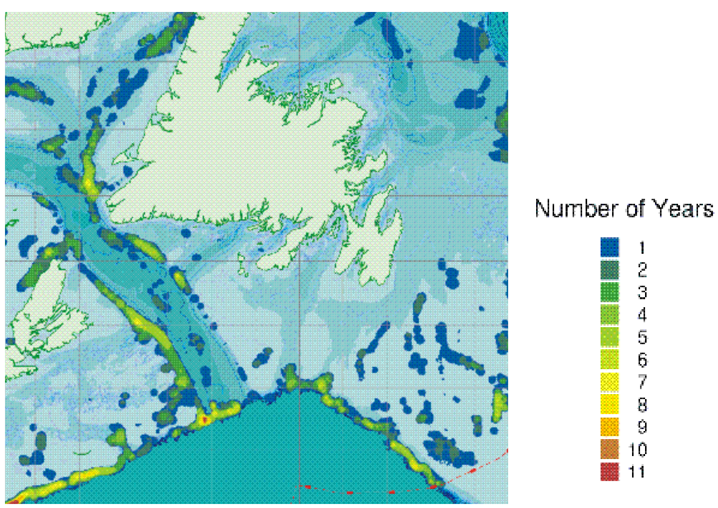


Figure A3. Areas of high intensity trawling 1990 – 2000 (Kulka and Pitcher 2001).

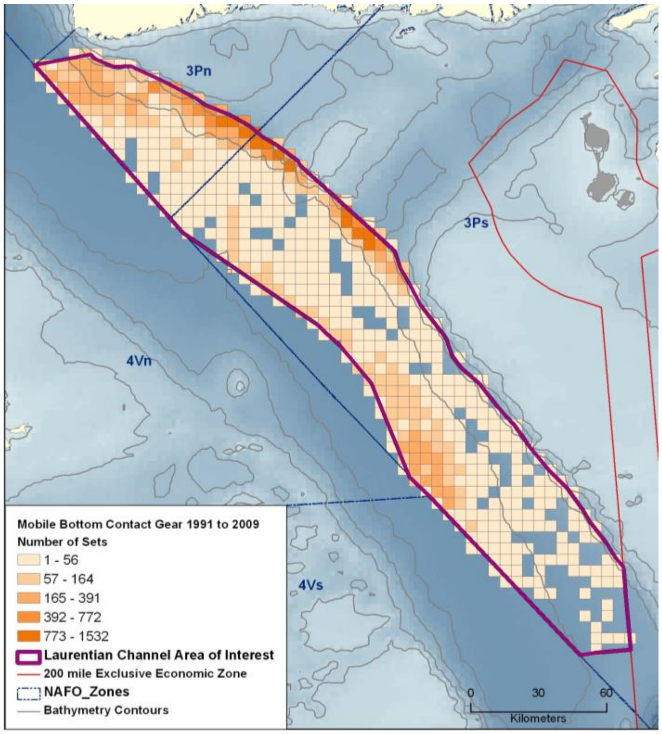


Figure A4. Mobile bottom contact gear use from 1991 to 2009 (DFO Oceans).

- Bottom trawling, primarily for redfish, occurs throughout much of the AOI and is currently the most commonly used gear type in this area. Bottom trawl has been used consistently in the Laurentian Channel for decades, but use has decreased since the 1990s (Kulka and Pitcher 2001).
- Overlap between coral distribution (including all sea pen areas) and bottom trawling (Figure 4) is estimated to be 65%.

Score = 6.5

Contact

- In relation to bottom trawl, Quantitative Fishing Gear Scores (DFO 2007b) for "contact" are high (75-100%) for hard and soft corals and sponges.
- Data on corals are provided primarily by DFO research trawl surveys, and catchability of various coral species likely varies considerably (DFO 2010). Some coral species may be flexible to contact with a passing trawl to some extent by bending, or even withdrawing into the sediments, and would be scored at the low end of the range (75%), while taller, more rigid hard coral species and large sponges would have the highest likelihood of contact and would be scored at the high end of the range (100%).
- The main threats to coral species in the area are those activities that involve contact with the sea floor where corals occur, e.g. primarily bottom contact fisheries, which could result in displacement of individuals (DFO 2010).
- Because this CO focuses on a range of coral species, an intermediate score of 90% is selected within the (75-100%) range.

Score = 9.0

Duration

- Corals are non-motile and found in the AOI throughout the year.

COD CLOSURES		
Mixing Closure	Nov 15 – May 15*	3Ps (d,e,g) western portion of 3Ps(a) closed to all fleets
Spawning Closure	March 1 – May 31*	All 3Ps closed
REDFISH CLOSURES		
Mixing Closure	Nov 15 – June 30	3Ps(d) closed to all bottom fishing
Spawning Closure	April 1 – June 30	Unit II closed

- The AOI essentially consists of areas 3Ps(d) and 3Ps(g). Bottom trawl for cod is used from May 15 to Nov 15 (~ 6 months). Bottom trawl targeting redfish is used from July 1 to November 15 in 3Ps(d) (~4.5 months), and from July 1 to March 31 in 3Ps(g) and the remainder of 3Ps (~9 months). Since there are different dates set for different subdivisions within the AOI, an average of these will be used (6 + 4.5 + 9 /3) = 6.5

Score = 6.5

Intensity

- Halpern *et al*. (2008) developed maps showing the global intensity of several anthropogenic stressors including demersal destructive fishing, which includes bottom trawl fisheries (see map below). This map can be used to provide guidance in scoring the intensity of a stressor in relation to maximum (100%) intensity in a global context, in accordance with the scale provided below.

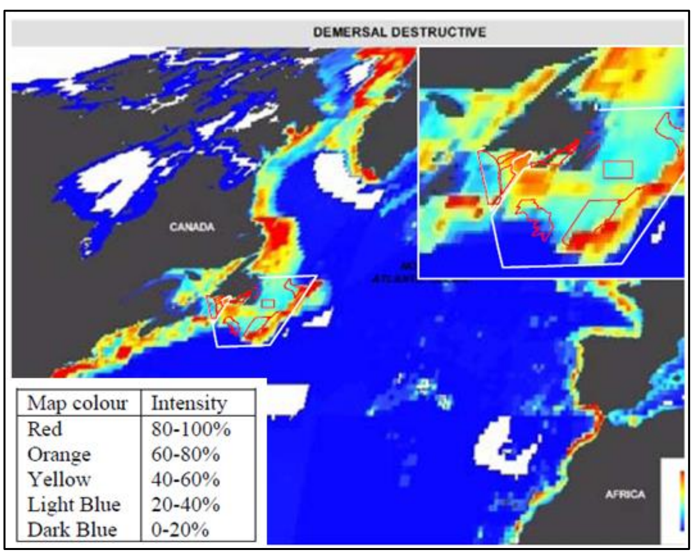


Figure A5. Global intensity of bottom trawl use, adapted from (Halpern et al. 2008).

- Halpern *et al*. (2008) show a low to medium range (dark blue (0-20%) to light blue (20-40%)) for the

Laurentian Channel AOI. Halpern's maps are based on 1999-2003 data.

- Kulka and Pitcher (Figure 3 above) studied the spatial extent of highly trawled areas in the Grand Banks. Some locations within the AOI are shown as being persistent areas of high intensity trawling.
- From 2002 to 2008, 92% of all catch in the AOI was caught utilizing a bottom trawl, primarily in the redfish fishery.
- Therefore, the intensity will be scored at the high end of the range suggested by the global map from Halpern (2008), at 40%.

Score = 4.0

Magnitude of Interaction= (6.5 x 9 x 6.5 x 4)/1000 = **1.5**

SENSITIVITY:

Sensitivity of the CO to acute impacts

- There is varying vulnerability among the different orders of corals and sponges. Corals with carbonate skeletons are more sensitive to physical damage than non-skeletal corals because they cannot reattach if they are dislodged. All sea pens have a flexible proteinaceous skeleton and polyps arranged along the rachis, but branching patterns vary widely (Wareham, Biophysical RAP).
- Mobile bottom fishing gears result in direct mortality of corals and sponges as a result of breaking, crushing and burying. Some coral species may be able to avoid contact with a passing trawl to some extent by bending, or even withdrawing into the sediments, but important structural corals with carbonate skeletons are easily broken or dislodged and cannot re-attach. Trawling also increases sedimentation which can be hazardous to corals and sponges, congesting polyps and inhibiting feeding processes (Edinger *et al.* 2007), particularly those that are buried or crushed onto the sediments.
- Trawling is likely to damage far more corals and sponges than just those that are recovered by the trawl. Most corals and small sponges will be broken off but pass between the footgear and the base of the net, remaining broken on the seafloor. Indirect effects of trawling also include the physical alteration and removal of nonbiotic structures, such as boulders, causing loss of suitable substrate for coral colonization or re-colonization by coral larvae (Gass 2003).
- Wareham and Edinger (2007) analyzed coral bycatch data from the 'Fisheries Observer Program' and found that the Otter trawl had the highest frequency of coral bycatch of all gear types (Wareham and Edinger 2007).
- Fishing Gear Quantitative Scores (DFO 2007b) for "harm" category are high (75-100%) for both soft and hard corals and sponges.
- Mobile bottom fishing gears result in direct mortality of corals as a result of breaking, crushing and burying. However sea pens are soft and flexible and likely to incur less damage than hard corals.
- Acute sensitivity is estimated at 80%.

Score = 8.0

Sensitivity of the CO to chronic impacts

- Large Gorgonian corals are the longest lived and probably the set of species most vulnerable to damage from fishing gear. Small Gorgonians occur on mud bottoms and provide structurally important habitats in deep soft sediment environments. Longevity of the small Gorgonians has not been studied but their smaller size suggests a shorter lifespan. Cup corals can occur free-lying on sand or mud bottoms while others can be found attached to bedrock or cobble-boulder substrate. Those attached to hard substrates have been known to live for hundreds of years while the life span of others is shorter, specifically Flabellum. Both sea pens and soft corals can retract during sediment disturbance. Sea pens have a foot that can possibly enable them to reattach when disturbed.
- Deep-sea corals are slow growing and long-lived (Edinger *et al.* 2007). Evidence of deleterious effects on deep-sea corals by mobile fishing gear (e.g. trawls) has been published in detail (Wareham and Edinger 2007). Anthropogenic impacts to corals include immediate physical damage with subsequent slow recovery rates, as well as the potential for secondary effects due to alterations in associated benthic and fish communities (Templeman and Davis 2006).
- Although the areas of sea pen concentrations recognized by fishers in the Laurentian Channel have persisted despite a long history of intensive deep-water trawl fishing in the region (Kulka and Pitcher 2001), there is little information on changes in abundances of deep-sea corals through time (Gass and Willison 2005).

Score = 8.0

Sensitivity of ecosystem to harmful impacts to the CO

- Corals have been noted as providing important structural habitat for many species. Corals can create unique habitats, e.g. isolated islands; provide structure, e.g. thickets; and add complexity; e.g., sea pen fields in soft mud environments. As microhabitat they provide rest areas, feeding areas, nursery areas, and refuge from predation across various life stages (DFO 2010).
- Deep-sea corals and sponges increase the structural complexity of the ocean floor and can provide protection from predation for other species. Given the apparent importance of cold water corals as habitat for species of redfish, including *Sebastes mentella* and *Sebastes marinus*. Fishers report that areas with deep-sea corals are good fishing grounds.
- Sea pens can occur in multi-species assemblages. Witch flounder, *Glyptocephalus cynoglossus*, which was most abundant along the margins of the Laurentian Channel, was most numerous in sets with sea pens at all depths.
- Edinger *et al.* (2007) observations suggest that the importance of soft corals, sea pens, and small gorgonians as potential fish and invertebrate habitat, especially for juveniles, should not be overlooked. Work in the Newfoundland and Labrador offshore area contributes to understanding the potential importance of soft corals and sea pens as potentially habitat-forming organisms, particularly for juvenile fish and invertebrates such as shrimp and crab. Groundfish and commercial invertebrate abundances on the shallow (< 200 m) or deep (200–400 m) shelf were often greatest in soft coral sets.
- Deep-sea coral and sponge communities are considered one of the most biodiverse ecosystems in the deep sea and are considered as core biological components for the identification on Vulnerable Marine Ecosystems (VMEs) by NAFOs working group on the ecosystem approach to fisheries management (Northwest Atlantic Fisheries Organization 2010). Corals and sponges play important ecological roles in the lifecycles of many species associated with them, providing feeding sites,

nursery habitat, physical substrates for attachment and shelter from predators for invertebrates and fish, including both commercial and non-commercial species (Edinger *et al.* 2007; Fuller *et al*. 2008).

- Any activity or stressor that affects coral and sponge communities could potentially have a significant negative affect on other components in the ecosystem.

Score = 7.0

Sensitivity = (8 + 8 + 7)/3 = **7.7**

Risk of Harm = (Magnitude of Interaction)(Sensitivity)=(1.5)(7.7) = **11.6**

Corals – oil and gas exploratory drilling

MAGNITUDE OF INTERACTION:

Areal extent

- This CO refers to "corals, particularly sea pens". From DFO research trawl surveys, 3 Orders (*Alcyonaceans, Scleractinians,* and *Pennatulaceans*), including 14 species, of corals have been documented through 229 coral specimens from the Laurentian Channel AOI. These include 2 species of gorgonians, 5 species of soft corals, 1 species of solitary cup coral, and 6 species of sea pens (DFO 2010).
- Sensitive habitats occurring in the AOI are represented by various species of corals. However, of the corals occurring in the AOI, sea pens have been recorded in the greatest numbers and with the greatest diversity; and have also been described as having their highest regional concentrations within the Laurentian Channel (DFO 2010).
- The CO refers to "corals, particularly significant concentrations of sea pens". Therefore the areal extent will consider the areas outlined in Figure 3 for sea pens, as well as the areas where coral diversity and richness is high (Figures A1 and A2).
- The current AOI boundary crosses two deep sedimentary basins: the Sydney Basin in the northern half and the Laurentian Basin in the southern half. Both have significant hydrocarbon potential and proven finds. There is no oil production in the AOI to date. Currently, there is one Exploration License issued by the C-NLOPB in 2009 in the Sydney Basin. To date, there has been no drilling activity in the Sydney Basin. In order to keep their rights to the Exploration License there, Husky may acquire more seismic data in the next few years and then must drill a well by 2014.

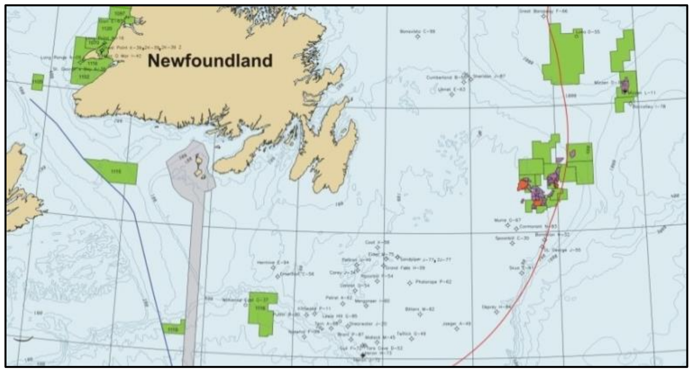


Figure A6. Current exploration and production licences.

- Overlap between coral distribution (including all sea pen areas) and the current oil and gas exploration area (Figure 6) is estimated to be 40%, however, drilling will not take place throughout the entire licence area, just in the footprint of the wells.

Score = 2.0

Contact

- The main threats to coral species in the area are those activities that involve contact with the sea floor where corals occur, e.g. primarily bottom contact fisheries, which could result in displacement of individuals (DFO 2010).
- Oil and gas exploration drilling occurs on the seafloor where corals are located. Contact is therefore complete – 100%. Reminder that the extent of overlap between corals and the exploration licence was considered in Areal Extent above.

Score = 10

Duration

- Corals are non-motile and found on seafloor throughout the year.
- Exploration drilling in the licence can occur at any time between now and 2014. It is common for 1 to 4 wells to be drilled per year during exploration. Each well may take from 50 to 100 days to complete (Jacques Whitford 2007).
- At this time there is no call for bids for the Sydney Basin and Laurentian Basin. However, there may be interest in the future.
- Considering longest possible drilling timeframe (4 wells, 100 days per well) there could potentially be 400 cumulative days of drilling up to 2014. Therefore 400 days/730 days (2 years) is approximately 40%.

Score = 4.0

Intensity

- There is no oil production currently taking place in the AOI. Drilling considered in this assessment will include exploratory drilling, not oil production drilling.

- An Exploration License confers the right to explore for, and the exclusive right to drill and test for, petroleum; the exclusive right to develop those portions of the Newfoundland and Labrador offshore area in order to produce petroleum; and the exclusive right, subject to compliance with the other provisions of the Accords Acts, to obtain a production licence (Jacques Whitford 2007).
- It is difficult to speculate about future hydrocarbon production in these areas where both basins are relatively unexplored at this point. However, indications are that these areas are prone to natural gas resources and if resources are found in sufficient volumes to justify development then this could mean a potential natural gas project which would translate into increased seismic, drilling, production and transportation activity (e.g. pipeline or tanker).
- Intensity is scored at the medium range because drilling will be taking place in the next 2 years in order for Huskey to keep their rights to the Exploration License, however there is only one License in the current AOI boundary.

Score = 5.0

Magnitude of Interaction = (2 x 10 x 4 x 5)/1000 = **0.4**

SENSITIVITY*:*

Sensitivity of the CO to acute impacts

- Oil and gas exploration (and production) drilling can negatively affect deep-sea corals and sponges by the placement of rigs and pipelines in coral and sponge areas and by the discharge of drilling mud and cuttings.
- Platform placement can damage corals by directly crushing them, by increasing sedimentation levels in the water column via the re-suspension of naturally occurring bottom sediments and by altering essential currents and nutrient flows, resulting in less suitable habitat for corals. Drilling muds that do not contain drill cuttings have a fairly high density, and the increase in sedimentation can negatively affect corals (Gass 2003).
- Oil and gas drilling involves removal of bottom sediments and any associated benthic organisms including corals.
- Since this activity will directly crush, smoother or remove corals, we have selected a score of 100%.

Score = 10

Sensitivity of the CO to chronic impacts

- Any corals and sponges that are directly removed by drilling, excavation activity or associated pipeline construction, or buried under dredge spoils, drill cuttings or muds will be permanently destroyed.
- Associated activities may affect corals over a broader area by increasing sedimentation levels in the water column via the re-suspension of naturally occurring bottom sediments, as well as potentially toxic drill cuttings and muds (Gass 2003).
- Exposure to disturbances, either physical or chemical, often results in the retraction of coral polyps. If these defense reactions persist for long periods of time because of continued exposure to a pollutant or physical disturbance, they can have various results: decreased nutrient assimilation and production, altered biochemical composition, depressed respiration and nitrogen excretion, partial

or complete inhibition of growth and deposition of calcium carbonate skeleton, bacterial infection, and eventually death can result from chronic exposure to a pollutant (Gass 2003).

- Deep-sea corals are very slow growing and long-lived (Edinger *et al*. 2007). Due to low growth rates, anthropogenic impacts to corals include immediate physical damage with subsequent slow recovery rates, as well as the potential for secondary effects due to alterations in associated benthic and fish communities (Templeman and Davis 2006). Growth rates of deep-sea corals are similar to growth rates of most massive, shallow water coral species which is estimated between 4.1mm to 25mm per year. Growth rates and life spans are particularly important when determining recovery rates for damaged coral colonies (Gass 2003). Some of the coldwater corals are hundreds of years old and take decades to recover after being damaged (Wareham and Edinger 2007).
- This factor is scored high because activity will result in permanent destruction of corals.

Score = 9.0

Sensitivity of ecosystem to harmful impacts to the CO

- Corals have been noted as providing important structural habitat for many species. Corals can create unique habitats, e.g. isolated islands; provide structure, e.g. thickets; and add complexity; e.g., sea pen fields in soft mud environments. As microhabitat they provide rest areas, feeding areas, nursery areas, and refuge from predation across various life stages (DFO 2010).
- Deep-sea corals and sponges increase the structural complexity of the ocean floor and can provide protection from predation for other species. Given the apparent importance of cold water corals as habitat for species of redfish, including *Sebastes mentella* and *Sebastes marinus*. Fishers report that areas with deep-sea corals are good fishing grounds.
- Sea pens can occur in multi-species assemblages. Witch flounder, *Glyptocephalus cynoglossus*, which was most abundant along the margins of the Laurentian Channel, was most numerous in sets with sea pens at all depths.
- Edinger *et al.* (2007) observations suggest that the importance of soft corals, sea pens, and small gorgonians as potential fish and invertebrate habitat, especially for juveniles, should not be overlooked. Work in the Newfoundland and Labrador offshore area contributes to understanding the potential importance of soft corals and sea pens as potentially habitat-forming organisms, particularly for juvenile fish and invertebrates such as shrimp and crab. Groundfish and commercial invertebrate abundances on the shallow (< 200 m) or deep (200–400 m) shelf were often greatest in soft coral sets.
- Deep-sea coral and sponge communities are considered one of the most biodiverse ecosystems in the deep sea and are considered as core biological components for the identification on Vulnerable Marine Ecosystems (VMEs) by NAFOs working group on the ecosystem approach to fisheries management (Northwest Atlantic Fisheries Organization, 2010). Corals and sponges play important ecological roles in the lifecycles of many species associated with them, providing feeding sites, nursery habitat, physical substrates for attachment and shelter from predators for invertebrates and fish, including both commercial and non-commercial species (Edinger *et al*. 2007; Fuller *et al*. 2008).
- Any activity or stressor that affects coral and sponge communities could potentially have a significant negative affect on other components in the ecosystem.

Score = 7.0

Magnitude of Interaction= (10 + 9 + 7)/3 = **8.7**

Risk of Harm = (Magnitude of Harm)(Sensitivity)=(0.4)(8.7) **= 3.5**

Corals – submarine cables

MAGNITUDE OF INTERACTION:

Areal extent

- This CO refers to "corals, particularly sea pens". From DFO research trawl surveys, 3 Orders (*Alcyonaceans, Scleractinians,* and *Pennatulaceans*), including 14 species, of corals have been documented through 229 coral specimens from the Laurentian Channel AOI. These include 2 species of gorgonians, 5 species of soft corals, 1 species of solitary cup coral, and 6 species of sea pens (DFO 2010).
- Sensitive habitats occurring in the AOI are represented by various species of corals. However, of the corals occurring in the AOI, sea pens have been recorded in the greatest numbers and with the greatest diversity; and have also been described as having their highest regional concentrations within the Laurentian Channel (DFO 2010).
- The CO refers to "corals, particularly significant concentrations of sea pens". Therefore the areal extent will consider the areas outlined in Figure 3 for sea pens, as well as the areas where coral diversity and richness is high (Figures A1 and A2).
- There is one submarine cable which transects the AOI – the Hibernia Atlantic's Canada Express cable project. The Persona cable crosses 3Pn, which has been removed from the AOI boundary.

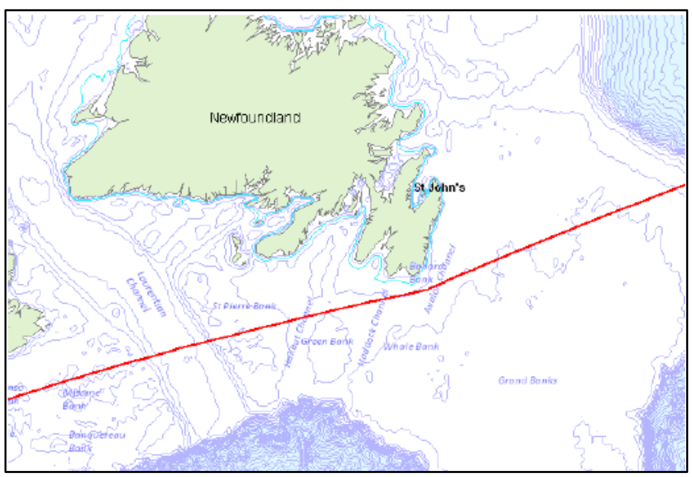


Figure A7. Hibernia Atlantic's Canada Express submarine cable route.

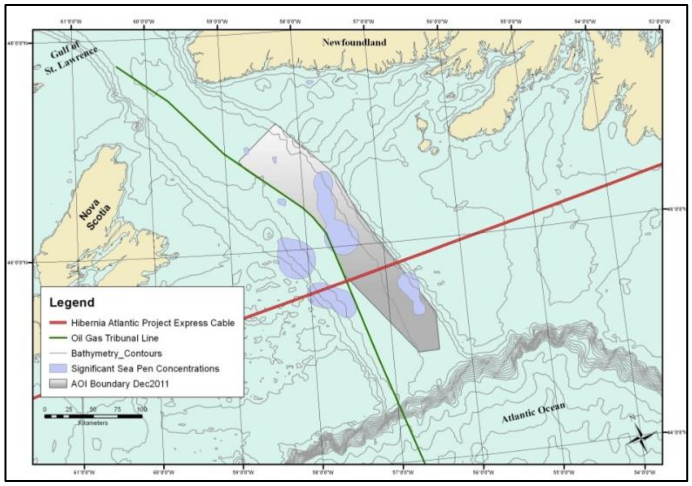


Figure A8. Hibernia cable route and significant sea pen concentrations.

- The cable corridor is typically 500m wide.
- Overlap with the area impacted by the cable with coral distribution is estimated to be 10%, because it does not intersect with significant concentrations, but will likely cross some corals in the area.

Score = 1.0

Contact

- The main threats to coral species in the area are those activities that involve contact with the sea floor where corals occur which could result in displacement of individuals (DFO 2010).
- 'Global Marine Systems' cable ship *Innovator* (subject to commercial agreement) (145 m, 14,277 GT) will lay cable with an MD3 plough to achieve cable burial depth of at least 1 meter where possible throughout the Canadian continental shelf from the Halifax landfall near Herring Cove to north of Flemish Cap. The cable is also to be buried in the Laurentian Channel. The cable will be surface laid in depths greater than 1500 m across the Atlantic.
- The cable itself is narrow, at 43mm for thicker parts and 28mm for thinner parts. The trench for the cable will also be narrow, at 20cm across. It will naturally fill in quickly in softer soils and will take more time in harder soils.
- Corals occur on the seafloor, and the cable will be buried in the seafloor to a depth of at least 1m. Therefore contact is 100%.

Score = 10

Duration

- Corals are non-motile and found on seafloor throughout the year.
- Installation of the cable is targeted for March to August 2012. The installation of the portion of the cable which crosses the AOI is estimated to be one month.
- It is assumed that impacts to corals will only occur during the installation phase of the project. Once the cable is in place, no further impacts are expected. Areas where the cable is exposed may not be

habitable for corals, however due to the prevalence of sandy bottom it is expected the cable will be buried throughout the AOI.

- 1 month/12 months

Score = 0.1

Intensity

- Since the Hibernia cable is the only one present in the AOI, and no cable projects are proposed for the next few years, the intensity is scored low.

Score = 3.0

Magnitude of Interaction = (1 x 10 x 0.1 x 3)/1000 = **0.003**

Due to the short duration of this stressor (submarine cables) the 'Risk of Harm' score is negligible. Even if the Sensitivity was at a maximum of 10, the Risk of Harm score would be just 0.03.

Conservation Objective: Protect juvenile areas for smooth skate and ensure that human activities in the Laurentian Channel MPA do not impair their reproduction and survival.

- Commercial fishing – bottom trawl

Black dogfish – bottom trawl

MAGNITUDE OF INTERACTION:

Areal extent

- Black dogfish are concentrated in the Laurentian Channel, into Hermitage Channel and near the St. Pierre Bank. Virtually all large catches in the NL surveys by Kulka (defined as >15 individuals per tow) were located in the Laurentian Channel. Black dogfish were about 10 times more densely concentrated there than in the Grand Banks and Labrador Shelf slope waters (Kulka 2006).
- Large (pregnant) females migrate to the shallow (<400 m) portion of the Laurentian Channel where pupping occurs. The young then move into deeper waters of the channel. As they grow they move into deeper waters of the slope (Kulka 2006).
- Black dogfish are generally distributed inside the AOI (~ 69% inside). This appears influenced by temperature and depth (>3.8 ^{o}C and > 300m) where the species is usually distributed by size and sex with respect to depth. Movement within the AOI does not occur on a seasonal basis, but rather movements are contained within the area based on reproductive activity and maturity (DFO 2010).
- Of the fish COs considered, only black dogfish and the northern wolffish occur more frequently within the AOI (69% and 52% inside respectively) than outside the AOI within 3Ps, based on DFO trawl surveys (DFO 2010).

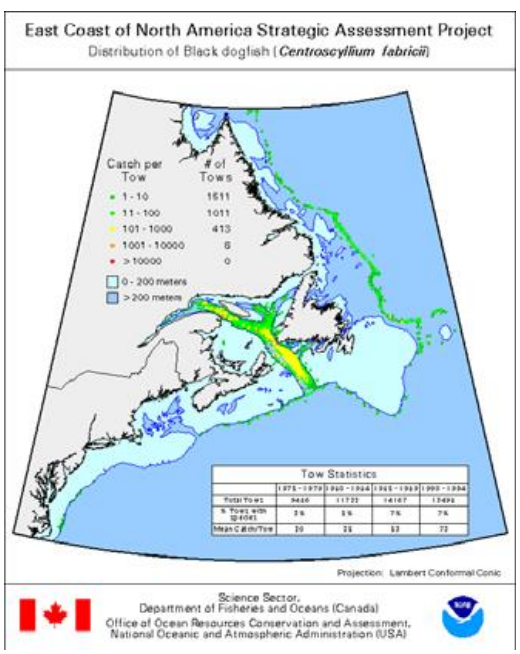


Figure A9. Distribution of black dogfish (Brown et al. 2005).

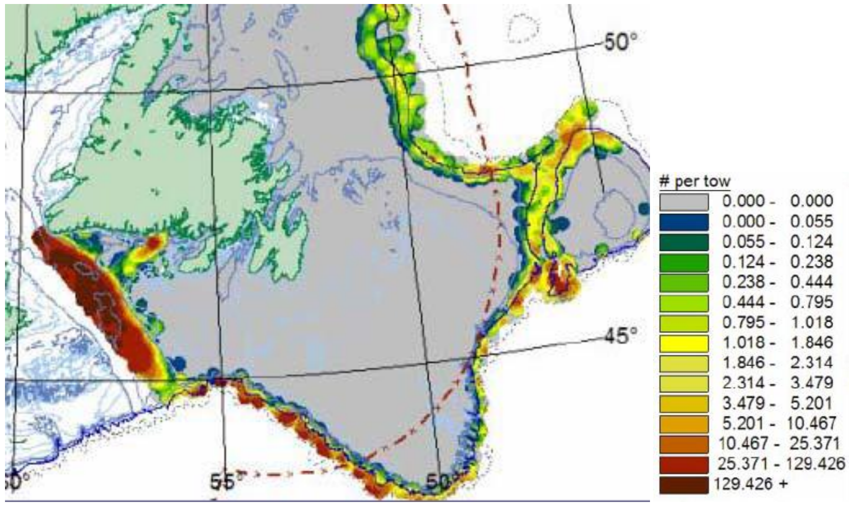


Figure A10. Distribution of black dogfish from the Grand Banks to Davis Strait based on NL trawl survey data from 1971-2005 (Kulka 2006).

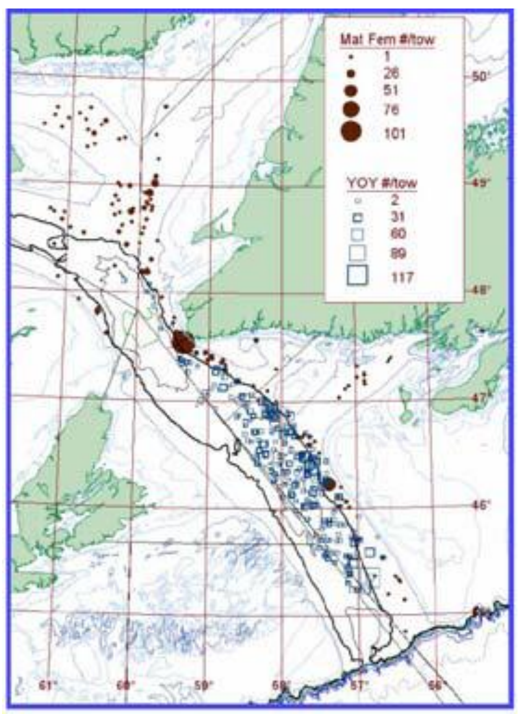


Figure A11. Distribution of large mature females (filled circles) and young of the year (open squares) black dogfish in Canadian waters (Kulka 2006).

- Black dogfish are a deepwater species, and are most abundant along the slope at the depths that redfish are harvested. Bottom trawl is the most commonly utilized gear type for redfish. Redfish is the primary fishery accounting for 89% of the total catch by weight from 2005 – 2009.

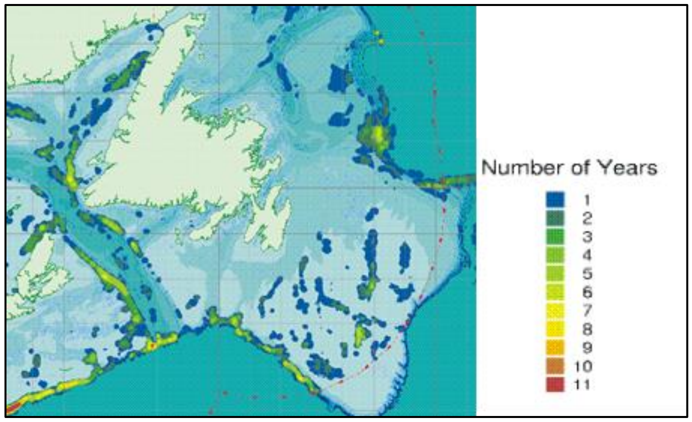


Figure A12. Areas of high intensity trawling 1990 – 2000 (Kulka and Pitcher 2001).

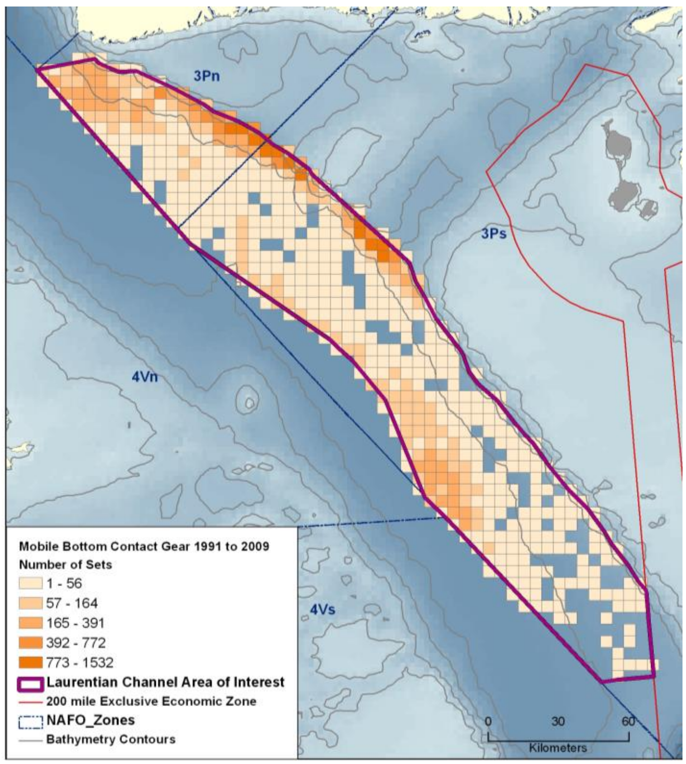


Figure A13. Mobile bottom contact gear use from 1991 to 2009.

- Bottom trawling, primarily for redfish, occurs throughout much of the AOI and is currently the most commonly used gear type in this area. Bottom trawl has been used consistently in the Laurentian Channel for decades, but use has decreased since the 1990s (Kulka *et al*. 2001).
- Overlap between black dogfish distribution and bottom trawling is estimated to be 70%.

Score = 7

Contact

- Black dogfish are a bathy-demersal species resident in waters as shallow as 300 m but generally found in water deeper than 500 m. They can occupy a wide range of depths: 98% from 400 to 1 400 m, but highest concentrations are found in 350-500 m in the Laurentian Channel (Kulka 2006).
- In relation to bottom trawl, Quantitative Fishing Gear Scores (DFO 2007b) for "contact" are high (75-100%) for elasmobranchs (sharks).
- Black dogfish have a highly structured distribution with separation of life stages by area and depth. Large mature (presumably pregnant) females are concentrated along the periphery (<400 m) of the Laurentian Channel. Newly born (17-30 cm) young concentrate in the deeper mid-channel and older juveniles are found within the deepest part of the channel at 500-600 m (Kulka 2006).
- Trawling activity in the AOI targets redfish almost exclusively, which is also a deepwater species (redfish comprised 84% of landings from 2005-2009).
- Although there is no directed fishery for black dogfish, they are captured as bycatch with trawls in the Laurentian Channel, therefore it is scored in the high range.

Score = 7

Duration

- Black dogfish occupy the AOI year-round, where they are 10 times more densely concentrated than other Canadian slope waters. It appears that the Laurentian Channel is the sole pupping ground for this species in the northwest Atlantic, but timing of pupping has not yet been confirmed.

COD CLOSURES		
Mixing Closure	Nov 15 – May 15*	3Ps (d,e,g) western portion of 3Ps(a) closed to all fleets
Spawning Closure	March 1 – May 31*	All 3Ps closed
REDFISH CLOSURES		
Mixing Closure	Nov 15 – June 30	3Ps(d) closed to all bottom fishing
Spawning Closure	April 1 – June 30	Unit II closed

- The AOI essentially consists of areas 3Ps(d) and 3Ps(g). Bottom trawl for cod is used from May 15 5o Nov 15 (~ 6 months). Bottom trawl targeting redfish is used from July 1 to November 15 in 3Ps(d) (~4.5 months), and from July 1 to March 31 in 3Ps(g) and the remainder of 3Ps (~9 months). Since there are different dates set for different subdivisions within the AOI, an average of these will be used (6 + 4.5 + 9 /3) = 6.5

Score = 6.5

Intensity

- Halpern *et al*. (2008) developed maps showing the global intensity of several anthropogenic stressors including demersal destructive fishing, which includes bottom trawl fisheries (see map below). This map can be used to provide guidance in scoring the intensity of a stressor in relation to maximum (100%) intensity in a global context, in accordance with the scale provided below.

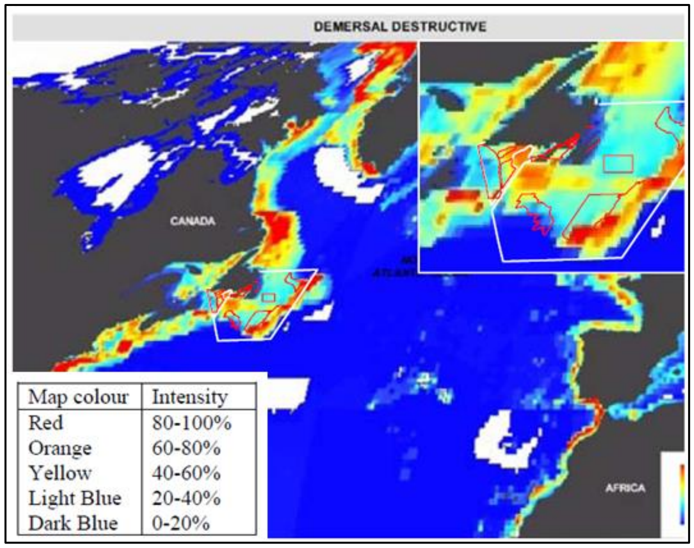


Figure A14. Global intensity of bottom trawl use, adapted from (Halpern et al., 2008).

- Halpern *et al.* (2008) show a low to medium range (dark blue (0-20%) to light blue (20-40%)) for the Laurentian Channel AOI. Halpern's maps are based on 1999-2003 data.
- Kulka and Pitcher (Figure 6 above) studied the spatial extent of highly trawled areas in the Grand Banks (below). Some locations within the AOI are shown as being persistent areas of high intensity trawling.
- From 2002 to 2008, 92% of all catch in the AOI was caught utilizing a bottom Otter trawl, primarily in the redfish fishery.
- Therefore, the intensity will be scored at the high end of the range suggested by the global map from Halpern (2008), at 40%.

Score = 4

Magnitude of Interaction = (7 x 7 x 6.5 x 4)/1000 = **1.3**

SENSITIVITY:

Sensitivity of the CO to acute impacts

- Black dogfish are concentrated in the Laurentian Channel within the AOI; have a highly structured distribution with separation by age and depth; they are a demersal species found feeding on or just off the seafloor; pregnant females (ovoviparous species, therefore eggs develop inside and are born almost fully formed) and juveniles are found at various depths where trawling occurs.
- Notably, the Laurentian Channel is the only known area for black dogfish pupping in Canadian waters, with specific timing of these events currently under investigation.

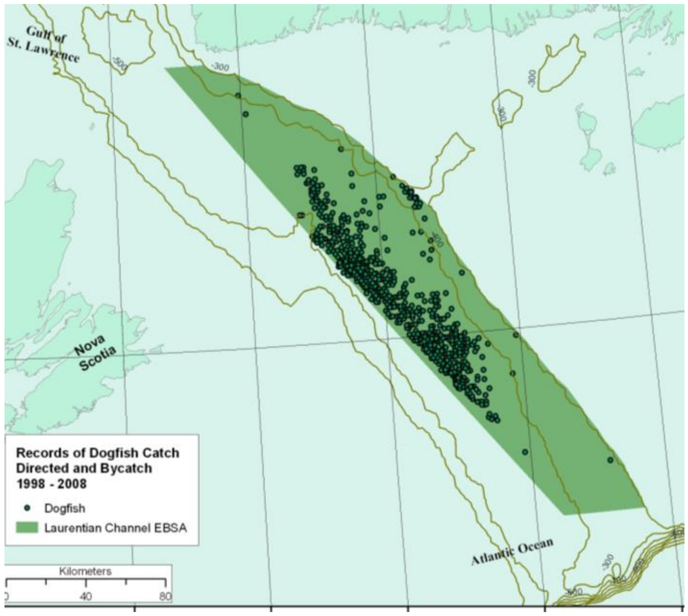


Figure A15. Records of dogfish catch 1998 – 2008 in the AOI (DFO Oceans).

- There is no directed fishery for this species but they are taken as bycatch in a number of deepwater fisheries, with 54 t of dogfish discarded in redfish fishery (2002-05) in the AOI (DFO Policy & Economics).

  Score = 8

Sensitivity of the CO to chronic impacts

- Like many elasmobranch species, the black dogfish grows slowly, reaches sexual maturity at a late age and has low fertility (Fisheries and Oceans 1996).
- Litter size is typically around 4 to 40 live young (Kulka 2006).
- Life history of this deep-water species has proven they are vulnerable, and potential risk increased due to the fishing effects, which have been extending towards deeper water in the last years (González *et al*. 2007).
- In the Laurentian Channel, the spring index fluctuated at a relatively low level during the 1970s and early 1980s then increased rapidly. The index leveled off and stabilized until the mid-1990s. Since that time, it has declined, perhaps reaching stability in recent years. It appears that the adult (spawning stock) segment of the population was stable after 1995 while juveniles in the Laurentian Channel declined (Kulka 2006).
- The Laurentian Channel is the only known area of aggregation, and the only known pupping site within the northwest Atlantic (Kulka 2006), and fisheries in this area predominantly use bottom trawl. Therefore the score will be assigned in the high range.

  Score = 8

<u>Sensitivity of ecosystem to harmful impacts to the CO</u>

- Black dogfish preyed mostly on pelagic and benthopelagic prey (crustaceans, scyphozoans and fish) and redfish. The also feed on cephalopods, jellyfish and small fishes (González *et al*. 2007; Jacques Whitford 2003).
- This species has no known predators (Jacques Whitford 2003).
- There is a lack of information in published documents regarding the trophic role of black dogfish or their association with other organisms.

Score = 2

Sensitivity= (8 + 8 + 2)/3 = **6**

Risk of Harm = (Magnitude of Interaction)(Sensitivity)=(1.3)(6) **= 7.8**

Conservation Objective: Protect juvenile areas for smooth skate and ensure that human activities in the Laurentian Channel MPA do not impair their reproduction and survival.

- Commercial fishing – bottom trawl
- Seabed alteration – oil and gas exploratory drilling

Smooth skate – bottom trawl

MAGNITUDE OF INTERACTION:

Areal extent

- In Newfoundland, the species occurs in five distinct areas separated by large areas where none have been observed (see Fig. 1). It is uncertain whether the five distinct areas constitute separate, genetically distinct, reproductive units. (Kulka *et al*. 2006).
- 44% of smooth skate in 3Ps were found in the AOI. This appears influenced by temperature and depth (greatest densities at 5-6^{o} C and 400-500 m), and potentially prey availability. Movement within or out of the AOI likely does not occur on a seasonal basis. However, a spatial separation of sizes in the study area has been demonstrated where primarily small juveniles occur in the Laurentian Channel, and much larger fish are found on the banks (DFO 2010).
- Fish in the lower Laurentian Channel are mainly juveniles, average size <0.54 kg and they were found throughout the Channel. Most of the young animals were found in the Laurentian Channel, suggesting this area might be a young juvenile ground. Most of the adults were found on the southwest slope of the Grand Banks and up on shelf areas in shallower water (McPhie 2006).

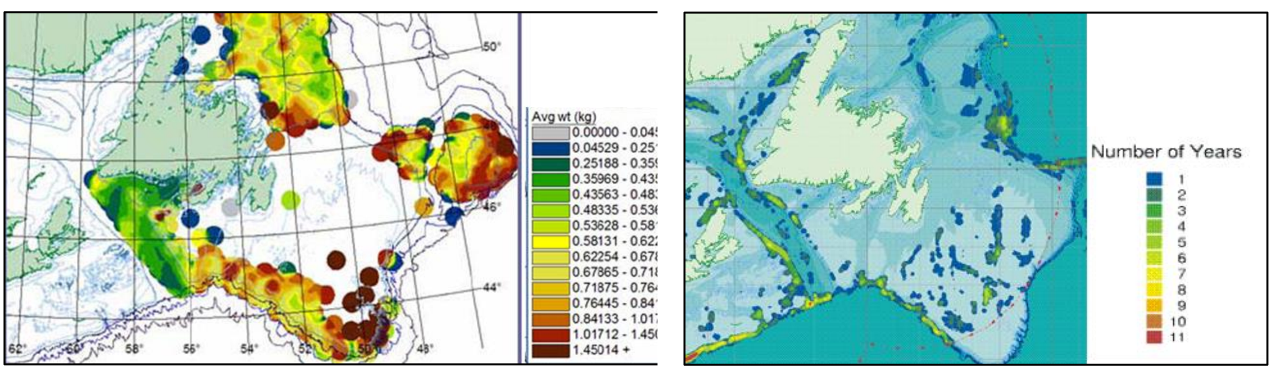


Figure A16. Map of average weight of smooth skate (weight/number per tow) from NL Region surveys for 1995 – 2005 (Kulka et al. 2006); and Areas of high intensity trawling 1990 – 2000 (Kulka and Pitcher 2001).

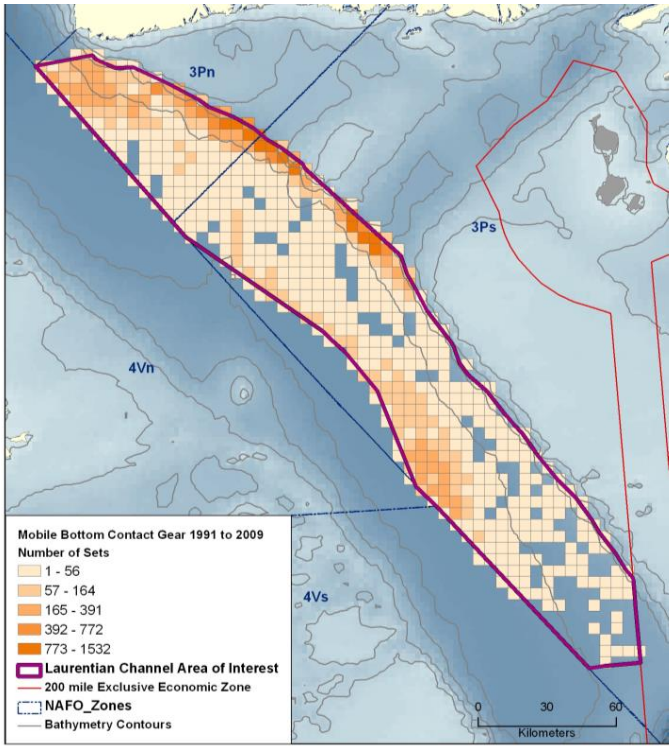


Figure A17. Mobile bottom contact gear use from 1991 to 2009 (DFO Oceans).

- Bottom trawling, primarily for redfish, occurs throughout much of the AOI and is currently the most commonly used gear type in this area. Bottom trawl has been used consistently in the Laurentian Channel for decades, but use has decreased since the 1990s (Kulka *et al.* 2001).
- Since juvenile smooth skate are distributed throughout the Laurentian Channel, overlap with bottom trawl activity is estimated to be 70%.

Score = 7

Contact

- In relation to bottom trawl, Quantitative Fishing Gear Scores (DFO 2007b) for "contact" are high (75-100%) for elasmobranchs (skates and rays).
- Smooth skate live on soft mud and clay bottom, often in deep troughs and basins (Scott & Scott 1988). They are found at depths ranging from 46 to 457 m with greatest abundances noted below 110 m, though may be occasionally captured in shallow areas (Jacques Whitford 2007). Kulka *et al*. (2006) found that 90% of survey sets containing smooth skate occurred between 70m and 480m (Kulka *et al*. 2006).
- Smooth skates are often found lying partially buried in sand or gravel, which are the types of bottom they generally prefer.
- Skates produce few large eggs (purses), which are deposited on the bottom (Kulka *et al*. 2006). Skate have been observed to hug the bottom when fishing gear approaches. Catchability of skate by research trawl gear has been considered low given the sedentary nature of the group and likely underestimates the presence of smooth skate (Kulka *et al*. 2006).

- Contact is scored in the lower end of the range suggested (75-100%), because the CO refers mainly to juvenile smaller fish (<30cm) which are less likely to be caught in trawls, and because Kulka's study reported the species to have low catchability in trawls. However, skate egg purses are deposited on the seafloor.

  Score = 7.5

Duration

- Smooth skate (adult and juvenile) occupy the AOI year-round.

COD CLOSURES		
Mixing Closure	Nov 15 – May 15*	3Ps (d,e,g) western portion of 3Ps(a) closed to all fleets
Spawning Closure	March 1 – May 31*	All 3Ps closed
REDFISH CLOSURES		
Mixing Closure	Nov 15 – June 30	3Ps(d) closed to all bottom fishing
Spawning Closure	April 1 – June 30	Unit II closed

- The AOI essentially consists of areas 3Ps(d) and 3Ps(g). Bottom trawl for cod is used from May 15 5o Nov 15 (~ 6 months). Bottom trawl targeting redfish is used from July 1 to November 15 in 3Ps(d) (~4.5 months), and from July 1 to March 31 in 3Ps(g) and the remainder of 3Ps (~9 months). Since there are different dates set for different subdivisions within the AOI, an average of these will be used (6 + 4.5 + 9 /3) = 6.5

  Score = 6.5

Intensity

- Halpern *et al*. (2008) developed maps showing the global intensity of several anthropogenic stressors including demersal destructive fishing, which includes bottom trawl fisheries (see map below). This map can be used to provide guidance in scoring the intensity of a stressor in relation to maximum (100%) intensity in a global context, in accordance with the scale provided below.

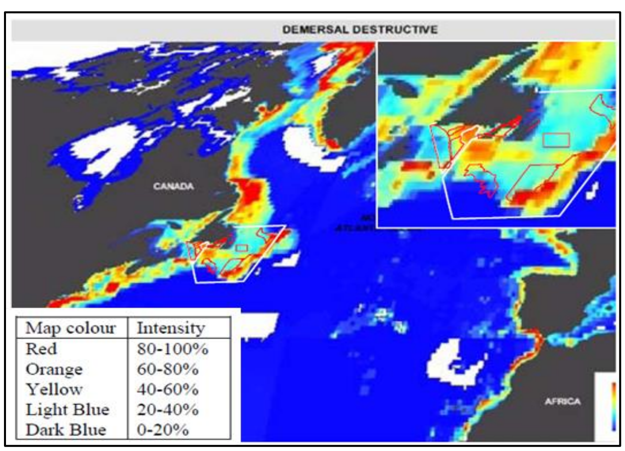


Figure A18. Global intensity of bottom trawl use, adapted from (Halpern et al. 2008).

- Halpern *et al*. (2008) show a low to medium range (dark blue (0-20%) to light blue (20-40%)) for the Laurentian Channel AOI. Halpern's maps are based on 1999-2003 data.
- Kulka and Pitcher (Figure 2 above) studied the spatial extent of highly trawled areas in the Grand Banks. Some locations within the AOI are shown as being persistent areas of high intensity trawling.
- From 2002 to 2008, 92% of all catch in the AOI was caught utilizing a bottom Otter Trawl primarily in the redfish fishery.
- Therefore, the intensity will be scored at the high end of the range suggested by the global map from Halpern, at 40%.

Score = 4

Magnitude of Interaction = (7 x 7.5 x 6.5 x 4)/1000 = **1.4**

SENSITIVITY:

Sensitivity of the CO to acute impacts

- Bottom trawl was assigned an ecological rating of "high impact" (the highest of 5 categories) in relation to groundfish (Fuller *et al*. 2008).
- Currently, the skate fishery does not discriminate between species and all skate exhibiting wing widths ≥ 46 cm (~61 cm tail length) are retained. As such, the relatively small body size of the smooth skate will likely continue to limit the capture of this species in skate fisheries within the region (Grant 2009). This CO refers to smooth skate <30cm, therefore they are less likely to be caught in trawls, and not retained in the skate fishery. However, length frequencies from NL Region trawl surveys captured smooth skate in the range of 7 to 73 cm, which is likely close to the entire range of sizes found in the population (Kulka *et al*. 2006).
- McPhie (2006) found that most of the young animals were found in the Laurentian Channel, suggesting this area might be a young juvenile ground. The fact that they caught so many juveniles tells us that they are vulnerable to capture in trawls. There is no information on the incidence of juveniles in catches, but younger fish are noted to live in deeper water than adults (Kulka *et al*. 2006), and are therefore susceptible to trawling.

Skate catch & bycatch (KGM)
Laurentian Channel & Slope Polygon

	Direct	*Skate bycatch in other fisheries*					
Year	Skate	Cod	Greysole	White Hake	Halibut	Monkfish	Redfish
1998	2,711	680	506	-	-	-	559
1999	7,894	-	-	-	58	-	91
2000	-	-	-	-	-	-	765
2001	-	1,945	-	-	-	-	111
2002	336	9	-	-	-	206	-
2003	5,169	186	-	18	22	6,444	-
2004	-	-	-	-	-	-	549
2005	1,317	17	-	-	13	1,409	-
2006	1,486	338	-	-	-	5,108	20
2007	7,513	-	-	-	-	518	-
2008	-	-	-	-	-	-	-
	26,426	3,175	506	18	93	13,685	2,095

Figure A19. Skate catch and bycatch in Laurentian Channel Area of Interest

- Skate fishery (non-directed smooth) is low in AOI = 17 t (2005-2009), and this fishery catches both thorny and smooth skate (5% smooth).

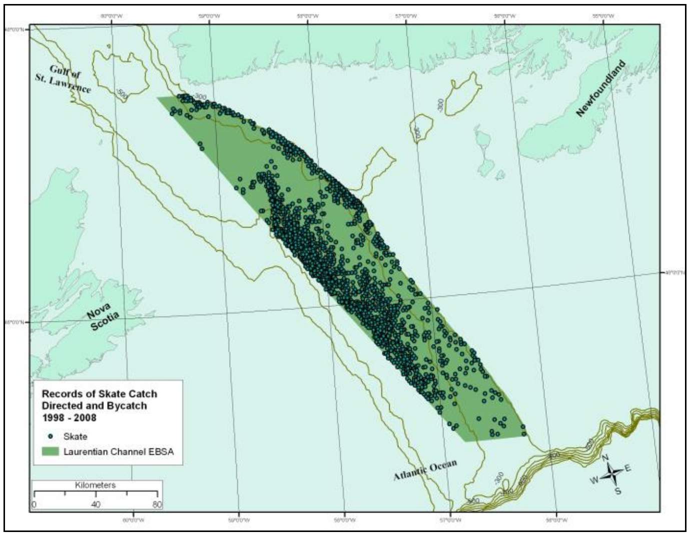


Figure A20. Records of skate landings, directed and bycatch 1998 – 2008 (DFO Oceans)

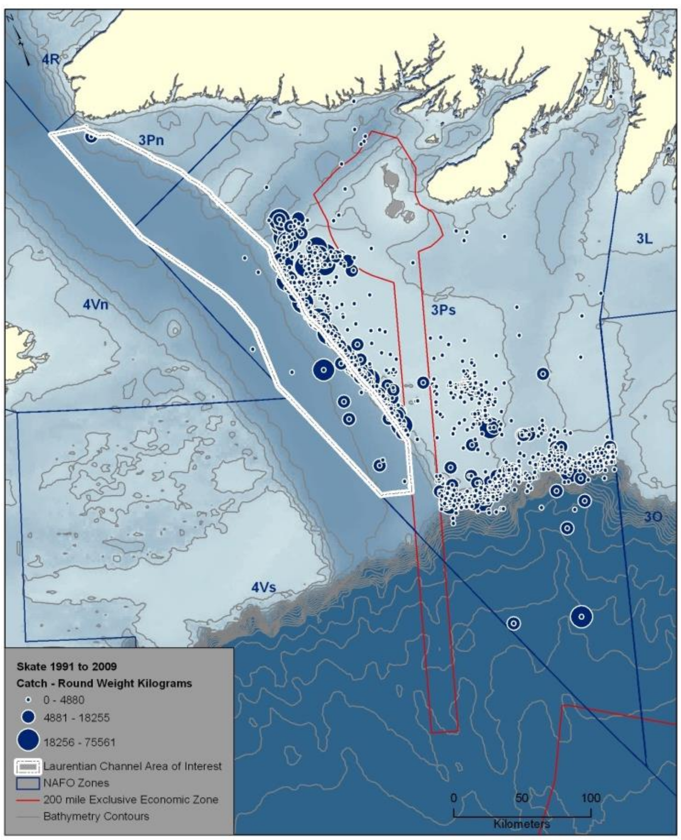


Figure A21. Commercial catch by weight of skate (all skate) 1991 – 2009.

- On average, 82% of smooth skate catch in NL taken in Laurentian Channel.
- Skate bycatch is high in both the monkfish and redfish fisheries.
- Smooth skate <30cm are caught in trawls, but not in great amounts. However, the AOI is reportedly a nursery area for juveniles, which is unique in the PBGB LOMA, and important to the maintenance of the stock. Therefore the score assigned is in the medium range.

  Score = 6

Sensitivity of the CO to chronic impacts

- Smooth skate's low reproductive potential brought about by slow growth, late sexual maturation, low fecundity, and long reproductive cycles result in low intrinsic rates of increase and is thought to lead to low resilience to fishing mortality (Kulka *et al*. 2006).
- They attain sexual maturity at 50 cm tail length (TL) for males and 33-48 cm TL for females, which was estimated to correspond to an age of approximately 5 years. Smooth skate have a maximum age of 14-15 years (Grant 2009).
- Skates produce few large eggs (purses) deposited on the bottom, therefore there is no chance for wide dispersion as is the case for teleost species that broadcast large numbers (thousands to millions) or eggs or larvae into the water column where they can disperse over very large distances. While it is possible that local strong bottom currents could move the large, semi-adherent egg cases over short distances, perhaps in on the scale of meters, wide dispersion is unlikely (Kulka *et al.* 2006).
- Trends in abundance and area occupied show an increase in the Laurentian Channel (abundance since 1995, area occupied overall) (Kulka *et al*. 2006). A comparison of rates of decline of smooth skate in areas of high intensity trawling compared to areas of no trawling indicated no difference in decline rate, suggesting the species was not cropped down during that time frame. Thus, it appears that although fishing removals clearly contributed to the decline, it is likely not the only factor contributing to the decline. However, it is clear that since fishing grounds overlap quite extensively with the distribution of smooth skate and thus, mortality due to fishing has contributed to the population declines to varying degrees among areas and gears (Kulka *et al*. 2006).
- The Laurentian Channel is the only known nursery area within the northwest Atlantic; the species have low intrinsic rates of increase; purses are deposited on the seafloor; and juveniles and adults are captured in trawls. Although adult populations have increased recently, we do not have similar information on juveniles (Kulka *et al*. 2006). Trawling is the most commonly used gear type in the AOI, and targets redfish which occur at a similar depth. However, trends in abundance show an overall increase in the Laurentian Channel for 1995 to 2005. Therefore the score will be assigned in the medium range.

  Score = 5

Sensitivity of ecosystem to harmful impacts to the CO

- There is no information on record of skates or egg capsules in the stomachs of many other species.
- Skates are strictly carnivorous and feed mostly at night (Scott and Scott 1988). On the Grand Banks, the smooth skate diet contained 22 prey items of which 72% by weight was crustaceans. The second most important prey group for the smooth skate was fish (26%), of which a large portion was capelin (8%). Smaller individuals (< 29 cm) fed mainly on mysids and larger individuals (≥ 40 cm) had

a more varied diet of shrimp, crab and fish (Gonzalez *et al*. 2006).

- There is a lack of information in published documents regarding the trophic role of smooth skate (<30cm) or their association with other organisms.

Score = 2

Sensitivity = (6 + 5 + 2)/3 = **4.3**

Risk of Harm = (Magnitude of Interaction)(Sensitivity)=(1.4)(4.3) **= 6.0**

Smooth skate – oil and gas exploratory drilling

MAGNITUDE OF INTERACTION:

Areal extent

- See 'Areal extent' information above.
- Fish in the lower Laurentian Channel are mainly juveniles, average size <0.54 kg and they were found throughout the Channel. Most of the young animals were found in the Laurentian Channel, suggesting this area might be a young juvenile ground. Most of the adults were found on the southwest slope of the Grand Banks and up on shelf areas in shallower water (McPhie 2006).

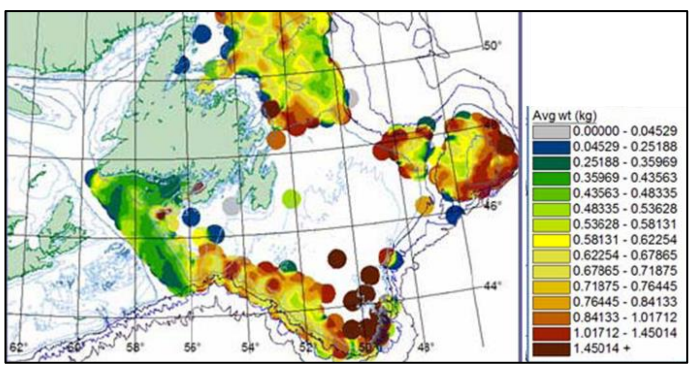


Figure A22. Map of average weight of smooth skate (weight/number per tow) from NL Region surveys for 1995 – 2005 (Kulka et al. 2006)

- The current AOI boundary crosses two deep sedimentary basins: the Sydney Basin in the northern half and the Laurentian Basin in the southern half. Both have significant hydrocarbon potential and proven finds but there is no oil production in the AOI to date. Currently, there is one Exploration Licence issued by the C-NLOPB in 2009 in the Sydney Basin. To date, there has been no drilling activity in the Sydney Basin. In order to keep their rights to the Exploration Licence there, Husky may acquire more seismic data in the next few years and then must drill a well by 2014.

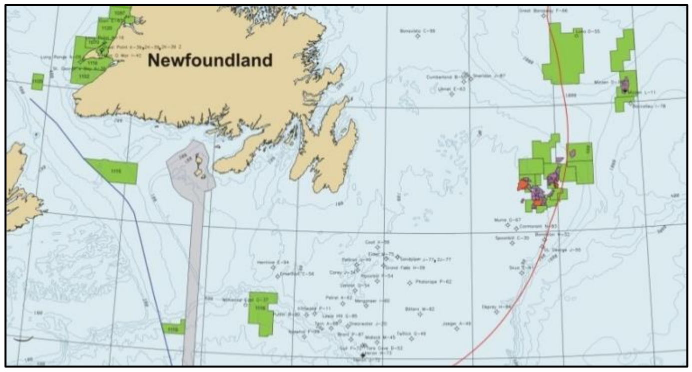


Figure A23. Current oil exploration and production licences.

- Overlap between juvenile areas for smooth skate and the current oil and gas exploration area (Figure 2) is estimated to be 100%.

  Score = 2

Contact

- Smooth skate live on soft mud and clay bottom, often in deep troughs and basins (Scott and Scott 1988). They are found at depths ranging from 46 to 457 m with greatest abundances noted below 110 m, though may be occasionally captured in shallow areas (Jacques Whitford 2007). Kulka *et al*. (2006) found that 90% of survey sets containing smooth skate occurred between 70m and 480m (Kulka *et al*. 2006).
- Smooth skates are often found lying partially buried in sand or gravel- which is the type of bottom they generally prefer. On the Grand Bank, the smooth skate diet contained 22 prey items of which 72% by weight was crustaceans (Gonzalez *et al*. 2006), and therefore feed on the seafloor.
- Skates produce few large eggs (purses), which are deposited on the bottom (Kulka e*t al*. 2006).
- For the Sydney Basin the current Exploration Licence spans a water depth from 200 to 400 m within the AOI (Jacques Whitford 2007).
- Drilling will be conducted by a drill rig (jack-up, anchored or dynamically-positioned drill ship or semi-submersible), depending on water depth. Vertical seismic profiling (VSP) and well site shallow geohazard survey activities may also be conducted in conjunction with the drilling (Canada-Newfoundland and Labrador Offshore Petroleum Board 2007).
- Fish in the lower Laurentian Channel are mainly juveniles, average size <0.54 kg and they were found throughout the Channel. Smooth skate are demersal, often lying and feeding in the sediment, with egg cases deposited on the seafloor. Juveniles and oil drilling occurs on the seafloor, with parts of the rig leading through the water column to the surface. Therefore contact is considered to be in the high range.

  Score = 7

Duration

- Division 3Ps is only surveyed in the spring DFO research survey, so we do not have a complete knowledge regarding their distribution throughout the year, however, there are five distinct areas where the species is found, and this configuration appears to be consistent over time (Kulka *et al.* 2006). This information, as well as lack of any evidence of migration, suggests that their presence in the Laurentian Channel area is constant in all months of the year.

- Exploration drilling in the licence area can occur at any time between now and 2014. It is common for 1 to 4 wells to be drilled per year during exploration. Each well may take from 50 to 100 days to complete (Jacques Whitford 2007).
- At this time there is no call for bids for the Sydney Basin and Laurentian Basin. However, there may be interest in the future.
- Considering longest possible drilling timeframe (4 wells, 100 days per well) there could potentially be 400 cumulative days of drilling up to 2014. Therefore 400 days/730 days (2 years) is approximately 40%.

Score = 4

Intensity

- There is no oil production currently taking place in the AOI. Drilling considered in this assessment will include exploratory drilling, not oil production drilling.
- An Exploration Licence confers the right to explore for, and the exclusive right to drill and test for, petroleum; the exclusive right to develop those portions of the Newfoundland and Labrador offshore area in order to produce petroleum; and the exclusive right, subject to compliance with the other provisions of the Accords Acts, to obtain a production licence (Jacques Whitford 2007).
- It is difficult to speculate about future hydrocarbon production in these areas where both basins are relatively unexplored at this point. However, indications are that these areas are prone to natural gas resources and if resources are found in sufficient volumes to justify development then this could mean a potential natural gas project which would translate into increased seismic, drilling, production and transportation activity (e.g. pipeline or tanker).
- Intensity is scored at the medium range because drilling will be taking place in the next 2 years in order for Huskey to keep their rights to the Exploration Licence, however there is only one Licence in the current AOI boundary.

Score = 5

Magnitude of Interaction = (2 x 7 x 4 x 5)/1000 = **0.3**

SENSITIVITY:

Sensitivity of the CO to acute impacts

Potential interactions between offshore drilling activities and fish and fish habitat relate primarily to:

- attraction to subsurface structures and lights
- avoidance due to noise or other disturbances
- potential contamination due to wastewater discharges (e.g. deck drainage)
- potential smothering, contamination and habitat alteration due to the discharge and deposition of drill muds and cuttings
- well abandonment
- contamination in the event of a spill or blowout (Jacques Whitford 2003).

- A safety exclusion zone would extend approximately 500 m from a drill rig with an exclusion zone of 0.8 km^2 in total area. The presence of the structure and a 0.8 km^2 temporary fishery exclusion zone may alter the local abundance and distribution of fish in the area; however, it will be for a short duration (generally 80-100 days). The temporary alteration of habitat would have an overall short term duration (1 – 12 months), low magnitude and small (<1 -10 km) geographic extent effect on fish populations. Therefore, the overall effect on fish and fish habitat is considered to be 'not significant' in the Strategic Environmental Assessment (Jacques Whitford 2003).
- There are no studies identifying specific habitat requirements for juvenile smooth skate. There is no information provided regarding drilling activity impacts on smooth skate specifically, but the effects on fish listed above would be similar. Some of these affects are potential stressors which may or may not occur (ie. well blowout), and the overall impact will be a function of type and duration of drilling, etc.
- Considering the range of activities and discharges from oil exploration drilling, smooth skate (<30cm) nursery areas are likely to be impacted by disturbance and avoidance of the area, but probably not resulting in death of individuals in most cases. However, because this is an area known for nursery/rearing, females and juveniles may be more susceptible to contaminants and disturbance. Therefore, sensitivity is scored at the high end of the low range.

  Score = 4

Sensitivity of the CO to chronic impacts

- Low reproductive potential brought about by slow growth, late sexual maturation, low fecundity, and long reproductive cycles result in low intrinsic rates of increase for smooth skate, and is thought to lead to low resilience to fishing mortality (Kulka *et al*. 2006).
- Skates produce few large eggs (purses) deposited on the bottom, therefore there is no chance for wide dispersion as is the case for teleost species that broadcast large numbers (thousands to millions) or eggs or larvae into the water column where they can disperse over very large distances. While it is possible that local strong bottom currents could move the large, semi-adherent egg cases over short distances, perhaps in on the scale of meters, wide dispersion is unlikely (Kulka *et al.* 2006).
- In the northeastern sector (including the Grand Banks, southwest slope, and Laurentian and other Channels), the adult component has undergone a significant recovery since the early 1990s while abundance has remained low in the southern Gulf and northeast Scotian Shelf. A conservative estimate of population increase was 12-28% for the Newfoundland Region (southern Laurentian Channel/southwestern Grand Bank) (Kulka *et al*. 2006).
- The estimate of minimum number of fish based on the spring survey in Div. 3NOPs (the NL portion of the Laurentian concentration) was 0.7 million in 1978-87 and 2.66 million in 1995-2004. The index increased from 2.6 million in 1996 to 3.5 million in 2005 (Kulka *et al*. 2006).
- The Laurentian Channel is the only known nursery area within the northwest Atlantic and the species has low intrinsic rates of increase. Although adult populations have increased, we do not have similar information on juveniles (Kulka *et al*.2006). The long-term impact of oil and gas drilling will depend on the number of wells, and the area of impact surrounding them. This activity is not expected to seriously impact the nursery/rearing of smooth skate, but there is a potential for many areas to be developed over 10 years. Therefore score will be assigned on the medium-low range.

Score = 3

Sensitivity of ecosystem to harmful impacts to the CO

- There is no information on record of skates or egg capsules in the stomachs of many other species.
- Skates are strictly carnivorous and feed mostly at night (Scott and Scott 1988). On the Grand Banks, the smooth skate diet contained 22 prey items of which 72% by weight was crustaceans. The second most important prey group for the smooth skate was fish (26%), of which a large portion was capelin (8%). Smaller individuals (< 29 cm) fed mainly on mysids and larger individuals (≥ 40 cm) had a more varied diet of shrimp, crab and fish (Gonzalez *et al*. 2006).
- There is a lack of information in published documents regarding the trophic role of smooth skate (<30cm) or their association with other organisms.

Score = 2

Sensitivity = (4 + 3 + 2)/3 = **3**

Risk of Harm = (Magnitude of Interaction)(Sensitivity)=(0.3)(3) **= 0.9**

Conservation Objective: Promote the survival and recovery of Northern wolffish by minimizing risk of harm from human activities in the Laurentian Channel MPA and by identifying, conserving and protecting Northern wolffish habitat.

- Commercial fishing – bottom trawl

Northern wolffish – bottom trawl

MAGNITUDE OF INTERACTION:

Areal extent

- The northern wolffish is found in cold, continental shelf waters across the North Atlantic from Norway to southern Newfoundland. In the western North Atlantic, it occurs in significant numbers only off northeast Newfoundland. Elsewhere in Canadian waters, the species occurs only as an occasional stray (COSEWIC 2001).
- Approximately 52% of northern wolffish in 3Ps are located inside the AOI. This appears to be influenced by water temperature (prefers 3.5 - 6°C).
- Movement patterns are unknown; although a tagging study by Templeman showed limited movement in Labrador waters (within 8 km of the tagging site) (DFO 2010).
- Northern wolffish are non-schooling, non-migratory, and somewhat territorial (COSEWIC 2001).

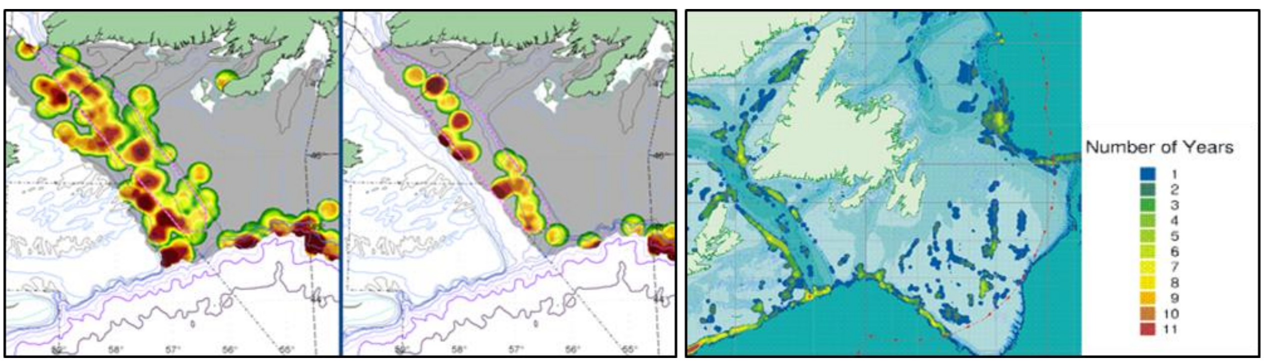


Figure A24. Distribution of wolfish species 1996 – 2002 (right) and 2003 - 2009 (left) (unpublished); and Areas of high intensity trawling 1990 – 2000 (Kulka and Pitcher 2001).

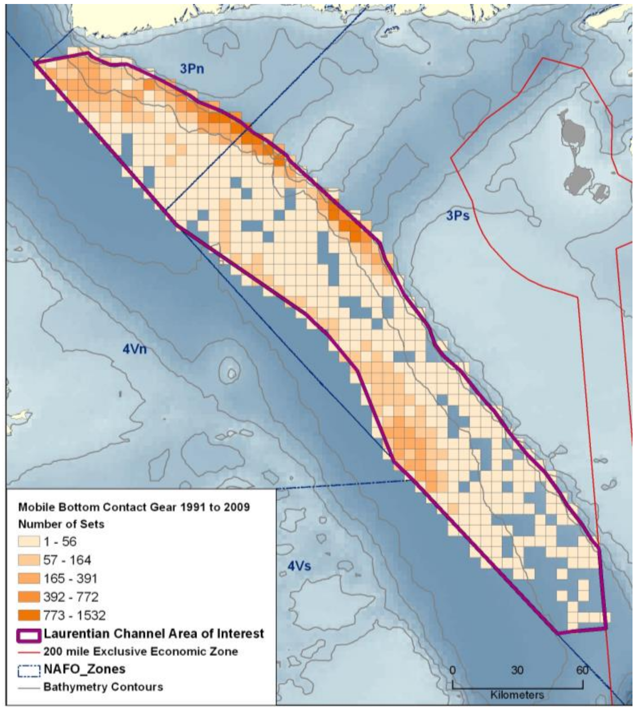


Figure A25. Mobile bottom contact gear use from 1991 to 2009 (DFO Oceans).

- Bottom trawling, primarily for redfish, occurs throughout much of the AOI and is currently the most commonly used gear type in this area. Bottom trawl has been used consistently in the Laurentian Channel for decades, but use has decreased since the 1990s (Kulka *et al*. 2001).
- Overlap between Northern wolffish distribution and bottom trawling is estimated to be 65%.

Score = 6.5

Contact

- The Northern wolffish is a benthopelagic fish found in a broad range of depths, but most often at depths > 100 m in offshore waters over soft bottoms and in proximity to boulders at temperatures below 5°C; it is usually found in deep waters between 151 and 900 m.
- Northern wolffish occur in the Laurentian Channel along the slopes at depths of 90 to 200 m (Simpson and Kulka 2001).
- Wolffish feed mostly on midwater and bottom-living invertebrates (COSEWIC 2001).
- In contrast with Atlantic and spotted wolffish, the northern wolffish spends more time off bottom, and when on bottom, at deeper locations and over more diverse bottom types.
- Recent trawling activity in the AOI targets redfish almost exclusively (redfish comprised 89% of landings from 2005-2009).
- Although there is no directed fishery for northern wolffish, they are captured in trawls in the Laurentian Channel, therefore it is scored at the low end of the high range.

Score = 7.5

Duration

- The northern wolffish is found in the AOI throughout the year. Northern wolffish are non-schooling, non-migratory, and somewhat territorial (COSEWIC 2001).
- Spawning occurs late in the year, usually in September, but can vary greatly in time and place. Eggs are deposited in a large mass on the sea bottom and are guarded by the male until they hatch (by mid-December).

COD CLOSURES		
Mixing Closure	Nov 15 – May 15*	3Ps (d,e,g) western portion of 3Ps(a) closed to all fleets
Spawning Closure	March 1 – May 31*	All 3Ps closed
REDFISH CLOSURES		
Mixing Closure	Nov 15 – June 30	3Ps(d) closed to all bottom fishing
Spawning Closure	April 1 – June 30	Unit II closed

Score = 6.5

Intensity

- Halpern *et al*. (2008) developed maps showing the global intensity of several anthropogenic stressors including demersal destructive fishing, which includes bottom trawl fisheries (see map below). This map can be used to provide guidance in scoring the intensity of a stressor in relation to maximum (100%) intensity in a global context, in accordance with the scale provided below.

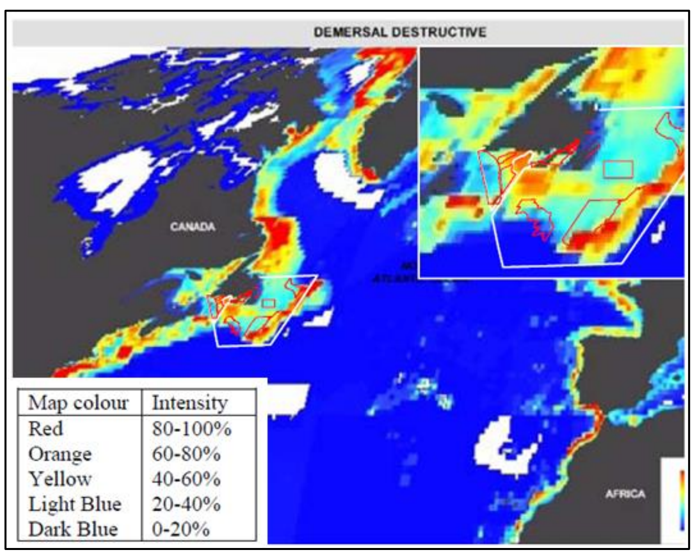


Figure A26. Global intensity of bottom trawl use, adapted from (Halpern et al. 2008).

- Halpern *et al.* (2008) show a low to medium range (dark blue (0-20%) to light blue (20-40%)) for the Laurentian Channel AOI. Halpern's maps are based on 1999-2003 data.
- Kulka and Pitcher (Figure 4 above) studied the spatial extent of highly trawled areas in the Grand

Banks (below). Some locations within the AOI are shown as being persistent areas of high intensity trawling.

- From 2002 to 2008, 92% of all catch in the AOI was caught utilizing a bottom Otter Trawl primarily in the redfish fishery.
- Therefore, the intensity will be scored at the high end of the range suggested by the global map from Halpern, at 40%.

Score = 4

Magnitude of Interaction = (6.5 x 7.5 x 6.5 x 4)/1000 **= 1.3**

SENSITIVITY:

Sensitivity of the CO to acute impacts

- The impact of incidental capture of wolffish in many fisheries is thought to be the leading cause of human induced mortality. However, what proportion mortality due to fishing activities contributes to total mortality and to the decline of these species is unclear. Commercial fishing gears generally catch adult wolffish (spawning component).
- Wolffish landings in the western Atlantic peaked in 1979 at around 22,000 tonnes but had fallen steadily to around 2,000 tonnes by 1997 (COSEWIC 2001). The highest wolffish bycatches in Subdivision 3Ps (40%) were1995-2002 (annual average = 114,223 t).
- Removals as bycatch have a negative impact on northern wolffish populations, and bottom trawling that destroys and disrupts spawning habitat is detrimental as well (COSEWIC 2001). Since the early 1990s, the reduced trawling effort has resulted in less bycatch of wolffish.
- The requirement to release threatened wolffish species taken incidentally in Canadian fisheries was instituted in 2003-2004. Survival rates of wolffish after release from various commercial fishing gears remain unknown.
- Northern wolffish do not figure in commercial landings, although they are taken as bycatch. Commercial fishing data list all three species of Wolffish as “Catfish”. Except for a 27-ton average in Canadian annual landings of Atlantic Wolffish reported for Division 3P in 2005-2009, all other recorded data (including non-Canadian) remain as Catfish.
- The groundfish trawls in which wolffish are caught result in incidental mortality and damage to fish which come in contact with the gear but are not caught. Perhaps even more importantly, the steel doors of the net, along with heavy bottom lines and rollers, scour the seabed. This can cause significant habitat damage by removing or redistributing the rocks and boulders under and around which these fish shelter, spawn, and build nests. However, for practical reasons, trawling operations avoid rocky areas since it can lead to the destruction of expensive gear. This may afford some level of protection for rocky habitats.

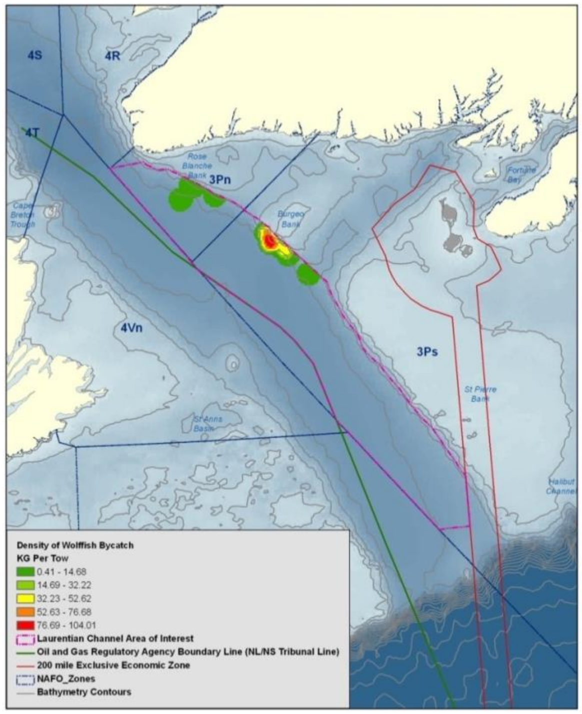


Figure A27. Wolffish bycatch in commercial fishery 1991 -2009.

- Bottom trawling for fish, in addition to digging up and disrupting bottom habitats, also re-suspends bottom sediments which can smother spawning areas and damage gills (COSEWIC 2001).
- Bottom trawling, specifically the redfish fishery, is the main source of fishing mortality in the AOI, but trawling is not the only cause of declining abundance, therefore it is scored moderately.

Score = 7

Sensitivity of the CO to chronic impacts

- Northern wolffish is listed as threatened under the *Species at Risk Act*, Schedule 1.
- Sperm and egg production is low in all 3 species of wolffish, and fertilization is internal. Females deposit cohesive egg masses on rocks and in crevices, and males fast while guarding these egg "nests". Large hatchlings (2 cm in length) possess yolk sacs and are pelagic; the entire larval stage is spent close to the nest area (DFO 2010).
- Spawning occurs late in the year, and the demersal eggs are extremely large. Average fecundity is about 27,000 eggs/ female. Maturity is reached at 5 years of age or more and the fish lives to at least 14 years (COSEWIC 2001).
- Scientific surveys from all parts of the western Atlantic range indicate that numbers of this large, slow-growing, long-lived, solitary, nest-building fish have declined over the past 20 years. Since 1978, abundance in the primary range off northeast Newfoundland is down by 98%. Numbers have declined steadily, the number of locations where the species occurs has declined, and the range may be shrinking (COSEWIC 2001).
- Not enough is known about the long term population trends of these species, or the environmental influences to fully understand how critical the abundance levels reached in the mid-1990s are to the

survival of the species in Canadian waters (Kulka *et al*. 2007). It seems likely that a combination of natural and human induced mortality, perhaps in combination with poor recruitment, caused the wolffish populations to decline (Kulka *et al*. 2007).

- Harvesting technology, specifically bottom trawling and dredging, have been identified by COSEWIC as possible causes of wolffish habitat alteration. Incremental losses of nesting and shelter habitat (habitat alterations, degradation and associated fragmentation) due to fishing are potential threats to the recovery of wolffish species, which have limited dispersal and possible nesting requirements (Kulka *et al.* 2007).
- The Wolffish Recovery Team includes representatives from industry, academia, and the provincial and federal governments. The Recovery Strategy and Management Plan (2007) was written with extensive input and cooperation from the Recovery Team and other stakeholders as appropriate. The goal of the Plan is to increase the population levels and distribution of *A. denticulatus, A. minor and A. lupus* in eastern Canadian waters such that the long-term viability of these species is achieved.
- Because the northern wolffish is not the target of a directed fishery in the North Atlantic it is unmanaged and there are no specific mechanisms, such as total allowable catch limits, in place that afford it protection (COSEWIC 2001). When caught, it is discarded.
- Population structure, absolute estimates of population size, and relative contribution of threats to the decline are unknown. Canadian spring and autumn research vessel surveys are used as estimators of biomass and abundance trends for Wolffish. Knowledge of exactly how habitat has and is being utilized and to what extent available habitat is critical to the species survival or recovery is unknown (Kulka *et al.* 2004). With development of that knowledge, a better understanding of the threats can be achieved and measures required to mitigate factors limiting recovery can be refined (Kulka *et al*. 2007).
- Wolffish species exhibit a relatively late age at maturation, a sedentary lifestyle, and larval site fidelity; making them vulnerable to natural and human-induced factors. However, while certainly contributing to the total mortality, the evidence is contrary to the hypothesis that trawling is the only or perhaps the proximal cause for the decline in wolffish. This suggests significant non-fishery influences coupled with fishery related mortality contributing to the distribution and abundance changes observed.
- Northern wolffish, while depleted, seem somewhat stable in recent years and may be entering a recovery phase.

Score = 5

<u>Sensitivity of ecosystem to harmful impacts to the CO</u>

- The northern wolffish feeds on bathypelagic and benthic invertebrates, such as comb jellies, jellyfish, crabs, brittle stars, and starfish. The crustaceans and molluscs on which it feeds tend to be softer-shelled than those eaten by other wolffish species, and tend to be fixed less firmly to the bottom substrate since the northern wolffish's relatively weaker teeth are poorly suited for attacking heavily-armoured prey; sea urchins, nonetheless, have been reported among its stomach contents. The diet of pelagic young consists of planktonic invertebrates and fish eggs and larvae, exactly the same as in other wolffish species.
- Though its role as a forage fish is undetermined, it does appear to be a food source for several species. Because of its generally low abundance, however, it is most unlikely to be an important

prey species. Though not known to be an important prey species, the northern wolffish has been reported in the stomach contents of ringed seals, golden redfish, cod, and Greenland shark (COSEWIC 2001).

Score = 3

Sensitivity = (7 + 5 + 3)/3 **= 5**

Risk of Harm = (Magnitude of Interaction)(Sensitivity)=(1.3)(5)**= 6.5**

Conservation Objective: Ensure that human activities in the Laurentian Channel MPA do not impair the reproduction and survival of porbeagle shark.

- Commercial fishing – longline
- Disturbance – Seismic surveys – There has been little research on seismic effects on sharks; however, sharks are known to have very acute hearing for low frequency sounds, which they use to locate prey (Dr. Steve Campana, pers. comm., DFO Science). Therefore, it is possible that seismic surveys may have behavioural (not lethal) effects on porbeagle sharks in the area. The effect of seismic on shark hearing requires further study (DFO 2012). The allowance of seismic surveys during summer and fall, known times of porbeagle concentrations, will need consideration.

Porbeagle shark – longline

MAGNITUDE OF INTERACTION:

Areal extent

- Within Canada, porbeagle shark are found from northern Newfoundland into the Gulf of St. Lawrence and around Newfoundland to the Scotian Shelf and Bay of Fundy (Scott and Scott 1988).
- Porbeagle shark are generally distributed in Atlantic Canada south of Labrador, including throughout the AOI. The distribution appears influenced by temperature (2-15 °C), but not by depth. Movement into the AOI occurs around May, with movement out of the AOI to areas further south occurring in late fall.
- One of only two mating grounds for porbeagle occurs off southern NL and the entrance to the Gulf of St Lawrence, including in the AOI (DFO 2010).

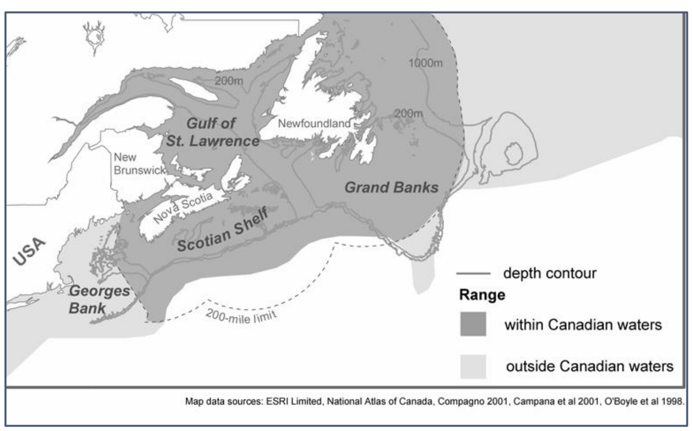


Figure A28. Range of the porbeagle shark population in the Northwest Atlantic, within Canada (dark gray) and outside of Canada (light gray (COSEWIC 2004).

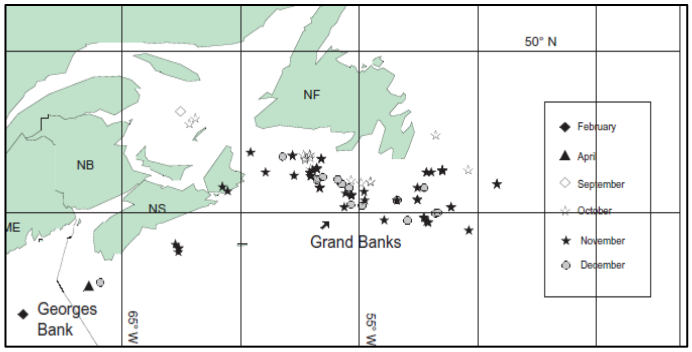


Figure A29. Map of the capture locations of all gravid female porbeagles by month of capture. Approximate locations of Georges Bank and the Grand Banks are indicated (Jensen et al. 2002).

- Preferred areas for porbeagle fishing are selected on the basis of proximity to areas near the edge of the continental shelf- oceanographic fronts where prey can be more concentrated or abundant (Campana and Joyce 2004).

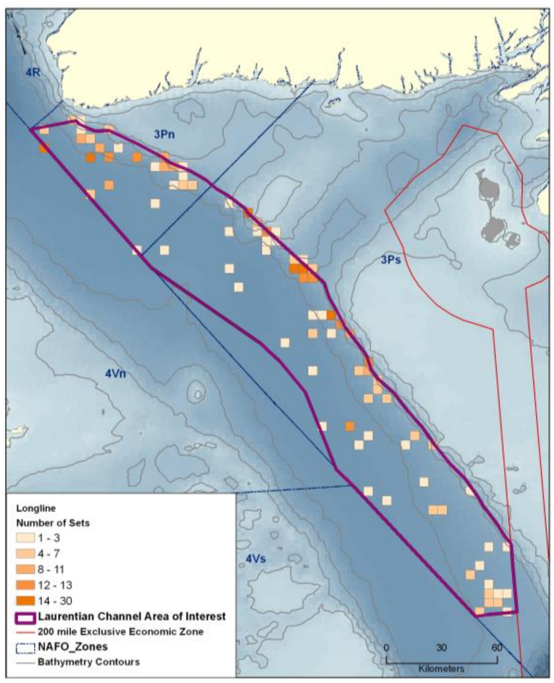


Figure A30. Records of longline gear use from 1991 to 2009 (DFO Oceans)

- The main directed fisheries using longline in the AOI target cod, Atlantic halibut, Greenland halibut, and white hake, with Maritimes fishers targeting porbeagle.
- The areal extent of the CO is considered to be 100% of the AOI. Overlap between porbeagle distribution and longline use is estimated to be 15%.

Score = 1.5

Contact

- In relation to longline, Quantitative Fishing Gear Scores (DFO 2007b) for "contact" are occasional (1-25%) for elasmobranch species.
- Porbeagle is the only directed commercial shark fishery in Atlantic Canada.
- Porbeagle sharks are taken almost exclusively by a Canadian directed pelagic longline fishery, which occurs mainly in Maritimes, but also within the AOI.
- It is caught as bycatch in other fisheries using longline (DFO 2005; DFO 2006).
- The assessment methodology guidance suggests a maximum contact score for a directed fishery.

Score = 10

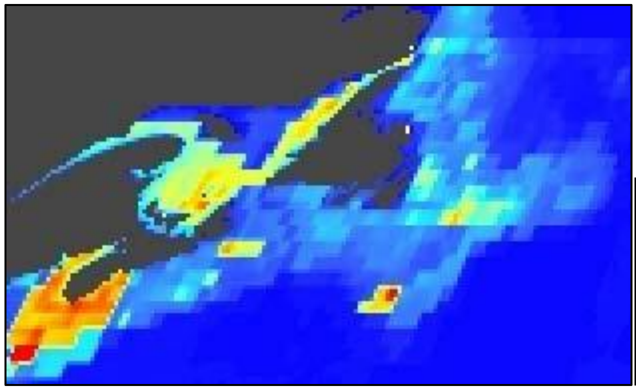
Duration

- Porbeagle shark carry out extensive annual migrations up and down the east coast of Canada. Porbeagle first appear in the Gulf of Maine, Georges Bank and southern Scotian Shelf in Jan-Feb, move northeast along the Scotian Shelf through the spring, and then appear off the south coast of Newfoundland and in the Gulf of St. Lawrence in the summer and fall. This pattern is repeated from year to year (Campana *et al*. 2010).
- They are found in Newfoundland waters, on St. Pierre Bank and the Laurentian Channel, in summer and fall (June to November). Mating occurs from September to November.
- The Canadian fishery for porbeagle shark occurs in the western North Atlantic, following the shark as they move onto the Scotian Shelf in late spring, then into the Gulf of St. Lawrence and onto the Grand Banks during the summer and early fall. Porbeagle shark move into deeper water in late fall and move off the Continental Shelf in winter. (DFO 2007c).
- Closures include the Divisions 4Vn3LNOP fall closure to protect pupping females, and an area inside 12 miles off the southwest coast of Nova Scotia known as the Bluefin Exclusion Zone (BEZ) from August 1 annually (DFO 2007c).
- The fall closure of NAFO Divisions 4Vn and 3LNOP is for all shark fishing from September 1 to December 31 - by licence condition (DFO 2007c).
- Within the AOI, longline can be utilized from May 15 to February 28 (9 months) for other species. Longline fisheries may take place in all the 6 months when porbeagle are present off southern Newfoundland, however, the directed fishery is closed for 3 of those months.
- Longline can be used for 9.5 /12 months (score 7.9). The directed fishery occurs for 8/12 months (score 6.7). The average of these two provides the duration score.

Score = 7.3

Intensity

- Global maps (Halpern *et al*. 2008) for demersal, non-destructive fisheries with low bycatch, which include longlines, show predominantly a medium low (light blue) intensity relative to global levels for a score range of 20% to 40% (see figure below). This map can be used to provide guidance in scoring the intensity of a stressor in relation to maximum (100%) intensity in a global context, in accordance with the scale provided below.



Map colour	Intensity
Red	80-100%
Orange	60-80%
Yellow	40-60%
Light Blue	20-40%
Dark Blue	0-20%

Figure A31. Global Intensity of demersal non-destructive, low-bycatch fisheries (adapted from Halpern et al. 2008).

- Longline use in the AOI is minimal. In the AOI, dredge, gillnet, pot, longline and Danish seine accounted for, on average, less than 4% of the combined catch over the period 2005 to 2009.

Score = 2

Magnitude of Interaction = (1.5 x 10 x 7.3 x 2)/1000 = **0.2**

SENSITIVITY*:*

Sensitivity of the CO to acute impacts

- In relation to longline, Quantitative Fishing Gear Scores (DFO 2007b) for "harm" is low (1-25%) for elasmobranch species in the LOMA.
- Longlines were also given a "high impact" rating in relation to groundfish and sharks (Fuller *et al*. 2008). Longlining is a threat to porbeagle shark's survival and recovery in the Northwest Atlantic due to bycatch mortality. The bycatch landings of porbeagle sharks are now comprised mostly of juveniles (COSEWIC 2004).
- In Canada, porbeagle sharks are currently harvested in a directed fishery, managed under the Canadian Atlantic Pelagic Shark Integrated Fisheries Management Plan, and as bycatch in the Atlantic Canadian large pelagics and groundfish fisheries. They are also harvested by other countries.
- Longline is the predominant gear used for the directed fishery targeting porbeagle shark. Sharks are also taken as bycatch in pelagic longline fisheries for swordfish and tuna.
- Almost all porbeagle catches have been taken by the Canadian fleet, and landings have declined from a peak of 1,615t in 1994 to 224t in 2002 (COSEWIC 2004).
- More than 80% of the recent annual catch has been taken on the Scotian Shelf in the spring, at a time when availability is largely limited to immature sharks. (Campana *et al.* 2008). Porbeagle recruit to commercial fisheries during their first year (Francis *et al*. 2008).
- Campana *et al.* (2003) states: "All lines of evidence indicate that fishing mortality is largely and solely responsible for the decline in population abundance since 1961."
- The COSEWIC listing document (COSEWIC 2004) also does not identify any factors other than fishing that may be either responsible for the decline or limiting recovery.

- No formal management of porbeagle occurred until 1995 (introduction of Shark Management Plan).
- NFLD: 10 licences (1995)→ 5 licences (2000) → 0 licences (2002-present).
- TAC : 185t (135t directed for Maritimes, Gulf, Quebec; 50t bycatch).

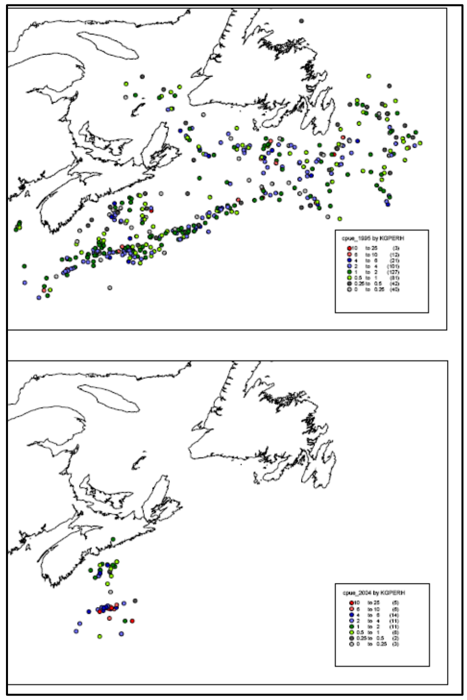


Figure A32. Comparison of the spatial distribution of CPUE in 1995 (top) and 2004 (bottom) (Campana 2005).

- Unlike other sharks the porbeagle must swim at all times in order to breathe, which means that even if caught as bycatch on longlines, chances of survival if released are very slim.
- The abundance of porbeagle sharks declined greatly since Canada entered the fishery in the 1990s, after an earlier collapse and partial recovery. Fishery quotas have been greatly reduced and the fishery has been closed in some areas where mature sharks occur. The landings now are comprised mostly of juveniles. Its life history characteristics, including late maturity and low fecundity, render this species particularly vulnerable to overexploitation (COSEWIC 2004).

Score = 8

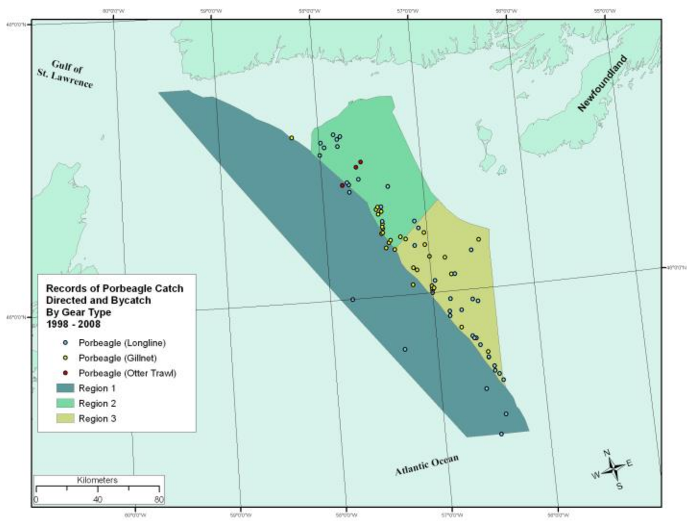


Figure A33. Records of porbeagle catch 1998 – 2008.

Sensitivity of the CO to chronic impacts

- It's estimated there are about 190,000 porbeagles in Canadian waters - putting the stock at about one-quarter of its level in 1961 when the fishery first started (Campana *et al.* 2010).
- In 2004, porbeagle were designated as endangered by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) and are being considered for listing on Schedule 1 of the *Species at Risk Act* (SARA) (DFO 2006c).
- The directed porbeagle fishery has been under management since 2002 (COSEWIC 2004).
- Total estimated porbeagle discards by the large pelagic fleet in the latter half of the year have averaged 21 t annually since 1996, with an average of 27 t annually since 2000. The size composition of these discards is unknown (Campana *et al.* 2010).
- The abundance of porbeagle spawners has continued to decline, and is probably due in part to high exploitation on juvenile porbeagle during the late 1990's. Population size is expected to increase now that exploitation rates are lowered, as cohorts subjected to lower exploitation have time to mature (Campana 2005).
- Evidence indicates that fishing mortality is largely and solely responsible for the decline in population abundance since 1961 (Campana *et al*. 2001).
- Sharks are typically slow growing and although their survival rate from birth is high, sharks produce few young per year. Given these characteristics, sharks are highly susceptible to overfishing and slow to recover from stock depletion. The precautionary approach to shark management and conservation is therefore very important to ensure healthy and sustainable shark populations.
- Therefore, a score is selected within the high range.

Score = 9

Sensitivity of ecosystem to harmful impacts to the CO

- The porbeagle population reached dangerously low levels in the mid-1990s, when quotas soared to 1,500 t in the Atlantic region versus today's catch allowance of 185 t.

- Estimates of the population size in 2009 range from 196,911 to 206,956 sharks.
- The estimated number of mature females range from 11,339 to 14,207 or about 6% of the population. The total biomass was estimated at around 10,000 t in 2009. Such a biomass would place the 2009 value at between 20-24% of its value in 1961 (Campana *et al.* 2010).
- Until recently, scientists knew of only one breeding ground for porbeagles off Newfoundland and Labrador's southern coast. The area was closed to directed shark fishing shortly after it was identified as a mating area. Campana located a second mating area on Georges Bank in 2008 (Campana *et al*. 2010).
- Porbeagle shark is a top predator.

Score = 8

Sensitivity = (8 + 9 + 8)/3 = **8.3**

Risk of Harm = (Magnitude of Interaction)(Sensitivity)=(0.2)(8.3)**=1.7**

Conservation Objective: Promote the survival and recovery of leatherback sea turtles by minimizing risk of harm from human activities in the Laurentian Channel MPA.

- Commercial fishing – longline (entanglement)
- Disturbance – ship strikes
- Marine debris/litter

Leatherback sea turtle – longline

MAGNITUDE OF INTERACTION:

Areal extent

- Leatherback turtles have not been systematically surveyed around Newfoundland and distribution maps rely largely on opportunistic reporting and tracking of small numbers of individuals.
- The primary determinant of movement and behaviour of leatherbacks is the spatial and temporal distribution of their primary prey, gelatinous plankton generally known as jellyfish. In general jellyfish abundance is highest in coastal waters (James *et al.* 2006).
- The largest concentrations occur on the continental shelf and slope; but also further offshore (DFO 2010).
- Notably, the south coast of Newfoundland, i.e., the AOI, is one of the most highly-frequented leatherback foraging areas in Atlantic Canada, and they return to the same sites annually (DFO 2010).

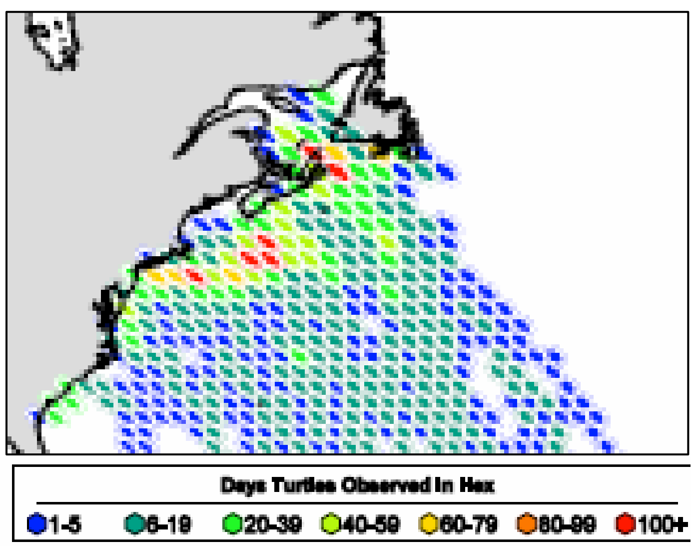


Figure A34. Habitat use by leatherback turtles on foraging grounds in the northwest Atlantic (Turtle Expert Working Group 2007).

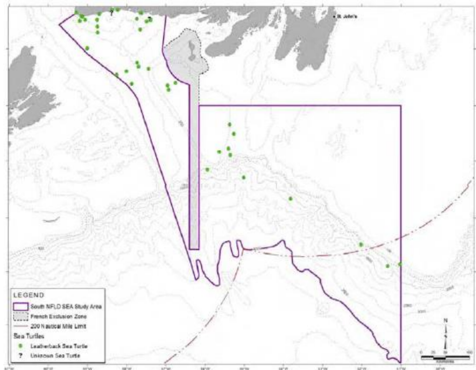


Figure A35. DFO records of sightings and entanglements of leatherback sea turtles, 1982-2007 (Jacques Whitford 2007).

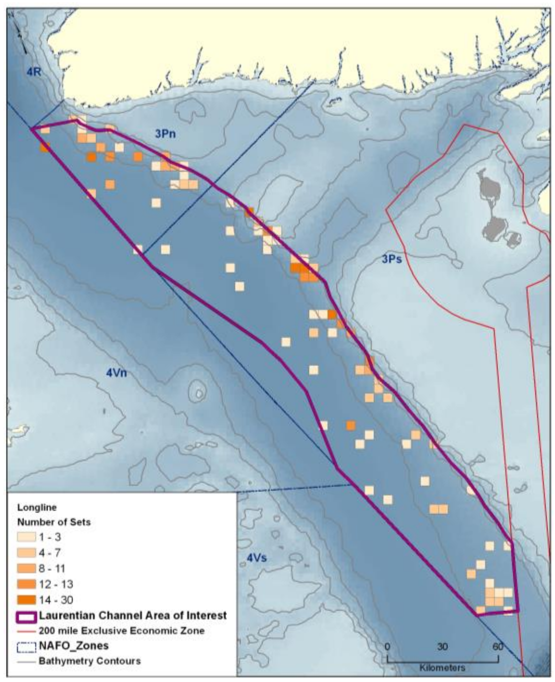


Figure A36. Records of longline gear use from 1991 to 2009 (DFO Oceans).

- Although areas within the LOMA have been identified as important areas for leatherback aggregation and feeding, leatherbacks are widely distributed within the Northwest Atlantic during the summer months and other areas may be of equal or greater importance.
- The main directed fisheries using longline in the AOI target cod, Atlantic halibut, Greenland halibut, and white hake.
- The areal extent of the CO is considered to be 100% of the AOI. Overlap between leatherback distribution and longline use is estimated to be 15%.

Score = 1.5

Contact

- Quantitative Fishing Gear Scores (DFO 2007b) for contact between bottom longline and leatherback, offshore are low (occasionally 1-25%).
- Although leatherbacks feed mainly on jellyfish, and are generally thought of as surface feeders, there is evidence that leatherbacks do not feed exclusively at the surface. Turtles equipped with time-depth recorders have been recorded diving beyond 1000m. This deep diving behavior may reflect nocturnal foraging for jellyfish and other soft-bodied invertebrates within the deeper water layers (James 2001).
- Jellyfish are planktonic, generally floating in surface waters, but in deep offshore areas may occur at considerable depths, and leatherbacks foraging in shelf waters off Canada appear to search for and capture much of their prey at depth, before returning to the surface to consume it (James *et al*. 2005). Figure 4 below shows the proportion of time two leatherbacks tagged off Nova Scotia spent in different depth ranges:

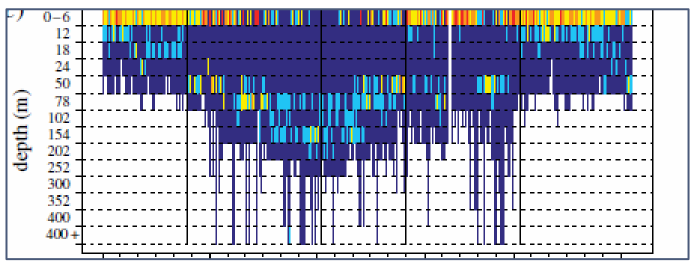


Figure A37. Diving behavior of two leatherback turtles tagged in coastal waters off Nova Scotia, Canada: Proportion of time (per 6 h sample) spent in different depth ranges (James et al. 2005).

- While jellyfish are the preferred prey for leatherbacks, baited longline hooks (numbering between 4000 and 6000 for certain fisheries) may attract them while feeding, increasing the likelihood of contact, rather than just a passive chance of encountering the gear.
- Entanglement in fishing gear has been identified as a significant threat to leatherbacks in the region (Atlantic Leatherback Turtle Recovery Team 2006; Griffin *et al*. 2008; Ledwell and Huntington 2007).
- Although diving behavior may lead to increased incidents of entanglement in offshore waters, surface buoy lines appear to be most problematic. Longlines may also be problematic while they remain near the surface while being set or tended (Atlantic Leatherback Turtle Recovery Team 2006).

Score = 6

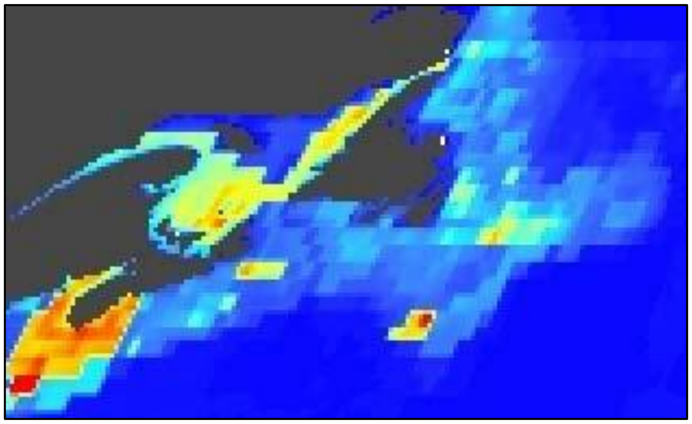
Duration

- The leatherback "season" in Canadian waters extends from May through December, with the majority of turtles present from July through to mid-October (DFO 2010).
- Longline can be utilized from May 15 to February 28 (9 months), and fisheries may take place in all months when leatherback sea turtles are known to be present off southern Newfoundland. Therefore the temporal overlap between presence of leatherbacks and fisheries utilizing longline is 100%.

Score = 10

Intensity

- Global maps (Halpern *et al.,* 2008) for demersal, non-destructive fisheries with low bycatch, which include longlines, show predominantly a medium low (light blue) intensity relative to global levels for a score range of 20% to 40% (see figure below). This map can be used to provide guidance in scoring the intensity of a stressor in relation to maximum (100%) intensity in a global context, in accordance with the scale provided below.



Map colour	Intensity
Red	80-100%
Orange	60-80%
Yellow	40-60%
Light Blue	20-40%
Dark Blue	0-20%

Figure A38. Global Intensity of demersal, non-destructive, low-bycatch fisheries (adapted from Halpern et al., 2008).

- Longline use in the AOI is minimal. In the AOI, dredge, gill-net, pot, long-line and Danish seine accounted for, on average, less than 4% of the combined catch over the period 2005 to 2009.

Score = 2

Magnitude of Interaction= (1.5 x 6 x 10 x 2)/1000 = **0.2**

SENSITIVITY:

Sensitivity of the CO to acute impacts

- Quantitative Fishing Gear Scores (DFO 2007b) for *harm* resulting from an interaction between longline and sea turtles range from low (occasionally 1-25%), to high (> 75% of the time).
- Entanglement in lines associated with fixed fishing gear constitutes the principal source of human-induced injury and mortality for leatherbacks in Canadian waters (DFO 2010).
- Incidental capture in fisheries is considered a leading cause of population decline (James *et al*. 2006). The susceptibility of leatherbacks to entanglements may result from their large body size, long pectoral flippers, and soft shell.
- Although incidental take of marine turtles on pelagic longlines is common, the majority of turtles are released alive; however, the post-capture mortality of these turtles is not known. Leatherbacks, like all sea turtles, demonstrate physiological tolerance to extended periods of anoxia. This ability presumably enables some entrapped turtles to survive long periods of forced submergence (James

2001).

- Impacts of entanglement can range from minor rope scars, to debilitating injuries, or moderate to severe morbidity due to gear remaining attached or imbedded in the turtle. In these cases, the ability of the animal to move and feed may be compromised by injuries, infection, interference with vital body functions (rope/netting confining limb, neck or mouth movement) or by the weight of gear. In severe cases death may occur months or even years later as a result of starvation or chronic infection (Atlantic Leatherback Turtle Recovery Team 2006).
- From 1997 to 2003, James *et al*. (2005) collected 83 records of leatherbacks interacting with fixed gear in shelf waters off eastern Canada. Of these records, 95% were of turtles entangled in buoy lines by one or both front flippers; 18% of all turtles were reported dead. As most interactions were voluntarily reported, these records surely represent only a small fraction of the total number of leatherback-fixed gear interactions occurring in Atlantic Canada.

Score = 8

Sensitivity of the CO to chronic impacts

- The global decline of leatherbacks has been largely attributed to incidental capture in fisheries, with pelagic longlines proposed as a key threat (James et al. 2005). As fixed gear fisheries receive relatively little observer coverage, the magnitude of the threat they pose to leatherbacks has not been adequately recognized nor addressed.
- The leatherback sea turtle is undergoing a severe global decline (> 70% in 15 years). In Canadian waters, incidental capture in fishing gear is a major cause of mortality. A long lifespan, very high rates of egg and hatchling mortality, and a late age of maturity makes this species unusually vulnerable to even small increases in rates of mortality of adults and older juveniles.
- The endangered leatherback sea turtle is protected under the federal *Species at Risk Act* (SARA).
- The leatherback turtle is classified as critically endangered by the International Union for the Conservation of Nature and as endangered by the Committee on the Status of Endangered Wildlife in Canada. Leatherbacks have experienced a dramatic population decline of more than 60% since 1982. Currently, the total number of nesting females is thought to be less than 35,000 worldwide (Atlantic Leatherback Turtle Recovery Team 2006).
- The Atlantic population appears to be more stable, but shows dramatic fluctuations from year to year. The relative density of leatherbacks in Canadian waters has been estimated at 100–900 turtles (during summer), but this is likely low, as there are no accurate population estimates for leatherbacks in Canadian waters (James 2001).
- Given the poor recovery rate for serious interactions, and low reproductive rates of leatherbacks, a moderate score was selected for chronic sensitivity.

Score = 6

Sensitivity of ecosystem to harmful impacts to the CO

- Leatherbacks depend on prey with very little nutritive content and since this species' diet of jellyfish is high in water and low in organic content, they must consume large quantities of food to fulfill their energy requirements (Atlantic Leatherback Turtle Recovery Team 2006).
- Jellyfish are generally considered a nuisance species which can foul fishing gear and force the closure of swimming beaches. Jellyfish also compete with larval fish for food (both eat zooplankton),

and are also known predators of larval fish (James et al. 2005). Leatherbacks help keep the jellyfish population under control, and may therefore help conserve fish species.

- Despite their relatively small numbers, leatherbacks represent a significant biomass due to their large size, and contribute significantly to the energetics of the marine ecosystem. Leatherbacks are highly mobile and their large scale movements contribute to the transfer of energy and biomass from seasonally productive areas to distant marine systems.
- Due to their large size and habit of basking on the sea surface, the charismatic megafauna have long attracted interest, and their presence within the MPA contributes to ecotourism opportunities.
- Canadian waters support one of the highest summer and fall densities of leatherbacks in the North Atlantic, and should be considered critical foraging habitat for this endangered species (James *et al*. 2006).

Score = 5

Sensitivity= (8 + 6 + 5)/3 **= 6.3**

Risk of Harm = (Magnitude of Interaction)(Sensitivity)=(0.2)(6.3)**=1.3**

Leatherback sea turtle – ship strikes

MAGNITUDE OF INTERACTION:

Areal extent

- Leatherback turtles have not been systematically surveyed around Newfoundland and distribution maps rely largely on opportunistic reporting and tracking of small numbers of individuals.
- The primary determinant of movement and behaviour of leatherbacks is the spatial and temporal distribution of their primary prey, gelatinous plankton generally known as jellyfish. In general jellyfish abundance is highest in coastal waters (James *et al*. 2006).
- Notably, the south coast of Newfoundland, i.e., the AOI, is one of the most highly-frequented leatherback foraging areas in Atlantic Canada, and they return to the same sites annually (DFO 2010). The largest concentrations occur on the continental shelf and slope, and further offshore (DFO 2010).
- The main shipping lanes between Newfoundland and the Maritime provinces pass through the AOI. The Laurentian Channel is the main route for ships entering and leaving the Gulf of St. Lawrence and the St. Lawrence seaway.

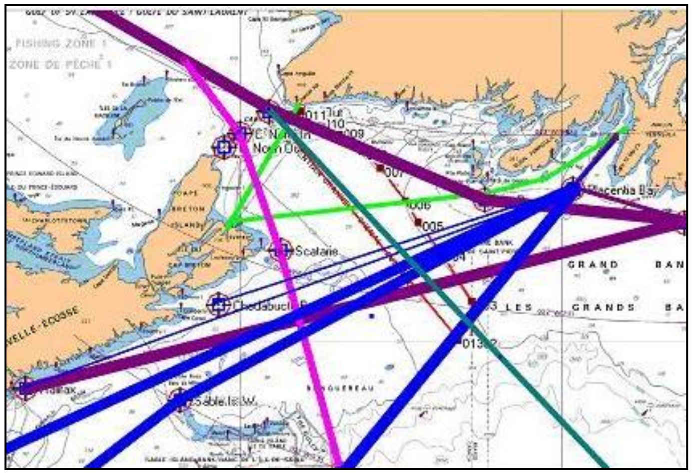


Figure A39. Traffic patterns showing the general regional patterns (Transport Canada Cpt. G. Anderson).

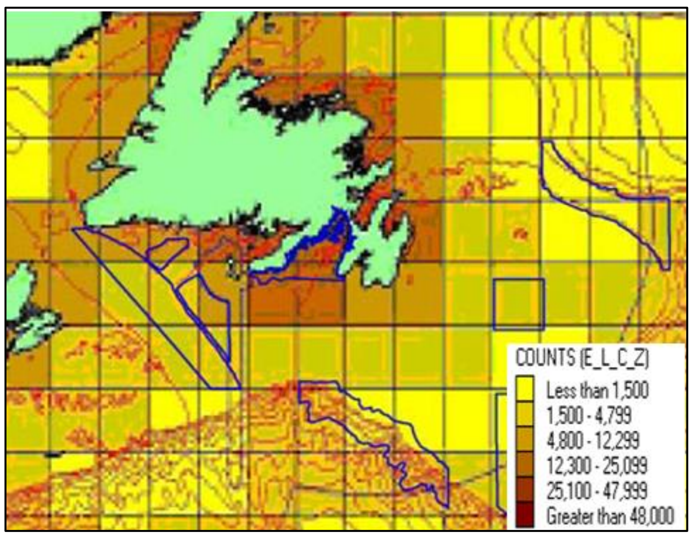


Figure A40. Annual vessel transits for all vessel types combined (Pelot and Wooton 2004).

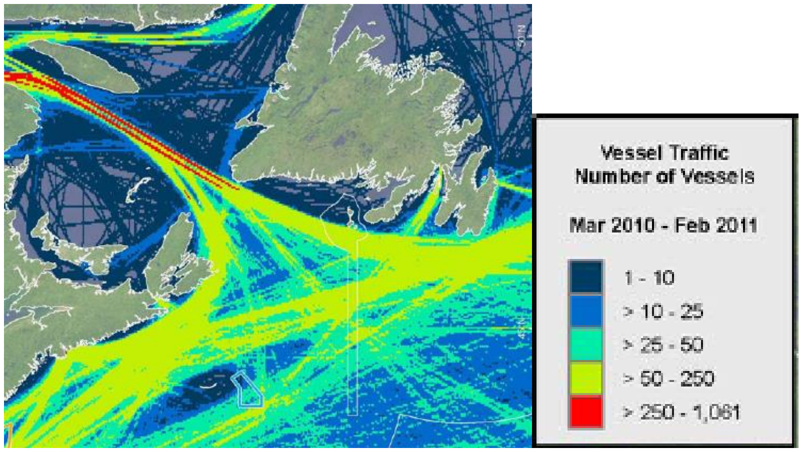


Figure A41. Composite raster of vessel track counts from March 2010 to February 2011, Long Range Identification and Tracking (LRIT) dataset (Koropatnik et al. 2012).

- The images above show that shipping occurs throughout the entire AOI, but to varying degrees. Ships use similar tracks, but each ship may vary its route. Since vessels (commercial, industrial, fishing, recreational, cruise) utilize most of the Laurentian Channel AOI, and leatherbacks can be found throughout, overlap between the two is estimated at 75%.

  Score = 7.5

Contact

- In areas where recreational boating, commercial fishing and ship traffic are concentrated, propeller and collision-related injuries may represent a source of mortality (Atlantic Leatherback Turtle Recovery Team 2006).
- Leatherback turtles breathe air, feed on planktonic jellyfish, and are noted to spend time at surface basking and sleeping. Therefore leatherbacks spend much of their time near the sea surface where they are vulnerable to ship strikes.
- Diving behaviour of leatherbacks in continental slope waters of the northeastern US and eastern Canada suggests that they spend 43 to 50% of their time at the water surface (Transport Canada 2007), however the AOI is one of the most highly-frequented leatherback foraging areas in Atlantic Canada, therefore more time is likely spent in surface waters.

  Score = 7

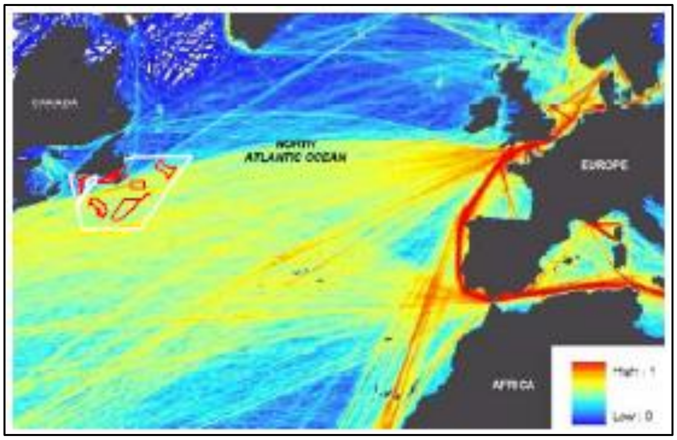
Duration

- The leatherback "season" in Canadian waters extends from May through December, with the majority of turtles present from July through to mid-October (DFO 2010).
- Most vessel traffic is relatively consistent throughout the year, with the exception of fishing and passenger vessels which are greatly reduced in the winter (December to March) (Pelot and Wootton 2004). Koropatnik *et al.* (2012) show that regular traffic patterns have the highest density in August, and the lowest in February.
- Since peak vessel traffic coincides with leatherback occurrence in the AOI, duration is 100%

Score = 10

Intensity

- Detailed maps of shipping density have been published which enable us to gauge intensity in relation to the global max (100%). Intensity of ship traffic is displayed in the following map by Halpern *et al*. in Fig. 9 below:



Map colour	Intensity
Red	80-100%
Orange	60-80%
Yellow	40-60%
Light Blue	20-40%
Dark Blue	0-20%

Figure A42. Commercial Shipping Activity in the Northwest Atlantic (Halpern et al. 2008).

- The Laurentian Channel and Slope AOI have between 4800-12,299 total vessel transits in an average year (Pelot and Wootton 2004), which includes merchant, cruise, and fishing vessel traffic. The Cabot Strait sees approximately 6,400 commercial vessel transits annually, many of which would likely pass through some portion of the AOI.
- These maps serve to highlight commercial traffic patterns for vessels transiting within 1,000 NM from Canada's Atlantic coast. The 12-month composite analysis shows the cumulative commercial vessel traffic for the entire study area. Annual vessel transits in this analysis show that the Laurentian Channel AOI had between 51 – 250 vessel transits (vessels >300 gross tonnes) between March 2010 and February 2011, which is the highest vessel traffic density around Newfoundland and Labrador.
- Therefore shipping within the AOI can be considered moderate (40-60%) on a global scale, as the shipping density is predominantly yellow in colour.

Score = 5

Magnitude of Interaction= (7.5 x 7 x 10 x 5)/1000 = **2.6**

SENSITIVITY:

Sensitivity of the CO to acute impacts

- Leatherbacks breathe air and spend time resting and feeding at the sea surface (James *et al.* 2005). Leatherback turtles are known to bask at the surface for extended periods of time when foraging in temperate waters and, therefore, are vulnerable to collisions with marine traffic (Atlantic Leatherback Turtle Recovery Team 2006).

- Marine mammals and leatherback sea turtles in the AOI can be killed or injured by collisions with ships and ship propellers. Leatherback sea turtles tend to be most vulnerable because they breathe air and spend much of their time at the surface, often sleeping or resting. Vessel strikes are considered a threat to leatherbacks in the marine environment (DFO 2010).
- Both the size and speed of a vessel are the main determinants for ship strikes, particularly for cetaceans. Jensen and Silber (2003) found that the range of speeds at which vessels were operating when a whale was hit was 2–51 knots, and the mean speed was 18.1 knots. The mean vessel speed which resulted in injury or mortality to the whale was 18.6 knots. Leatherbacks move more slowly, and may be impacted by even lower speeds than cetaceans.
- Shipping could also impact the AOI through pollution, aquatic invasive species, anti-fouling from hulls, and engine and propeller noise.
- The extended time periods during which leatherbacks use these northern areas place special emphasis on the need to protect turtles there.
- Acute impacts from ship strikes are not necessarily fatal, therefore it is scored moderately.

Score = 4

Sensitivity of the CO to chronic impacts

- The leatherback turtle was listed as endangered under SARA in June 2003. Fisheries and Oceans Canada – Maritimes Region, led the development of the recovery strategy.
- The leatherback turtle (*Dermochelys coriacea*) is a marine reptile that has experienced precipitous declines in recent years. Global population estimates of nesting females suggest that leatherbacks have declined by 70% from 1980 to 1995.
- A key challenge in the recovery of the Atlantic leatherback turtle is a general scarcity of information regarding the species' biology, distribution, habitat preferences and threats to the populations. In addition, the international nature of this species makes recovery efforts more complex (Atlantic Leatherback Turtle Recovery Team 2006).
- A long lifespan, very high rates of egg and hatchling mortality, and a late age of maturity makes this species unusually vulnerable to even small increases in rates of mortality of adults and older juveniles (James 2001). Generation time is estimated at <30 years (Atlantic Leatherback Turtle Recovery Team 2006).
- The Atlantic population appears to be somewhat stable, but shows dramatic fluctuations from year to year. The relative density of leatherbacks in Canadian waters has been estimated at 100–900 turtles (during summer), but this is likely low, as there are no accurate population estimates for leatherbacks in Canadian waters (James 2001).

Score = 3

Sensitivity of the ecosystem to harmful impacts to the CO

- Leatherbacks depend on prey with very little nutritive content and since this species' diet of jellyfish is high in water and low in organic content, they must consume large quantities of food to fulfill their energy requirements (Atlantic Leatherback Turtle Recovery Team 2006).
- Jellyfish are generally considered a nuisance species which can foul fishing gear and force the closure of swimming beaches. Jellyfish also compete with larval fish for food (both eat zooplankton),

and are also known predators of larval fish (James *et al.* 2005). Leatherbacks help keep the jellyfish population under control, and may therefore help conserve fish species.

- Despite their relatively small numbers, leatherbacks represent a significant biomass due to their large size, and contribute significantly to the energetics of the marine ecosystem. Leatherbacks are highly mobile and their large scale movements contribute to the transfer of energy and biomass from seasonally productive areas to distant marine systems.
- Due to their large size and habit of basking on the sea surface, the charismatic megafauna have long attracted interest, and their presence within the MPA contributes to ecotourism opportunities.
- Canadian waters support one of the highest summer and fall densities of leatherbacks in the North Atlantic, and should be considered critical foraging habitat for this endangered species (James *et al*. 2006).

Score = 5

Sensitivity= (4 + 3 + 5)/3 = **4**

Risk of Harm = (Magnitude of Interaction)(Sensitivity)=(2.6)(4)**=10.4**

Leatherback sea turtle – marine debris/litter

MAGNITUDE OF INTERACTION:

Areal extent

- Leatherback turtles have not been systematically surveyed around Newfoundland and distribution maps rely largely on opportunistic reporting and tracking of small numbers of individuals.
- The largest concentrations occur on the continental shelf and slope; but also further offshore. Notably, the south coast of Newfoundland, i.e., the AOI, is one of the most highly-frequented leatherback foraging areas in Atlantic Canada, and they return to the same sites annually (DFO 2010).
- The primary determinant of movement and behaviour of leatherbacks is the spatial and temporal distribution of their primary prey, gelatinous plankton generally known as jellyfish. In general jellyfish abundance is highest in coastal waters (James *et al*. 2006)
- It is estimated that 6.4 million tonnes of garbage go into the world's oceans every year. Plastic debris is of greatest concern due to its abundance, durability, and buoyancy (The Marine Debris Team 2005).
- There is no comprehensive data on marine litter available for the AOI, although coastal surveys have identified significant accumulation of marine litter on coastal beaches in Placentia Bay, St. Mary's Bay, and Conception Bay. In all areas, a high percentage of the debris was plastic. Domestic garbage was dominant in Conception Bay, while fishing-related debris dominated in Placentia Bay and St. Mary's Bay (DFO 2005b; Derriak 2002).
- Up to 80% of marine debris comes from the land, blowing and washing off beaches and carried to the sea by rivers, sewage systems, and storm drains. The remaining 20% is lost or discarded from boats and ships of all types and sizes (Derriak 2002). Major sources of marine litter include boat traffic (fishing and shipping) and ocean currents. Average annual marine traffic density in the AOI is

considered to be medium (Templeman and Davis 2006).

- Although little data is available on the concentration and distribution of marine litter in offshore areas or the AOI, surface currents can carry significant quantities of floating litter, and floating debris is known to concentrate at convergence zones.
- Islands such as Sable Island accumulate significant quantities of plastic debris, and neuston net tows of surface waters of the Gully MPA and surrounding areas off Nova Scotia found plastics in 80% of tows (Lucas 1992). The density of large debris inside the mouth of the Gully averaged almost three times that seen outside this area. Items included plastic grocery bags, nylon rope, potato chip bags, ice cream container lids, styrofoam, textile fibres, fishing line and fragments of plastic. Average densities in the entire study area were greater than that reported by researchers in the North Sea, North Pacific and central Pacific, but less than the Mediterranean (Dufault and Whitehead 1994).
- Since the horizontal movement of jellyfish is largely passive, they tend to concentrate where currents converge. These same currents concentrate other buoyant objects, including marine debris (e.g., plastic bags, discarded and lost fishing gear, etc.). Therefore, leatherbacks foraging in areas where jellyfish are concentrated may encounter significant amounts of potentially harmful materials of anthropogenic origin (James *et al*. 2001).
- Based on the pollution potential of the area including the density of vessel traffic and oceanographic conditions, the areal extent is estimated to be in the medium range.

Score = 6

Contact

- Leatherbacks breathe air and also spend time basking, resting, and feeding at the sea surface. Although there is evidence that leatherbacks do not feed exclusively at the surface (James *et al.* 2005), they feed mainly on planktonic jellyfish, and are generally thought of as surface feeders.
- Plastic particles and scraps of ropes, netting, six pack rings and related materials persist in the marine environment. Many plastics are buoyant in seawater, and float in surface waters where they interact with leatherbacks feeding at the sea surface.
- Feeding behavior may also put leatherbacks at risk indirectly. Leatherbacks depend on prey with very little nutritive content and must consume large quantities of food to fulfill their energy requirements (Atlantic Leatherback Turtle Recovery Team 2006). Possibly as a result of their insatiable appetite, leatherbacks will readily consume a variety of inedible buoyant objects such as plastic bags, styrofoam, balloons, condoms and plastic sheeting, leading to an array of health concerns and often resulting in death.
- The likelihood of contact is therefore considered high.

Score = 8

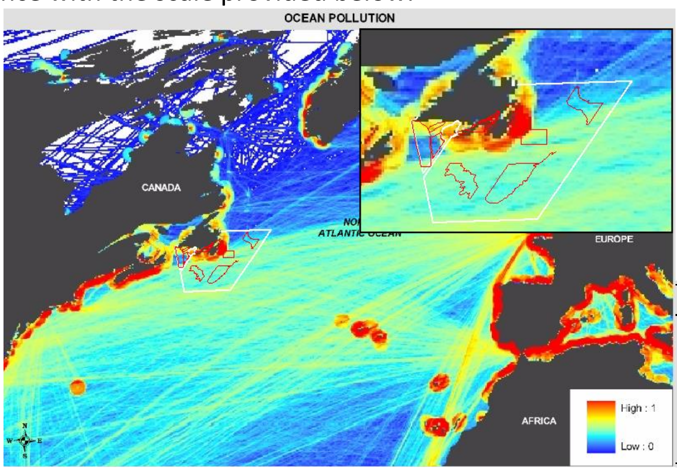
Duration

- Leatherbacks are typically present in the AOI from June to October, but can be present up to December (Atlantic Leatherback Turtle Recovery Team 2006).
- Litter is considered a chronic stressor which occurs regularly. Marine litter is persistent, consisting largely of plastic debris, and sources of litter (land-based activities, fishing boats, ships and winds/currents) are present throughout the year, and during all months leatherbacks are in the AOI.

Score = 9

Intensity

- Halpern *et al.* (2008) developed maps showing the global intensity of several anthropogenic stressors including ocean pollution (see Fig. 10 below). This map can be used to provide guidance in scoring the intensity of a stressor in relation to maximum (100%) intensity in a global context, in accordance with the scale provided below.



Map colour	Intensity
Red	80-100%
Orange	60-80%
Yellow	40-60%
Light Blue	20-40%
Dark Blue	0-20%

Figure A43. Global intensity of ocean pollution, adapted from (Halpern et al. 2008).

- Figure 9 shows a range of intensities within the AOI from medium (yellow) to low relative to global levels, for a score range of 0% to 60%.
- A score is selected between this range, considering aggregation potential and distance from land.

Score = 4

Magnitude of Interaction= (6 x 8 x 9 x 4)/1000 = **1.7**

SENSITIVITY:

Sensitivity of the CO to acute impacts

- The effect of marine pollution on sea turtles is not well quantified, and therefore the magnitude of pollution-related mortality is unknown. Leatherback sea turtles may be more susceptible to marine debris ingestion than other turtle species due to their pelagic existence and the tendency of floating debris to concentrate in convergence zones that adults and juveniles use for feeding areas and migration (Atlantic Leatherback Turtle Recovery Team 2006).
- Leatherbacks depend on prey with very little nutritive content and since this species' diet of jellyfish is high in water and low in organic content, they must consume large quantities of food to fulfill their energy requirements (James *et al*. 2005). This is the only known biological limiting factor in Canadian waters (Atlantic Leatherback Turtle Recovery Team 2006).
- Their specialized diet makes leatherbacks vulnerable to ingestion of plastics and other buoyant marine debris. This behavior is adaptive in exploiting large concentrations of jellyfish, and

leatherbacks will readily consume a variety of inedible buoyant objects such as fishing gear, plastic bags, styrofoam, balloons, condoms, and plastic sheeting. Ingestion of such materials may interfere with metabolism or gut function and lead to blockages in the digestive tract which could result in starvation, in the absorption of toxic by-products, or death (Atlantic Leatherback Turtle Recovery Team 2006).

- Since ingestion is deliberate and these materials may resemble their soft-bodied prey, and marine debris accumulates at convergence zones, where prey is also naturally concentrated, the magnitude of the threat that ingestion of marine debris poses may be grossly underestimated (James and Herman 2001).
- Acute impacts of ingestion of plastics, styrofoam and other waste can lead to both acute and chronic impacts. Acute impacts leading to mortality include blockage of the throat or digestive tract and physical injury from ingestion of hard objects. In general chronic impacts are of greatest concern.

Score = 4

Sensitivity of the CO to chronic impacts

- A long lifespan, very high rates of egg and hatchling mortality, and a late age of maturity makes this species unusually vulnerable to even small increases in rates of mortality of adults and older juveniles. Generation time is estimated at <30 years (James 2001).
- The leatherback turtle is classified as *critically endangered* by the International Union for the Conservation of Nature (IUCN) and as endangered by the Committee on the Status of Endangered Wildlife in Canada. Leatherbacks have experienced a dramatic population decline of more than 60% since 1982. Because male turtles do not return to land it is not possible to accurately count them; scientists determine the population of sea turtles by counting nesting females. Currently, the total number of nesting females is thought to be less than 35,000 worldwide (Atlantic Leatherback Turtle Recovery Team 2006).
- The Atlantic population appears to be more stable, but shows dramatic fluctuations from year to year. The relative density of leatherbacks in Canadian waters has been estimated at 100–900 turtles (during summer), but this is likely low, as there are no accurate population estimates for leatherbacks in Canadian waters (James 2001).
- A new study looked at necropsy reports of more than 400 leatherbacks that have died since 1885 and found plastic in the digestive systems of more than a third of the animals. Besides plastic bags, the turtles had swallowed fishing lines, balloon fragments, spoons, candy wrappers and more (Sohn 2009).
- Plastic debris cannot be digested, and larger items often accumulate in the digestive tract, reducing appetite and feeding capacity (The Marine Debris Team 2005). Ingested plastic can interfere with normal functioning of the digestive system, including severe ulceration leading to tissue necrosis resulting in malnutrition and death (Barreiros and Barcelos 2001). A high body burden of buoyant plastic, particularly foamed plastics can affect the animal’s buoyancy and impair their ability to dive.
- Moreover, the potential toxic effects of such ingestion, while poorly understood, may be significant (James and Herman 2001).
- Given their long lifespan, low reproductive rates, depleted status, and feeding strategy, leatherbacks are particularly vulnerable to chronic impacts of plastic debris, warranting a score in the moderate to high range.

Score = 3

Sensitivity of the ecosystem to harmful impacts to the CO

- Leatherbacks depend on prey with very little nutritive content and since this species' diet of jellyfish is high in water and low in organic content, they must consume large quantities of food to fulfill their energy requirements (Atlantic Leatherback Turtle Recovery Team 2006).
- Jellyfish are generally considered a nuisance species which can foul fishing gear and force the closure of swimming beaches. Jellyfish also compete with larval fish for food (both eat zooplankton), and are also known predators of larval fish (James *et al*. 2005). Leatherbacks help keep the jellyfish population under control, and may therefore help conserve fish species.
- Despite their relatively small numbers, leatherbacks represent a significant biomass due to their large size, and contribute significantly to the energetics of the marine ecosystem. Leatherbacks are highly mobile and their large scale movements contribute to the transfer of energy and biomass from seasonally productive areas to distant marine systems.
- Due to their large size and habit of basking on the sea surface, the charismatic megafauna have long attracted interest, and their presence within the MPA contributes to ecotourism opportunities.
- Leatherbacks may serve as an indicator of the degree of contamination of the oceanic food web by bio-accumulating substances such as heavy metals and polychlorinated biphenyls (PCBs) found in plankton-feeding jellyfish. Metal and PCB levels in the leatherback are expected to represent a biomagnification of concentrations found in their prey; however, to date, tissue samples derived from leatherbacks in European waters have not revealed evidence of significant chemical contamination (Atlantic Leatherback Turtle Recovery Team 2006).
- Canadian waters support one of the highest summer and fall densities of leatherbacks in the North Atlantic, and should be considered critical foraging habitat for this endangered species (James *et al.* 2006).

Score = 5

Sensitivity= (4 + 3 + 5)/3 = **4**

Risk of Harm = (Magnitude of Interaction)(Sensitivity)=(1.7)(4)**=6.8**

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