Multi-species migration in the Laurentian Channel and Slope

Potentially Harmful Activity (X)			Potentially Harmful Stressor (X)		
Fishing	Bottom trawl	**X**	Marine pollution	Oil pollution	**X**
	Scallop dredges			Industrial effluent	
	Clam dredges			Fishplant effluent	
	Midwater trawl	**X**		Sewage	
	Gillnets (bottom)	**X**		Historic military waste	
	Gillnets (pelagic)			Long range transport of nutrients	
	Longline	**X**		Acid rain	
	Seine (pelagic)			Persistent Organic Pollutants	
	Recreational cod fishery			Eutrophication	
	Crab pots	**X**		Ghost nets	
	Lobster pots			Litter	
	Whelk pots			Other contaminants (specify)	
	Other (specify)		Climate Change	Ice distribution	
Other harvest	Otter trapping			Temperature change	**X**
	Seal hunt			Sea-level rise	
	Seabird hunt			Ocean acidification	
	Seaweed harvest			Current shifts	**X**
Seabed alteration	Anchor drops/drags			Increased storm events	
	Ore spill			Increased UV light	
	Fish offal dumping			Oxygen depletion	
	Finfish aquaculture			Changes in freshwater runoff	
	Dredge spoil dumping			Other (specify)	
	Dredging		Harmful species	Green crab	
	Mining/Oil & gas drilling	**X**		*Membranipora*	
	Cables			Golden Star Tunicate	
Coastal alteration	Freshwater diversion			Violet Tunicate	
	Subtidal construction			Vase Tunicate	
	Intertidal/coastal construction			*Codium fragile*	
				Clubbed Tunicate	
	Other (specify)			*Didemnum*	
Disturbance	Vessel traffic	**X**		Harmful Algal Blooms	
	Ship strikes	**X**		Disease organisms (human waste)	
	Ecotourism			Disease organisms (aquaculture)	
	Marine construction			Other (specify)	
	Seismic surveys	**X**	Other		
	Navy sonar	**X**			
	Other (specify)				

Background Information

The eastern slope of the Laurentian Channel in 3Pn and 3Ps is an area of upwelling, resulting in high primary productivity during the spring (Templeman & Davis, 2006). Shelf edges and bank slopes are often highly productive areas (e.g. the west side of the St. Pierre Bank), and are therefore often critical locations for spawning and feeding fish, as well as birds and marine mammals (Rose, 2007). Various species of fish, marine birds and marine mammals are attracted to the high levels of plankton that occur along the slope during the spring and congregate to feed. The slope is also an important area for fish spawning and migration. Atlantic cod, white hake, haddock, and redfish are among the species that spawn along the eastern slope of the Laurentian Channel (Jacques Whitford, 2007).

Migration involves persistent movement between two destinations. The migrations of baleen whales include the longest known annual movements of any mammal (Corkeron & Connor, 1999). It is realized that further, more specific, information in this area is needed in order to carry out effective ecosystem based-management. The ability to better understand and possibly map the specific migration routes of many of the species of interest would, in turn, allow ecosystem based management to be based on smaller zones and seasonality when necessary (Templeman & Davis, 2006).

1. Fish migration

A range of fish species inhabit the EBSA at various times of the year. Because of its depth, the Laurentian Channel serves as a major break separating several stocks of shallow water fish species. The region is characterized by a complex spatial and temporal pattern of seasonal occurrences and distributions, migration patterns, spawning times and locations, as well as complex ecological relationships within and between species. Generally, most species produce eggs and larvae during the spring, but larval and pelagic juveniles remain in the water column through most of the summer (Jacques Whitford, 2003).

-Atlantic cod

- Atlantic cod occur throughout the St. Pierre Bank and Laurentian and Halibut Channels during winter, with a portion of the population migrating to more inshore areas during the summer months. Sixty percent of the Northern Gulf stock mixes with the 3Ps stock during their time spent wintering on the south coast of Newfoundland (Jacques Whitford, 2007).
- The Northern Gulf cod stock are distributed north of the Laurentian Channel, off Newfoundland and Labrador's west coast and along the north shore of Quebec in NAFO Divisions 4RS and Subdivision 3Pn. The majority of these cod migrate to deep water (greater than 400 m) east of the Cabot Strait in the autumn (Fisheries and Oceans Canada, 2008b).
- Local fishers reported that cod migration commences as early as September and by January, there are very few cod left in the Gulf. Cod were reported to be plentiful in 3Pn by March (Jacques Whitford, 2007).

- Atlantic cod were assessed by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) as endangered in May 2005 but were not added to SARA Legal list (COSEWIC, 2003). They are on Schedule 3 of SARA as a Species of *Special Concern*.

-**Atlantic herring**- Found in Channel in winter, migrate across Cabot Strait in summer.
-**Atlantic salmon**- Atlantic salmon migrate through the area from spring to fall on their way to and from summer feeding areas off Labrador and Greenland (Jacques Whitford, 2003). Atlantic salmon return annually to their natal river or tributary for spawning. Both post-smolt (juvenile) and adult salmon migrate from northeastern North America in the spring and summer to waters off Labrador to overwinter. They return to coastal North American in the fall, passing through the Laurentian Channel and St. Pierre Bank in the SEA Area (Reddin 2006). While at sea, adult salmon were found spending a considerable amount of time in the upper portion of the water column (Jacques Whitford, 2007).
-**Greenland halibut**- Prespawning winter concentration occur in the Laurentian Channel to the southwest of St. Georges Bay, and summer feeding concentrations are found at the mouth of the St. Lawrence River to the north of Anticosti.
-**Haddock**- Found in Channel and slope spring to fall- migrate south in winter
-**Lumpfish**-Lumpfish undergo a coastal migration for spawning which takes place in May and June. Males arrive on the spawning grounds several weeks in advance of the females to establish their territories (Jacques Whitford, 2007).
-**Mackerel**- Present on slope between St. Pierre Bank and Channel in winter- migrate northeast to spawn in summer.
-**Pollock**- Present on slope between St. Pierre Bank and Channel in winter- migrate inshore during summer.
-**Redfish** – During the fall, redfish migrate out of the Gulf of St. Lawrence through the Cabot Strait and into the Laurentian Channel, where they overwinter, returning to the Gulf of St. Lawrence in the spring (Jacques Whitford, 2003). Similar to cod, redfish overwinter in the Cabot Strait, returning to the upper Gulf of St. Lawrence in the spring. Redfish in Unit 1 migrate south to Cabot Strait, specifically to subdivisions 3Pn, 4VN, and 3Ps in the fall months (Jacques Whitford, 2007).
-**Witch flounder**- January-February they form a large pre-spawning concentration in the Laurentian Channel just southwest of St. George's Bay (Ollerhead et al., 2004).
-**Yellowtail flounder**- Migrate to Channel in winter, found on St. Pierre Bank in spring and summer

2. Marine mammal migration
Cetaceans comprise two suborders: the Mysticeti (i.e. baleen whales); and the Odontoceti (i.e. toothed whales). The baleen whales are made up of 12 large species that feed on pelagic euphausiids (Fisheries and Oceans Canada, 2000), other plankton, and schooling fish. The toothed whales are made up of approximately 70 species of whales, dolphins, and porpoises which feed on squid, fish and plankton. For the most part, data on cetacean distributions and population assessment on the Grand Banks are largely based on opportunistic sightings and scattered studies (Templeman & Davis, 2006).

The region is a major summer feeding area for several species of marine mammals, primarily migratory cetaceans. Harbour porpoises, Atlantic white-sided dolphins, blue,

humpback, right, fin, pilot, and minke whales are often sighted. Harp and hooded seals breed in the region, while grey seals are particularly numerous around Anticosti island. Harbour seals are resident and are found in all coastal areas (Parks Canada, 2009).

SARA marine mammals that may be present in this area include:

- Blue whale (endangered)
- Beluga whale, St. Lawrence estuary population (threatened)
- North Atlantic right whale (endangered)
- Fin whale (species of special concern)
- Harbour porpoise (threatened)

Whale migration

-In general, baleen whale migrations are seasonal movements between productive high-latitude feeding grounds and low-latitude breeding grounds. Whales travel to cold waters for feeding; they go to warmer waters to give birth.

-Within the Laurentian Channel common prey species include the euphasusiid krills *Meganyctiphanes norvegica* and *Thysanoessa* species and *Calanus* species. Calanus copepods in particular are an important prey for whales and are concentrated in the Laurentian Channel. *M. norvegica* is also abundant within the study area along the southeastern slope of Banquereau Bank (Jacques Whitford, 2003).

-Cabot Strait is an important migratory corridor for marine mammals moving in and out of the Gulf of St. Lawrence. Other major features of the area include seasonal ice cover which provides a platform for pinniped reproduction and limits access of marine mammals (primarily cetaceans) to the Gulf of St. Lawrence during winter months.

Five species of baleen whales occur on the Grand Banks with regular frequency. These include the **humpback whale, blue whale, fin whale, sei whale and the minke whale**. Most baleen whales on the Grand Banks are most commonly observed during summer months when prey species are most abundant. In winter months, baleen whales often move to warmer latitudes to calve. However, baleen whales may stay in cool temperate waters during autumn and winter months, but distribution during these periods are not well known since most surveys occur in spring and summer months.

Toothed whales found in the PBGB LOMA include: **sperm whale, northern bottlenose whale, short-beaked common dolphin, white-beaked dolphin, Atlantic white-sided dolphin, long-finned pilot whale, killer whale and harbour porpoise.** All odontocetes species have teeth to capture and grasp their prey (i.e., fish and squids) and most species are thought to use echolocation to navigate and assist in foraging. Most odontocetes occur seasonally on the Grand Banks (mainly summer), but very little is known on their distribution and current population status (Templeman & Davis, 2006).

- **Sei**- There are believed to be two stocks of sei whales in the western North Atlantic with non-overlapping distributions, one on the Scotian Shelf, the other in the Labrador Sea. The Nova Scotia stock migrates north along the continental slope from wintering

grounds off the eastern U.S., consistently reaching waters-off Nova Scotia by June and July. Sei whales largely disappear from this area for a period during late summer, then reappear in substantial numbers during a regular southward fall migration from mid September to mid-November.

- **Minke**- During summer months, dense concentrations of spawning capelin attract minke whales into bays along the east coast of Newfoundland. They are present there as early as April/May, and most have left by early August (Hammill et al., 2001), but may remain until October/November (Jacques Whitford, 2007).
- **Short-beaked common dolphin**- Migration into eastern Newfoundland occurs with summer warming (Jacques Whitford, 2003).
- **Atlantic white-sided dolphin**- More common in June than any other time of year (Jacques Whitford, 2007). One of the most common cetaceans in the Laurentian Channel area (Jacques Whitford, 2003).
- **Killer whale**- Can be present throughout the year, but sightings are rare (Jacques Whitford, 2003).
- **Sperm whale**- In the Atlantic, some bulls migrate along the continental slope at least as far north as Hudson Strait- this migration consists almost entirely of large males. They do not seem to enter the Gulf of St. Lawrence in large numbers. Long-distance movements across the North Atlantic, between southern Nova Scotia and the coast of Spain and between Iceland and the Azores, have been documented.
- **Blue whales-** During spring, summer, and fall, these whales occur along the north shore of the Gulf of St. Lawrence and off eastern Nova Scotia. In summer they also occur off the south coast of Newfoundland and in the Davis Strait, between Baffin Island and Greenland. They usually migrate south for the winter, but in years of light ice cover, some whales may remain in the St. Lawrence for much of the winter.
- **Fin whale**- They generally make seasonal migrations from low-latitude wintering areas to high-latitude summer feeding grounds.
- **Humpback**- During the fall, they migrate southward to winter and breed in tropical waters; during the spring, they return to northern feeding grounds for the summer.
- **Harbour Porpoise**- Coastal areas in summer, shallow offshore in winter.

Beaked whales: Beaked whales are typically pelagic in distribution and rarely sighted on the continental shelf. Most appear to be deep divers, and squid or deep-sea fish comprise the bulk of their diet.

- **Northern bottlenose whale**- It is endemic in the North Atlantic, where it is widely distributed in cold temperate and subarctic regions. The Scotian Shelf population is distinct from the Labrador population. Scotian Shelf population spends both summer and winter months close to the entrance of the underwater canyon they call home. May be found on the shelf or slope year-round (Templeman & Davis, 2006).
- **White-beaked dolphin**- Present year-round, although they are more commonly seen in nearshore waters during the summer.
- **Long-finned pilot whale**- They often travel in herds of several hundred, closely coordinating their activities and movements. Pilot whales live throughout the year in deep water, and are especially abundant on the continental slope. Squid, specifically short-finned squid (*Illex illecebrosus*) off Newfoundland, are the principal prey of pilot whales. The whales' distribution is governed largely by the squid migrations. They can be seen as

early as May, and stay inshore as late as October. In winter, they range from the Grand Banks as far south as North Carolina. May be found on the shelf or slope year-round (Templeman & Davis, 2006).

Species	Occurrence	Season	Habitat	Species at Risk (Canada and/or US Designations)
Northern Right Whale	Infrequent, rare	Summer	Mostly channel	✓
Minke Whale	Regular, common	Spring, summer, fall	Mostly banks	
Fin Whale	Regular, uncommon	Spring, Summer, Fall	Throughout	✓
Blue Whale	Regular, uncommon	All year, mostly spring, fall	Mostly channel	✓
Sei Whale	Regular, uncommon	Summer	Mostly channel	✓
Humpback Whale	Regular, uncommon	Spring, summer, fall	Mostly banks	✓
Sperm Whale	Regular, uncommon	All year, mostly summer	Throughout	✓
Beluga Whale	Infrequent, very rare	All year?	Throughout	✓
Northern Bottlenose Whale	Infrequent, rare?	All year?	Channel	✓
Sowerby's Beaked Whale	Infrequent, very rare	All year?	Channel	✓
Killer Whale	Almost never, very rare	All year	Throughout?	✓
Long-finned Pilot Whale	Regular, common	All year?	Throughout	
White-beaked Dolphin	Regular, common?	All year?	Throughout	
Atlantic White-sided Dolphin	Regular, common	All year, mostly spring, fall	Mostly channel	
Short-beaked Common Dolphin	Irregular, uncommon	Summer	Throughout	
Bottlenose Dolphin	Irregular, rare	Summer	Mostly channel	
Striped Dolphin	Irregular, uncommon	Summer	Mostly banks	
Harbour Porpoise	Regular, uncommon?	All year?	Mostly banks, inshore	✓
Grey Seal	Regular, common	Mostly summer	Throughout	
Harbour Seal	Regular, uncommon	All year	Mostly banks, inshore	✓
Harp Seal	Regular, uncommon	Late winter, early spring	Throughout	
Hooded Seal	Regular, uncommon?	Especially late winter?	Mostly channel?	
Note: ? indicates particularly uncertain status.				

Table 1: Summary of likely marine mammal presence in the Laurentian Subbasin (Jacques Whitford, 2003).

3. Pinniped migration

The six species of phocid seals commonly observed in the Placentia Bay-Grand Banks area include the harp, hooded, grey, harbour, ringed and bearded seals. Unlike whales, the seals have a terrestrial phase where they haul out on land or ice to give birth and suckle their young; they are therefore not year-round residents to the Grand Banks.

-Harp seals- Abundant and distributed widely throughout Newfoundland waters as they migrate annually between Arctic and sub-Arctic regions of the north Atlantic. Harp seals summer in Arctic waters and then migrate into the Grand Banks area in late fall to feed, pup and breed (March) and then moult (April/May) before heading back north to Greenland and the eastern Arctic for the summer.

-Hooded seals- Migratory seals that, like the harp seals, summer in Arctic and Greenlandic waters and then migrate into the Grand Banks and southern Gulf of St. Lawrence late in the fall to feed, pup and breed (March) and then migrate north in the spring to moult (late June/July) in Greenland.

-Grey seals- On the Grand Banks, are migrants from breeding populations further west (i.e. Gulf of St. Lawrence) and south (i.e. Sable Island). They congregate in the Gulf of

St. Lawrence for pupping and breeding from mid-December to late February, move onto Grand Banks in July and August.
-Harbour seals- The least migratory of all seal species. They are primarily found in bays and estuaries and frequent local haul-out sites. They are year-round residents of the Gulf of St. Lawrence, the St. Lawrence estuary and coastal Newfoundland. This is the only seal out of the four in the LOMA rated by COSEWIC, but only as 'data deficient'.
-Ringed seals- Known to have variable migration patterns with some individuals essentially non-migratory while others exhibit extensive seasonal movements. The species is most common along the northern coast of Labrador, but is commonly observed along the northeast coast of Newfoundland and occasionally extends into northeastern portions of the Grand Banks.
-Bearded seals- Often associated with drifting ice packs in shallow coastal waters, following its retraction and expansion between summer and winter each year.

Scoping

Bottom trawl:
Trawls are long, wedge-shaped nets of synthetic webbing that narrow into a funnel-shaped bag. The bottom trawl is dragged along the seafloor and kept open during a tow with large, oval, metal plates (doors). Footropes are often rigged with heavy steel rollers or chains to keep the net on the seafloor. Multi-year studies of the impacts of groundfish trawling carried out in the Atlantic by DFO show short-term disruption of benthic communities, including reductions in the biomass and diversity of benthic organisms. Some previously fished seafloor habitats showed recovery within one to three years but frequently trawled habitats remain in an altered state (Fisheries and Oceans Canada, 2006a).

This EBSA includes portions of sub-Divisions 3Pn, 3Psd, and 3Psg. Fisheries within each of these NAFO Unit areas varies, but over 1998-2007 in this EBSA, bottom trawl accounted for the most landings by weight of any gear type, which totalled 11,037 tonnes (55%, see Appendix A, Table 18). Redfish, cod and skate (smooth and thorny), and flatfish are fished with otter trawl in 3Ps, from approximately April 12 – February 28 (see Appendix A, Table 7). Vessels registered in Newfoundland accounted for 67.4 % of the total landings, and vessels registered in Scotia-Fundy region accounted for the remainder (as of 2003). Fish, cetaceans, and pinniped species use the Laurentian Channel as a migratory route to the Gulf of St. Lawrence. These species are likely to encounter bottom trawls in many places along their migration route. Trawling occurs starting in April for skate; June for cod, and July for redfish. This overlaps with many species migration timing. Bottom trawl could remove biomass, and cause avoidance behaviour in these species, both of which can influence migration. **Screened in.**

Midwater trawl:
Midwater trawls resemble otter trawls in that they are cone-shaped and constructed of webbing, except it is designed to fish at varying depths in the water column, and the nets are much bigger. They also have fewer weights, and thus can be adjusted for towing at various depths. Midwater trawls can be used to catch many species of fish, most

commonly herring, mackerel, redfish, pollock, capelin and shrimp. They are mainly used to capture pelagic species, but may also catch groundfish that rise off the bottom (Fisheries and Oceans Canada, 1989).

Midwater trawls were responsible for the second highest landings by weight over the years 1998-2007 in this EBSA (43%). Redfish is the main species targeted with this gear type, and the fishery is open from July 1 to March 31. There have been no reported landings in this EBSA from midwater trawl since 2002, and even if the gear were to be used in the future, it is not expected to affect migration of fish, cetaceans and pinnipeds to any great extent (Fisheries and Oceans Canada, 2008a). **Screened out.**

Gillnets (bottom):
Gillnets are fixed gear, and consist of vertical walls of mesh, with mesh openings sized such that target species in the desired size range are caught as they attempt to swim through the webbing, entangling their gills. Bottom gillnets are secured in direct contact with the seafloor by weights and have a high incidence of bycatch. Within the LOMA, offshore license holders are limited to 40-500 nets that are 91m in length and are usually joined together (Appendix A, Table 5). This amounts to a maximum of 45.5 km of net per license holder.

Landing data (by weight) from 1998-2007 show that gillnets were responsible for only 1% of catch in this EBSA. The main fisheries executed in the EBSA using gillnet are Atlantic cod, Greenland halibut, redfish, monkfish/skate, and white hake. The cod fishery was closed in 3Pn in 2003. The cod fishery in 3Ps is divided among gear types, with gillnetting accounting for 45% of the quota. Although this gear could catch some fish and marine mammal species, it comprises just 1% of landings in the EBSA from 1998-2007 (Fisheries and Oceans Canada, 2008a). The CP encompasses several species which occur at various depths in the water column. This gear type could pose a threat to species migration, but because it is used so infrequently it is unlikely to be a risk to migration. **Screened out.**

Longline:
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). Anchors attached to the longline secure the gear to the ocean floor. Longline is permitted in 3Ps/3Pn for the following fisheries: Greenland halibut, white hake, skate and cod. Although it is used in the EBSA, landings are minimal at just 27 tonnes in 10 years (less than 1% of total landings from 1998-2007), and limited to the slope (Fisheries and Oceans Canada, 2007; Fisheries and Oceans Canada, 2008a). DFO fishery data shows that longline was hardly used in this EBSA, in fact, since 2001 the highest landings taken with longline was 5 tonnes in 2006. With such limited use in this EBSA, longlines are not expected to be a stressor on multi-species migrations. **Screened out.**

Crab pots:
Although crab is a very important fishery in 3Ps and responsible for significant landings, most of the important areas are to the east of the EBSA in sub-Divisions 3Psf and 3Psh.

Harvesting locations are shown in The Grand Banks: Atlas of Human Activities, covering the years 2000 - 2003 (Fisheries and Oceans Canada, 2007) and the Sydney Basin SEA covering 2003 – 2005 (Jacques Whitford, 2007)- both of which show that crab is mainly taken from the area east of the Canada-France boundary. A very small portion is taken on the shelf of this EBSA, where it borders the St. Pierre Bank, but landings of crab averaged just 3.4 tonnes annually (Fisheries and Oceans Canada, 2008a). **Screened out.**

Oil and gas drilling:
The EBSA encompasses two oil and gas 'offshore areas'- Sydney Basin and the Laurentian Sub-basin (see Fig. 1). The Sydney Basin offshore area encompasses the upper half of the Laurentian Channel and Slope EBSA, and one exploration licence has been approved for this area to date. The Laurentian Sub-basin offshore area covers the lower half of the EBSA, and two exploration licenses have been approved as of 2009, and a 'call for bids' has gone out on another parcel, just below the two existing ones.

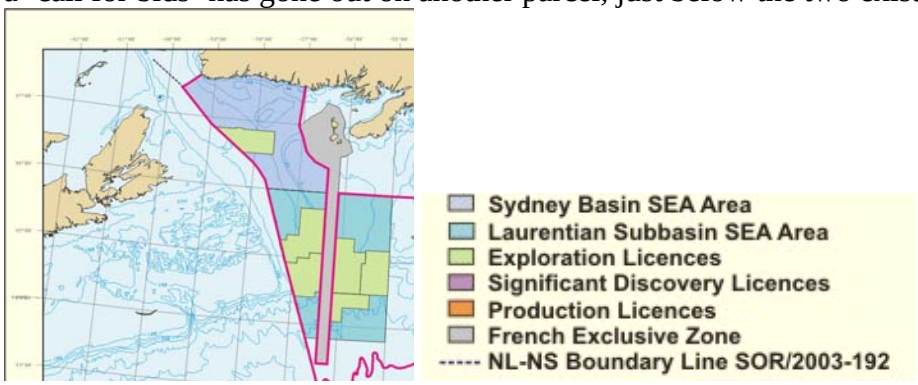


Figure 1. Petroleum offshore areas and exploration licences (CNLOPB, 2009)

In the Laurentian Sub-basin area, the proposed drilling area is located near the mouth of the Laurentian Channel at the offshore entrance to the Gulf of St. Lawrence. The first well is tentatively planned for the November of 2009 on EL1087. A second well may be drilled on EL 1081. Depending on results and seismic data interpretation, additional exploration and appraisal wells may be drilled in ELs 1082, 1085 and 1086. Drilling may occur year round up to the period of expiration for these licences. It is anticipated that from one to four wells per year could be drilled. Each well will take from 50 to 100 days to complete. Drilling will be conducted by a drill rig (jack-up, anchored or dynamically-positioned drill ship or semi-submersible), depending on water depth. Activities will be supported by supply vessels and offshore helicopters. Vertical seismic profiling (VSP) and well site shallow geohazard survey activities may also be conducted in conjunction with the drilling (Jacques Whitford, 2003).

The exploration drilling activities will be carried out in water depths ranging from 200 m to 3,000 m along the Laurentian Slope, and will include the Laurentian shelf, slope and abyssal plain. The drill rig will be the only surface structure. 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)^3 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).

The Sydney Basin is a much newer project, and received one exploration licence in 2009. No drilling has occurred to date, but will occur in the near future when drill rigs become available (Baird, 2009). The current exploration licence and remaining 2 parcels range in water depth from 200 to 400 m and are within the 200-mile limit (Jacques Whitford, 2007). The activities of geophysical sampling, exploration drilling, and well abandonment could impact species migration. **Screened in.**

Vessel traffic:
The main shipping lanes between Newfoundland and the Maritime provinces pass through this EBSA. 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 and Slope EBSA have between 4800-12,299 total vessel transits in an average year (Pelot & Wootton, 2004). This is considered 'medium-low' within the LOMA. The Cabot Strait sees approximately 6,400 commercial vessel transits annually, many of which would likely pass through some portion of the EBSA. From May 2002 to April 2003 there were a total of 3,801 vessel trips through the Laurentian Sub-basin area. The average number of trips per month over that period was 317 (Jacques Whitford, 2003). Additional vessel traffic will occur when exploration drilling begins in the EBSA. The drilling rig will be supported by three vessels of 12-15,000 HP. There will be, on average, two trips per week between the base and the platform. Personnel and light supplies will be transported to and from the drilling rig via twin-engine, offshore-rated helicopters. Flights would occur approximately six times per week (Jacques Whitford, 2007).

Vessel traffic could pose a risk to migration, especially for cetacean and pinnipeds, as it is a source of noise (collisions considered under 'Ship Strikes' below) 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 (Fisheries and Oceans Canada, 2006b). **Screened in.**

Ship strikes:
Vessel traffic is considered 'medium-low' density in this EBSA, but the Laurentian Channel is a noted migration route, and a main shipping route for vessels bound for the Gulf of St. Lawrence. Ship strikes are a risk to pinnipeds and cetacean migrations, but not fish migration. Ship strike injuries to whales take two forms: (1) propeller wounds characterized by external gashes or severed tail stocks; and (2) blunt trauma injuries indicated by fractured skulls, jaws, and vertebrae, and massive bruises that sometimes lack external expression (Laist et al., 2001).

Of 11 species known to be hit by ships, fin whales are struck most frequently; right whales, humpback whales, sperm whales, and gray whales are hit commonly. Ship strikes can significantly affect small populations of whales, such as northern right whale (Laist et al., 2001). Blue and fin whales often occupy shelf-break locations that frequently coincide with shipping lanes, which concentrate large vessel traffic. In a review of 292 records of ship strikes, Jensen and Silber (2004) reported that fin whales were the most commonly struck species, while blue and sei whales were two of the least likely to be struck. However, ship strikes offshore are more likely to go undetected. The mortality rate associated with ship strikes is 70-80% (Jensen & Silber, 2004). Disease, parasites, entanglement, or other factors may cause whales to spend more time at the surface and predispose them to being hit. Some collisions inflict only internal injuries, such as fractured vertebrae and skulls, with no obvious external damage (Laist et al., 2001).

The high proportion of calves and juveniles among stranded ship-struck right whales and humpback whales indicates that young animals may be more vulnerable to being hit by ships. This could be caused by the relatively large amount of time that calves and juveniles spend at the surface or in shallow coastal areas where they are vulnerable to being hit. It also may indicate that whales learn to avoid vessels as they mature. In either case, habitats preferred by nursing or juvenile right whales or humpback whales could be areas where collision risks are greater. Whales engaged in feeding also may be less responsive to approaching ships (Laist et al., 2001). Ship strikes could affect individual marine mammals, but is unlikely to impact multi-species migrations. **Screened out.**

Seismic surveys:
The most accurate and widely used means of finding good drilling locations is the seismic survey. Seismic surveying involves sending sound waves down into the ground 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.

The EBSA will undergo seismic exploration during the next 10 years, as it lies almost completely within two CNLOPB ‘offshore areas’: the Sydney Basin Offshore Area and the Laurentian Channel Offshore Area (see Fig. 5 above). Three exploration licences are located within the EBSA. Activities that may be associated with exploration licences include seismic and other geophysical surveys. Vertical seismic profiling (VSP) and well site shallow geohazard survey activities may also be conducted in conjunction with the drilling. These activities will occur at water depths ranging from 200m to 400m (Jacques Whitford, 2007).

The length of time of a seismic survey varies, but usually ranges from a week to a month. A typical seismic survey lasts two to three weeks and covers a range of approximately 555 to 1110 km. The ship towing the array is typically 60 to 90 m long and moves through the water at speeds usually in the range of 8 to 10 km/h (4.5 to 5.5 knots). Airguns release compressed air every 6 to 10 seconds for a duration of 10 to 30 milliseconds per shot. A cable is towed (500m to 8km in length) to record the reflected sound waves. The noise associated with airguns can range between approximately 215 to

260 dB. For an airgun with sound intensity of 250 dB at the source, noise levels over 30km away can be as high as 117 dB (Jacques Whitford, 2007). Seismic surveys can have both behavioral effects and physical effects on species present in the area. Behavioral affects would most likely affect migration as a whole, rather than physical affects.

Fish

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 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).

No mass fish kills associated with the operation of airguns have been recorded to date. Depending on source noise level, water depth and distance of the fish relative to the source, injuries (such as eyes and internal organs) would only occur within a few tens of metres, with lesser symptoms (such as hearing damage) possible out to several hundred metres. The expected distance for fish to react to a typical peak source level of 250 to 255 dB is from 3 to 10 km. there is overlap in the frequency of seismic signals and the sounds emitted by fish, so there is potential for sound reception and production in fish to be reduced (Jacques Whitford, 2003).

Cetaceans and Pinnipeds

Baleen whales rely on sound primarily for social communication. Whales may also use sound for predator detection, orientation, navigation, and possibly prey detection. Underwater noise has the potential to disrupt these behaviours. Chronic noise may result in population level changes in both short and long-term behaviour, while acute sounds may result in hearing damage leading to drastically reduced fitness or death. Noise is therefore a potential threat to individuals, the population, and the habitat of these species. While few data are available to assess physiological responses of marine mammals to anthropogenic noise, observed effects include both temporary and permanent hearing threshold shifts, the production of stress hormones, and tissue damage, likely due to air bubble formation or as a result of resonance phenomena. The impact on marine mammals is thus a function of the length of exposure, loudness, frequency, and nature of the sound. Seismic activity could cause physical damage to hearing, result in distribution changes due to noise or changes in food distribution (The Whale and Dolphin Conservation Society, 2004). **Screened in.**

Navy sonar:

Within Canada's 200 nautical mile limit, exercise areas can be found in Nova Scotia, Newfoundland and the Gulf of St. Lawrence. Before any exercises are conducted in these areas, Maritime Command Atlantic of the National Defence coordinates the publication of a notice to mariners for the specified area. The area of southern Newfoundland, except

within French territorial waters, are susceptible to holding sub surface exercises but the National Defence indicates that these zones have not been used in the past five years and there is no intention of using them in the next five years (Maritime Innovation, 2005). **Screened out.**

Oil pollution:
This EBSA has 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. Oil pollution may also result from the petroleum-related activities occurring in the two 'Offshore Areas'. Although an oil spill has the potential to harm numerous species, it will likely have no immediate impact on migration activities. However, if species are migrating through an area exactly at the time of a spill, they could be affected. Fish are less likely to be affected as they are present in deeper waters, whereas cetaceans and pinnipeds spend time at the surface. Pollution effects that have been observed in marine mammals include depression of the immune system, reproductive impairment, oiling of mucous membranes or eyes, lesions and cancers. Most of the effects are reversible and would not cause permanent damage to the animals. Marine mammals have been observed avoiding or attempting to avoid oil spills (Jacques Whitford, 2007). Considering the CP includes fish species as well, this should not pose a serious risk to migration activity. **Screened out.**

Temperature change:
Drinkwater (UNEP & UNFCCC, 2002) predicts a temperature increase of 2-4^{o}C in Southern Newfoundland waters by 2100, based on IPCC 2001 models. This rise will likely not be linear, but is expected to accelerate over time, and even given the worst case scenario an increase in 0.4^{o}C is all we can expect over the next ten years. This predicted rise in temperature may be balanced by a potential drop in temperature resulting from a reduced flow of the warm Gulf Stream Current and increased flow from the Labrador Currents as a result of increased ice melt.

One of the strongest characteristic of this area is that the surface temperature presents a large seasonal change (approximately 12°C magnitude) between summer and winter. In contrast, the bottom temperature remains quite constant, representing the on-shelf water penetration associated with the Scotian shelf slope-derived lower layer (Jacques Whitford, 2007). Temperature change could affect migration cues, may affect ice coverage, and may affect prey species for which some species migrate (e.g. capelin). Significant declines in zooplankton abundance have taken place off California since the 1970s and have been linked to increases in sea surface temperature (Doney, 2006). Matrilineal fidelity to feeding grounds has been observed in baleen species (humpback, right, and grey whales). Such fidelity implies a limited ability to locate new feeding grounds when changing oceanographic conditions lead to a significant shift in prey distribution. These changes are not likely to be significant over the next 10 years unless annual fluctuations in temperature are much greater than the average predicted change. **Screened out.**

Current shifts:
The flow of major ocean currents is driven by the sinking of super-cooled (heavy) water in specific areas of the ocean - as cold water sinks, warm water flows in to replace it, driving the large scale circulation of the ocean. Global warming is weakening this process. This weakening could cause changes in the currents over the next few years or decades. The exact effect and timing of such changes is hard to predict because currents and weather systems take years to respond and because there are other (unstudied) areas around the north Atlantic where water sinks, helping to maintain circulation. A decline in sub-polar circulation in the North Atlantic has been detected in recent years (Hakkinen & Rhines, 2004), potentially indicating a weakening of the Labrador Current. At the same time, rising temperatures leading to increased polar ice melt may at least temporarily increase the volume and decrease the salinity of the Labrador Current. The progress and consequences of these changes are difficult to forecast and research and monitoring are required to produce more informed predictions.

If climate change results in current shifts in this area, migration may be affected. The general circulation consists of modified Labrador Current Water, the inshore branch of which flows through the Avalon Channel and around Cape Race. This Branch then divides into two parts, one flowing to the west (splitting along both sides of the Burgeo Bank) around the north of St. Pierre Bank and the other flows to the south between the south of St. Pierre Bank and Green Bank. This southern branch then joins a part of the offshore branch that has flowed around the tail of the Grand Banks, westward along the continental slope to the Laurentian Channel and goes up into the Gulf of St Lawrence (Jacques Whitford, 2007). Changes to this circulation pattern may affect nutrients, temperature, migration cues, and impact prey species (capelin, krill, etc.). However, current shifts are unlikely to reach a level where the CP is seriously harmed within the next ten years. **Screened out.**

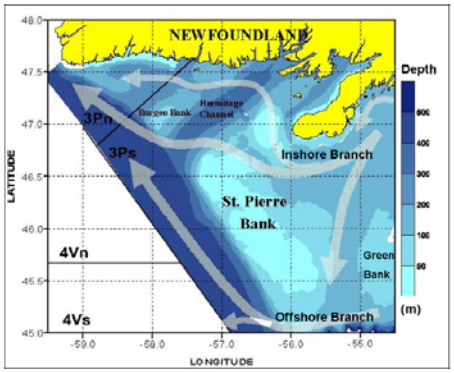


Figure 2. General oceanic circulation in the Laurentian Channel area (Jacques Whitford, 2007).

Key Activities/Stressor:
- Bottom trawl
- Oil and gas drilling
- Seismic surveys
- Vessel traffic

Reference List

1. Baird, M. (2009). ConocoPhillips leases offshore rig- Oil and gas company expects to drill a well off south coast later this year or early next. The Telegram [On-line]. Available: http://www.thetelegram.com/index.cfm?sid=267038&sc=82

2. CNLOPB (2009). Canada-Newfoundland and Labrador Offshore Petroleum Board. Internet [On-line]. Available: http://www.cnlopb.nl.ca/

3. Corkeron, P. J. & Connor, R. C. (1999). Why do baleen whales migrate? *Marine Mammal Science, 15,* 1228-1245.

4. COSEWIC (2003). *COSEWIC Assessment and Update Status Report on the Atlantic Cod Gadus morhua in Canada* Ottawa: Committee on the Status of Endangered Wildlife in Canada.

5. Doney, S. C. (2006). Plankton in a warmer world. *Nature, 444,* 695-696.

6. Fisheries and Oceans Canada (1989). *Underwater World: Atlantic Fishing Methods* Ottawa, Canada: Communications Directorate, DFO.

7. Fisheries and Oceans Canada (2000). *State of Phytoplankton, Zooplankton and Krill on the Scotian Shelf in 1998* (Rep. No. Stock Status Report G3-02). DFO Science, Maritimes Region.

8. Fisheries and Oceans Canada (2006a). *Impacts of trawl gears and scallop dredges on benthic habitats, populations and communities* (Rep. No. Science Advisory Report 2006/025). Canadian Science Advisory Secretariat, National Capital Region.

9. Fisheries and Oceans Canada (2006b). Recovery Strategy for Blue, Fin, and Sei Whales (Balaenoptera musculus, B. physalus, and B. borealis) in Pacific Canadian Waters. *Species at risk Act Recovery Strategy Series,* 1-53.

10. Fisheries and Oceans Canada The Grand Banks of Newfoundland: Atlas of Human Activities. *The Grand Banks of Newfoundland: Atlas of Human Activities,* (in press).

11. Fisheries and Oceans Canada. (2008a). 1998-2007 3LMNOP4R Effort and Catch. Policy and Economics Branch. [Newfoundland and Labrador Region Catch and Effort]. Fisheries and Oceans Canada.

12. Fisheries and Oceans Canada (2008b). *Assessment of cod stock in the northern Gulf of St. Lawrence (3Pn, 4RS) in 2007* (Rep. No. Science Advisory Report 2008/003). Canadian Science Advisory Secretariat, Quebec Region.

13. Hakkinen, S. & Rhines, P. (2004). Decline of Subpolar North Atlantic Circulation During the 1990s. *Science, 304,* 555-559.

14. Hammill, M., Lesage, V., Dube, Y., & Measures, L. N. (2001). *Oil and gas exploration in the Southeastern Gulf of St. Lawrence: A review of information on pinnipeds and cetaceans in the Area* (Rep. No. Research Document 2001/115).

15. Jacques Whitford (2003). *Strategic Environmental Assessment Laurentian Subbasin*.

16. Jacques Whitford (2007). *Strategic Environmental Assessment Sydney Basin Offshore Area*.

17. Jensen, A. S. & Silber, G. K. (2004). *Large Whale Ship Strike Database* (Rep. No. NMFS-OPR-25). U.S. Department of Commerce.

18. Laist, D. W., Knowton, A. R., Meade, J. G., Collet, A. S., & Podesta, M. (2001). Collisions Between Ships and Whales. *Marine Mammal Science, 17,* 35-75.

19. Maritime Innovation (2005). *Marine Traffic Surveys* (Rep. No. Gros Cacouna LNG Terminal).

20. Ollerhead, L. M. N., Morgan, M. J., Scruton, D. A., & Marrie, B. (2004). Mapping spawning times and locations for 10 commercially important fish species found on the Grand Banks of Newfoundland. *Canadian Technical Report of Fisheries and Aquatic Sciences, 2522,* iv-45.

21. Parks Canada (2009). National Marine Conservation Areas of Canada. Goverment of Canada [On-line]. Available: http://www.pc.gc.ca/eng/progs/amnc-nmca/index.aspx

22. Payne, R. S. (2004). *Long-range communication in large whales, ocean noise and synergistic impacts* (Rep. No. Submitted at the IWC 56 meeting, July 2004). IWC.

23. Pelot, R. & Wootton, D. (2004). *Maritime traffic distribution in Atlantic Canada to support an evaluation of a Sensitive Sea Area proposal* (Rep. No. 2004-05). Maritime Activity & Risk Investigation Network.

24. Rose, G. A. (2007). *Cod: The Ecological History of the North Atlantic Fisheries*. Breakwater Books.

25. Templeman, N. D. & Davis, M. B. (2006). *Placentia Bay-Grand Banks Ecosystem Overview and Assessment Report (DRAFT)* Newfoundland & Labrador: Fisheries and Oceans Canada.

26. The Whale and Dolphin Conservation Society (2004). *Oceans of Noise*.

27. UNEP & UNFCCC (2002). *Climate Change Information Kit* UNEP and UNFCCC.

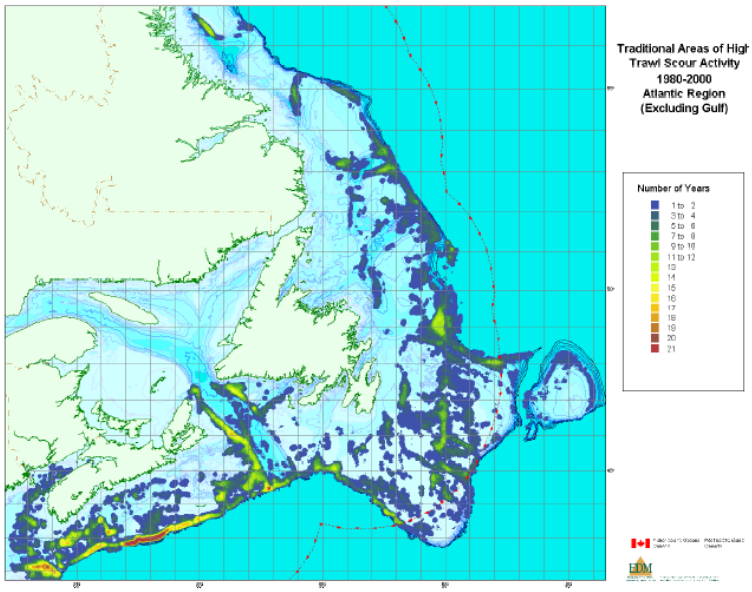
Multi-species migration in the Laurentian Channel and Slope

Bottom trawl

Magnitude of Interaction

Areal extent:

- Certain species of fish, cetaceans and pinnipeds move through the Laurentian Channel as part of their annual migration patterns. There is no map that adequately conveys the areal extent of these movements.
- The shelf edges and bank slope are often highly productive areas, and are therefore often critical locations for spawning and feeding fish, as well as birds and marine mammals (Jacques Whitford, 2003).
- Because of the wide variety of species, habitat requirements, and migration routes used by this CP, it can be assumed that the entire area of the EBSA is utilized, especially those areas near the shelf edge and slope.
- Bottom trawl has been utilized heavily in some parts of this EBSA over the period 1980-2000 (Kulka & Pitcher, 2001).



Maps depicting persistent areas of high intensity trawling in the Atlantic over the period 1980-2000, Gulf of St. Lawrence excluded

Figure 1. Maps depicting persistent areas of high intensity trawling in the Atlantic over the period 1980-2000 (Kulka & Pitcher, 2001).

- Over the period 1998-2007, bottom trawl accounted for the most landings by weight (11,037 tonnes), of any gear type (55%) in this EBSA (Fisheries and Oceans Canada, 2008). Fisheries using bottom trawl in the Laurentian Channel EBSA include cod, skate, and redfish (Appendix A, Table 7).

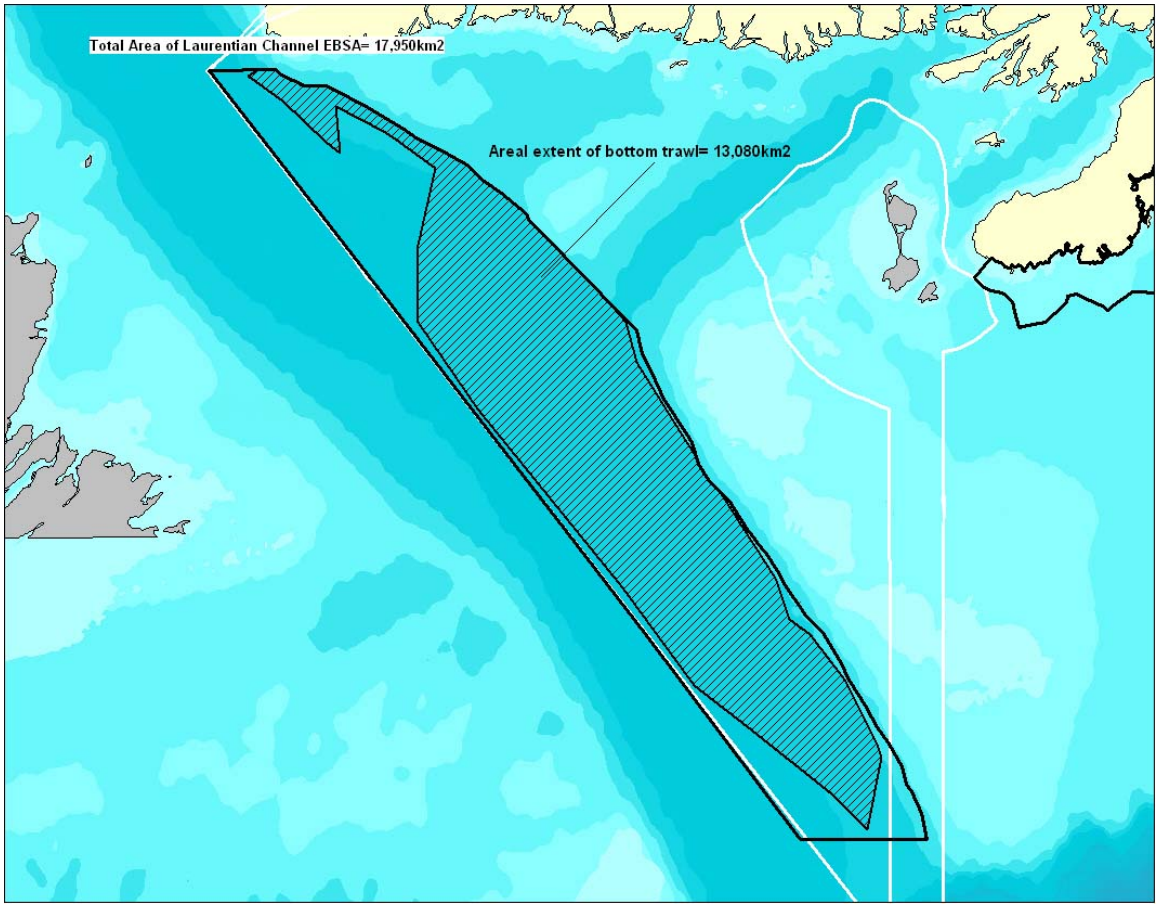


Figure 2. Areal extent of bottom trawl use, 1998-2007, Newfoundland Region fisheries (Fisheries and Oceans Canada, 2008).

- The Laurentian Channel and Slope EBSA encompass an area from the slopes of the banks (approximately 300m deep) to the western LOMA boundary in the middle of the Channel (500m deep).
- Trawling activity within the EBSA from 1998-2007 covered approximately 13,080km^2 (see image above). Multi-species migration occurs throughout the entire EBSA.

Score 7.3

Contact:

- In relation to bottom trawl, Quantitative Fishing Gear Scores (Fisheries and Oceans Canada, 2007a) for "contact" are high (75-100%) for bony fish species, high for elasmobranchs (sharks, skates and rays), high for forage fish species, nil for cetaceans, and low for pinnipeds.
- Trawling activity in this EBSA targets redfish almost exclusively, although Conservation Harvesting Plans (Fisheries and Ocean Canada, 2008) state that Atlantic cod, witch flounder and skate are also directed fisheries using trawl (redfish comprised 97% of landings from this EBSA over 1998-2007) (Fisheries and Oceans

- Because of the wide range of species included in this CP, and their varying distribution in the water column, we have chosen a moderate score for contact.

Score 5

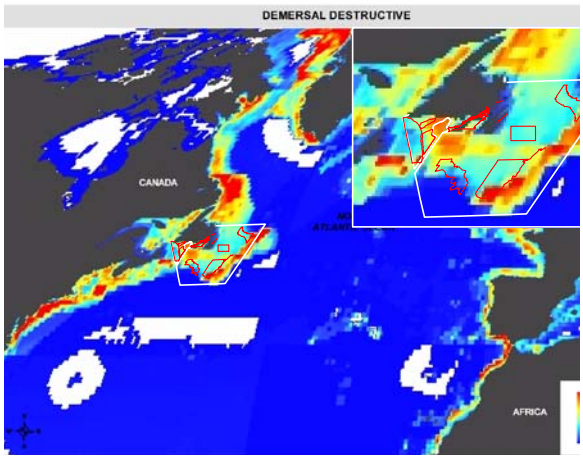
Duration:

- Most fish species are present in the Laurentian Channel and Slope EBSA during the winter. Most cetacean species are present in the summer. Pinnipeds are present from fall to spring. The exact timing of each different species migration pattern are not well known, but when all species are considered together, migration is happening throughout the year in this EBSA.
- Fisheries and Oceans 'Conservation Harvesting Plans' (Fisheries and Ocean Canada, 2008) outline the timeframe for specific fisheries in NAFO Division areas and are presented in Appendix A, Table 7. This EBSA is comprised of four different Sub-Divisions: 3Pn, 3Psd, 3Pse, and 3Psg. The duration of trawling varies between areas. Based on current Conservation Harvesting Plans which are reviewed annually, bottom trawl is permitted within the EBSA:
  - 3Pn: July 1- Feb 28 (8 months)
  - 3Psd: July 1 – Nov 15 (4.5 months)
  - 3Pse: April 1- March 31 (12 months)
  - 3Psg: April 1 – March 31 (12 months)
- Since bottom trawling occurs throughout the year, in at least some portions of the EBSA, and multi species migrations occur throughout the year (based on best available information), overlap in duration is 100%.

Score 10

Intensity:

- Halpern *et al.* (2008) have developed maps showing the global intensity of several anthropogenic stressors including demersal destructive fishing, which includes bottom trawl fisheries (see figure below). This map can be used to provide guidance in scoring the intensity of a stressor in relation to maximum intensity in a global context, in accordance with the scale provided below.
- (Halpern et al., 2008) show a low to medium range (dark blue (0-20%) to light blue (20-40%)) for the Laurentian Channel and Slope EBSA. Halpern's maps are based on 1999-2003 data.



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

Figure 3. Global intensity of bottom trawl use, adapted from (Halpern et al., 2008)

- Kulka and Pitcher (2001) studied the spatial extent of highly trawled areas in the Grand Banks (below). Some locations within the EBSA are shown as being persistent areas of high intensity trawling (Kulka & Pitcher, 2001).

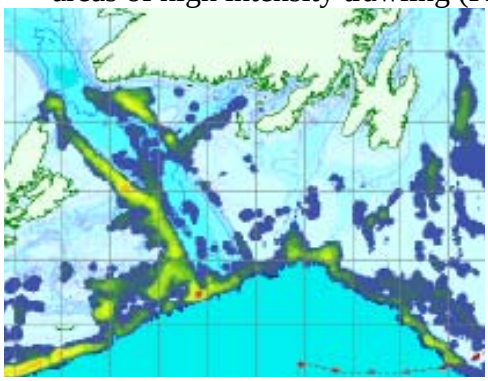


Figure 4. Maps depicting persistent areas of high intensity trawling in the Atlantic over the period 1980-2000 (Kulka & Pitcher, 2001).

- There is a directed trawl fishery in this EBSA for redfish, cod, witch flounder and skate, and many other fish species are taken as bycatch. Bycatch of pinnipeds and whales is not commonly reported, but it does occur occasionally (Fertl & Leatherwood, 1997; Ledwell & Huntington, 2007; Read et al., 2003).
- Bottom trawl landings totaled 169,159 tonnes in the entire LOMA from 1998-2007. Of that number, 11,037 tonnes were taken specifically in this EBSA. Ninety-seven percent of landings in this EBSA from 1998-2007 were redfish (Appendix A, Table 26) taken almost exclusively by bottom trawl.
- Although other areas of the LOMA are trawled more intensely, the Laurentian Channel and Slope EBSA is predominantly fished with bottom trawl. Therefore, we will score the intensity at the high end of the range suggested by the global map from Halpern (2008), at 40%.

Score 4

<u>Magnitude of Interaction:</u> (7.3 x 5 x 10 x 4)/ 1000= 1.5

Sensitivity

Sensitivity of the CP to acute impacts:

- In relation to bottom trawl, Quantitative Fishing Gear Scores (Fisheries and Oceans Canada, 2007a) for "harm" are variable for the wide range of species included in this CP (ranging from 'nil' to 'high') and without greater detail on the rationale behind the scores, they do not provide particularly useful guidance.
- Bottom trawl was assigned an ecological rating of "high impact" (the highest of 5 categories) in relation to groundfish, but a "medium low impact" for marine mammals (Fuller et al., 2008).
- Groundfish species are susceptible to bottom trawl, especially those that share similar depth range or habitat requirements as redfish, as this is the main species targeted with trawl. Migrations involve large aggregations of fish, and their susceptibility to being captured may increase during these times.
- While this is the most commonly used gear type on the Grand Banks, there is no evidence of cetacean entanglement in Newfoundland waters in published reports to date (Johnson et al., 2005; Ledwell & Huntington, 2007).
- Pinnipeds have been caught in trawls in the USA (see table below), but there is no records of entanglement in Newfoundland waters.

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
Gillnet	1921	3312	5626	3573	3540	3136	2472	2873	2323	2344
Trawl	19	36	34	10	29	3	15	17	14	11
Other	151	149	148	10	29	30	6	20	15	0
Total	2091	3497	5808	3593	3598	3169	2493	2910	2352	2355

Table 1: Estimates of pinnipeds bycatch in US fisheries (Read et al., 2003).

- Groundfish have a high likelihood of being caught in trawls, while cetaceans and pinnipeds have a low likelihood. Entanglement would impact an individuals' ability to participate in the normal migration behavior, and could result in death due to drowning or limited ability to feed.
- Therefore the score is an average between the likelihood of harm for each of the three components of the CP. Score 8 for groundfish, 2 for cetaceans, and 3 for pinnipeds. Average is 4.7.

Score 5

Sensitivity of the CP to chronic impacts:

- Cetaceans:

- Cetaceans are long-lived and have low reproductive rates, making them particularly vulnerable to exploitation and other population stress. For example, the annual rate of population increase in sperm whales has been estimated at approximately 1 percent (IWC, 2002). The blue whale is thought to live to 75 years, while the smaller minke whale, lives to 30 and 40 years and does not mature until 6 to 8 years (Templeman & Davis, 2006).
- Populations of cetaceans are reportedly low in the northwest Atlantic, and many populations are known to be vulnerable or endangered. Several species are in danger of extinction (Prideaux, 2003).
- Population trends in cetaceans are difficult to measure due to the imprecise nature of population estimates and limited availability of data (Templeman & Davis, 2006).
- The migration of many cetacean species is cyclical and predictable, coinciding with changes in season and the recurring changes in food availability. Overlapping migrations may occur, but specific populations may remain isolated from each other (Prideaux, 2003).

- Pinnipeds:
  - Harp seals can live up to 30 years, reach sexual maturity at 4-6 years, and the Atlantic harp seal population is healthy and abundant; nearly triple what it was in the 1970s. The current estimated harp seal population remains stable and healthy at more than 5.5 million animals (Fisheries and Ocean Canada, 2009).
  - From a hooded seal survey in 2005, it is estimated that the pup production from all herds is 120,100 and the total hooded seal population is 593,500.
  - Grey seals generally live for 15 to 25 years. The grey herd seal population is currently estimated to be about 300,000 animals. Females reach sexual maturity at 3-5 years, males at 4-6 years (Seal Conservation Society & Seal, 2002).
  - In contrast to many whale species, pinnipeds such as grey seals and harp seals have shown high population growth and long term resilience to anthropogenic impacts. For example, the grey seal population on the Scotian Shelf has been shown to increase nearly 12.5% annually over a 30 year period from the 1960s to early 1990s. Such high population growth rates have been linked to optimal environmental conditions (i.e., temperature, foraging conditions) that may not be typical in all years (Templeman & Davis, 2006).
- Fish:
  - Fish species include groundfish and pelagics- most of which reach sexual maturity at ages less than 10 years, produce large number of eggs or live young, and have stable population levels. Moratorium stocks in this EBSA include American plaice and haddock. Long-term affects of bottom trawling may impact migrations of these species by removing individuals, especially large spawners, and by causing a change in behavior.

- This CP includes some species which are listed as depleted and rare species within the LOMA Atlantic cod, haddock, south coast herring, and blue whale (**add 0.5 points**) (Fisheries and Oceans Canada, 2007b).
- This score chosen is an average value that represents all elements of the CP. The stressor of bottom trawl can impact populations in the long term, but this may not translate into impacts on their migrations. Trawling has occurred in this area for decades, and migrations appear to be continuing as per normal. Therefore a low score is chosen.

Score 2 + 0.5= 2.5

Sensitivity of Ecosystem to Harmful Impacts to the CP:

- The CP consists of at least thirteen species of cetaceans, five species of pinnipeds and 11 species of fish. Their role in the food web is complex as they range from top predators to small prey species.
- As large predators, marine mammals may play an important role in the structure and function of marine ecosystems through both direct and indirect impacts on prey populations
- Seals are opportunistic feeders, and consume a wide variety of prey species.
- The fish species in this area include full-time resident species, seasonal residents and occasional visiting species from areas further north and south. They are a main source of food for larger predators and seabirds, and consume smaller fish, crustaceans and plankton.
- Because there is such a wide variety of species, and because patterns of movement are yearly cycles of which other species depend, this CP will score high. Migrations are a means by which a species meets its needs (feeding, mating, breeding, etc).
- This CP includes some Ecologically Significant Species (Atlantic cod >35cm, Greenland halibut <40cm and >40cm, capelin, harp seals, and cetaceans) (**add 0.5 points**).

Score 9 + 0.5= 9.5

<u>Sensitivity:</u> (5 + 2.5 + 9.5)/3 = 5.7

<u>Risk of Harm:</u> MoI x S= 1.5 x 5.7 = 8.6

Certainty Checklist

Answer yes or no to all of the following questions. Record the number of NOs to the 9 questions, and record certainty according to the scale provided below:

1 No's = High certainty
2 - 3 No's = Medium certainty
≥ 4 No's = Low certainty

Y/N

N Is the score supported by a large body of information?
Y Is the score supported by general expert agreement?
N Is the interaction well understood, without major information gaps/sources of error?
N Is the current level of understanding based on empirical data rather than models, anecdotal information or probable scenarios?
Y Is the score supported by data which is specific to the region, (EBSA, LOMA, NW Atlantic?
Y Is the score supported by recent data or research (the last 10 years or less)?
Y Is the score supported by long-term data sets (ten year period or more)?
N Do you have a reasonable level of comfort in the scoring/conclusions?
N Do you have a high level of confidence in the scoring/conclusions?

Certainty Score: **Low**

For interactions with Low certainty, underline the main factor(s) contributing to the uncertainty:

Lack of comprehensive data
Lack of expert agreement
Predictions based of future scenarios which are difficult to predict
Other (provide explanation)

Suggest possible research to address uncertainty.

- **Better understanding of distribution of cetaceans throughout the year**
- **Research on migration patterns for all species**
- **More data on entanglement of pinnipeds and cetaceans in trawls**

Reference List

1. Fertl, D. & Leatherwood, S. (1997). Cetacean Interactions with Trawls: A Preliminary Review. *J.Northw.Atl.Fish.Sci., 22,* 219-248.

2. Fisheries and Ocean Canada (2008). *Conservation Harvesting Plan, Groundfish, Vessels less than 65 feet, Mobile Gear, Division 3Ps* Fisheries and Oceans Canada, Newfoundland Region, FAM.

3. Fisheries and Ocean Canada (2009). Facts about Seals- 2008. Fisheries and Oceans Canada [On-line]. Available: http://www.dfo-mpo.gc.ca/fm-gp/seal-phoque/reports-rapports/facts-faits/facts-faits2008-eng.htm

4. Fisheries and Oceans Canada (2007a). Draft proceedings of the Workshop on Qualitative Risk Assessment of Fishing Gears. In Government of Canada.

5. Fisheries and Oceans Canada (2007b). *Placentia Bay-Grand Banks Large Ocean Management Area Conservation Objectives* (Rep. No. 2007/042). Canadian Science Advisory Secretariat Science Advisory Report.

6. Fisheries and Oceans Canada. (2008). 1998-2007 3LMNOP4R Effort and Catch. Policy and Economics Branch. [Newfoundland and Labrador Region Catch and Effort]. Fisheries and Oceans Canada.

7. Fuller, S. D., Picco, C., Ford, J., Tsao, C.-F., Morgan, L. E., Hangaard, D. et al. (2008). *How we fish matters: Addressing the Ecological Impacts of Canadian Fishing Gear* Ecology Action Centre, Living Oceans Society, and Marine Conservation Biology Institute.

8. Halpern, B. S., Walbridge, S., Selkoe, K. A., Kappel, C. V., Micheli, F., D'Agrosa, C. et al. (2008). A Global Map of Human Impact on Marine Ecosystems. *Science, 319,* 948-952.

9. IWC (2002). *Report of the Standing Working Group on Environmental Concerns*.

10. Jacques Whitford (2003). *Strategic Environmental Assessment Laurentian Subbasin*.

11. Johnson, A., Salvador, G., Kenney, J., Robbins, J., Kraus, S., Landry, S. et al. (2005). Fishing Gear Involved in Entanglements of Right and Humpback Whales. *Marine Mammal Science, 21,* 635-645.

12. Kulka, D. W. & Pitcher, D. A. (2001). *Spatial and Temporal Patterns in Trawling Activity in the Canadian Atlantic and Pacific* (Rep. No. ICES CM 2001/R:02).

13. Ledwell, W. & Huntington, J. (2007). *Whale and leatherback sea turtles incidental entrapment in fishing gear in Newfoundland and Labrador and a summary of the Whale Release and Strandings Program during 2006* A Report to the Department of Fisheries and Oceans, St. John's, Newfoundland and Labrador, Canada.

14. Prideaux, M. (2003). *Conserving Cetaceans: The Convention on Migratory Species and its Relevant Agreements for Cetacean Conservation* Munich, Germany: WDCS.

15. Read, A. J., Drinker, P., & Northridge, S. (2003). *By-catches of Marine Mammals in U.S. Fisheries and a First Attempt to Estimate the Magnitude of Global Marine Mammal By-catch* (Rep. No. Scientific Committee Document SC/55/BC). Cambridge, UK: International Whaling Commission.

16. Seal Conservation Society & Seal (2002). Seal Conservation Society. Seal Conservation Socity [On-line]. Available: http://www.pinnipeds.org/main.htm

17. Templeman, N. D. & Davis, M. B. (2006). *Placentia Bay-Grand Banks Ecosystem Overview and Assessment Report (DRAFT)* Newfoundland & Labrador: Fisheries and Oceans Canada.

Multi-species migration in the Laurentian Channel and Slope

Oil and gas drilling

Magnitude of Interaction

Areal extent:

- Certain species of fish, cetaceans and pinnipeds move through the Laurentian Channel as part of their annual migration patterns. There is no map that adequately conveys the areal extent of these movements.
- The shelf edges and bank slope are often highly productive areas, and are therefore often critical locations for spawning and feeding fish, as well as birds and marine mammals (Jacques Whitford, 2003).
- Because of the wide variety of species, habitat requirements, and migration routes used by the components of this CP, it can be assumed that the entire area of the EBSA is utilized, especially those areas near the shelf edge and slope.
- The two offshore oil and gas areas encompass the entire area of the EBSA. However, we will only consider the areas that currently have exploration licences, and parcels that have been delineated for future 'call for bids (see the second image below). Overlap is estimated at 50%.

Score 5

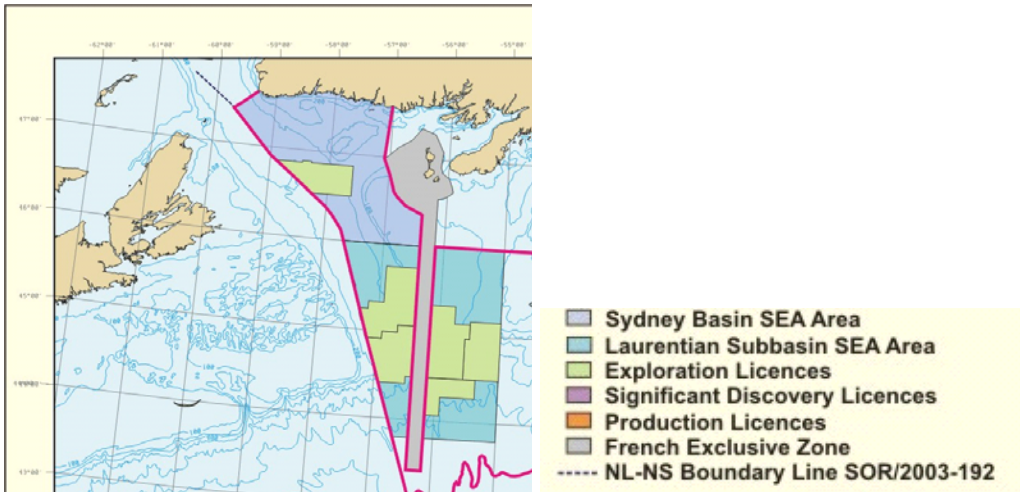


Figure 1. Petroleum offshore areas and exploration licences (CNLOPB, 2009)

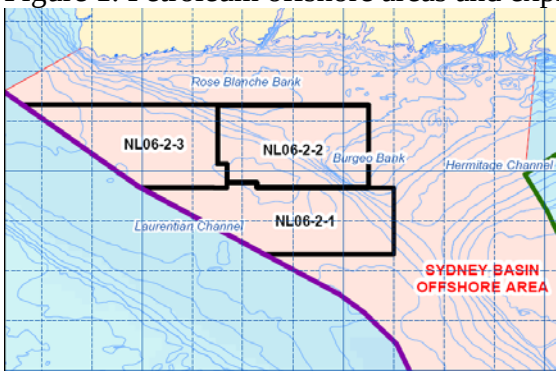


Figure 2. Sydney Basin Offshore Area, areas for call for bids (Jacques Whitford, 2007).

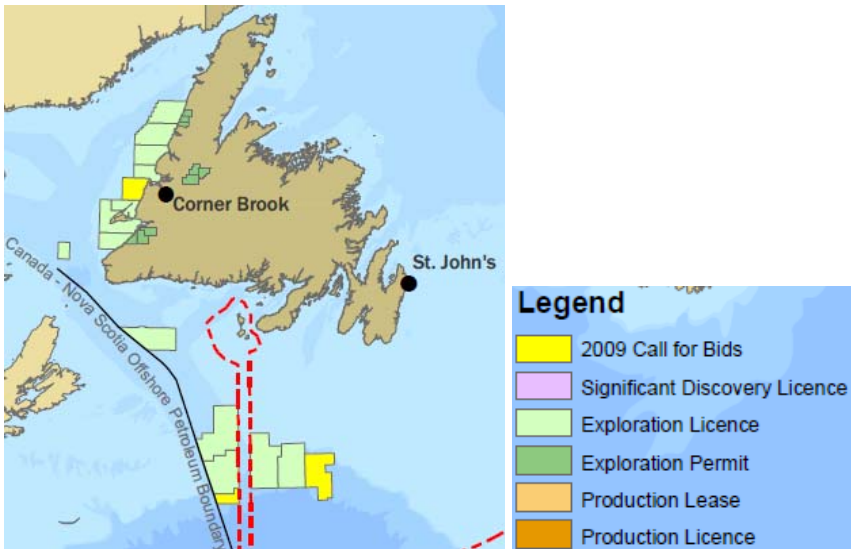


Figure 3. Laurentian Sub-basin Offshore Area, call for bids (CNLOPB, 2009)

Contact:

- The wide range of species included in this CP have varying distributions in the water column: groundfish near the bottom, pelagic fish in the water column, and cetaceans and pinnipeds found throughout the water column, and also spending time at the surface.
- Activities that are associated with exploration licences include seismic (considered as a separate stressor) and other geophysical surveys (taking core samples); drilling of wells (either exploration or delineation); and well abandonment. The primary discharge related to drilling of wells is drill cuttings. Water-based buds are usually used for the top sections of the well, with synthetic-based muds used for deeper sections of the well (Jacques Whitford, 2007).
- *For the Laurentian Channel Sub-basin*: the exploration drilling activities will be carried out in water depths ranging from 200 m to 3,000 m along the Laurentian Slope, and will include the Laurentian shelf, slope and abyssal plain (Canada-Newfoundland and Labrador Offshore Petroleum Board, 2007).
- *For the Sydney Basin*: the current exploration licence and remaining 2 parcels range in water depth from 200 to 400 m and are within the 200-mile limit (Jacques Whitford, 2007).
- Drilling of wells and deposition of cuttings occur on the seafloor. Drilling will be conducted by a drill rig (jack-up, anchored or dynamically-positioned drill ship or semi-submersible), depending on water depth. The drill rig will be the only surface structure, with drilling components reaching to the seafloor (Canada-Newfoundland and Labrador Offshore Petroleum Board, 2007).
- Since the majority of species in this CP are not bottom dwellers (drilling occurs on the seafloor), the score assigned will be in the higher end of the ‘low’ range. (Fish make up 1/3 the CP, and groundfish are most common in this EBSA, they live on/near the seafloor, therefore overlap is roughly 30%). However, some pinnipeds and cetaceans will also encounter demersal areas in their movements, therefore the score will be assigned a slightly higher number of 4.

Score 4

Duration:

- Most fish species are present in the Laurentian Channel and Slope EBSA during the winter. Most cetacean species are present in the summer. Pinnipeds are present from fall to spring. The exact timing of each different species migration is not well known, but when all species are considered together, migration is happening throughout the year in this EBSA.
- *For the Laurentian Sub-basin*: the first well is tentatively planned for the second quarter of 2009 on EL1087. A second well may be drilled on EL 1081. Depending on results and seismic data interpretation, additional exploration and appraisal wells may be drilled in ELs 1082, 1085 and 1086. Drilling may occur year round up to the period of expiration for these licences (9 years). It is anticipated that from one to four wells per year could be drilled. Each well will take from 50 to 100 days to complete (Canada-Newfoundland and Labrador Offshore Petroleum Board, 2007).
- *For the Sydney Basin*: the exploration activities considered within the scope of the SEA include exploratory and delineation drilling, seismic surveys including two-dimensional (2-D), three-dimensional (3-D), vertical seismic profiling (VSP) and geohazards surveys and well-site abandonment. The temporal boundary is the oil and gas activities as described that may occur in the SEA Area within the next 10 years (Jacques Whitford, 2007).
- If 1 to 4 wells could be drilled per year, and there are two oil exploration areas, then that is potentially 2 to 8 wells per year being drilled in the EBSA. We will score the 8 possible wells (because it is almost certain that more parcels will be explored within 10 years from now). Each well may take from 50 to 100 days to complete, and again, we take greater of estimates (100 days). Therefore, there could potentially be 800 days of drilling (cumulative within both areas). Since multi-species migrations occur throughout the year, duration is scored at a maximum of 100%.

Score 10

Intensity:

- Halpern *et al.* (2008) have developed maps showing the global intensity of several anthropogenic stressors including oil pollution (see Fig. 4 below). This map can be used to provide guidance in scoring the intensity of a stressor in relation to maximum intensity in a global context, in accordance with the scale provided below.
- The global map below (Halpern et al., 2008) for oil pollution (which includes oil production, vessel and land pollution) show a medium to high range (yellow: 60-80%) for the Laurentian Channel and Slope EBSA. Halpern's maps are based on 1999-2003 data.

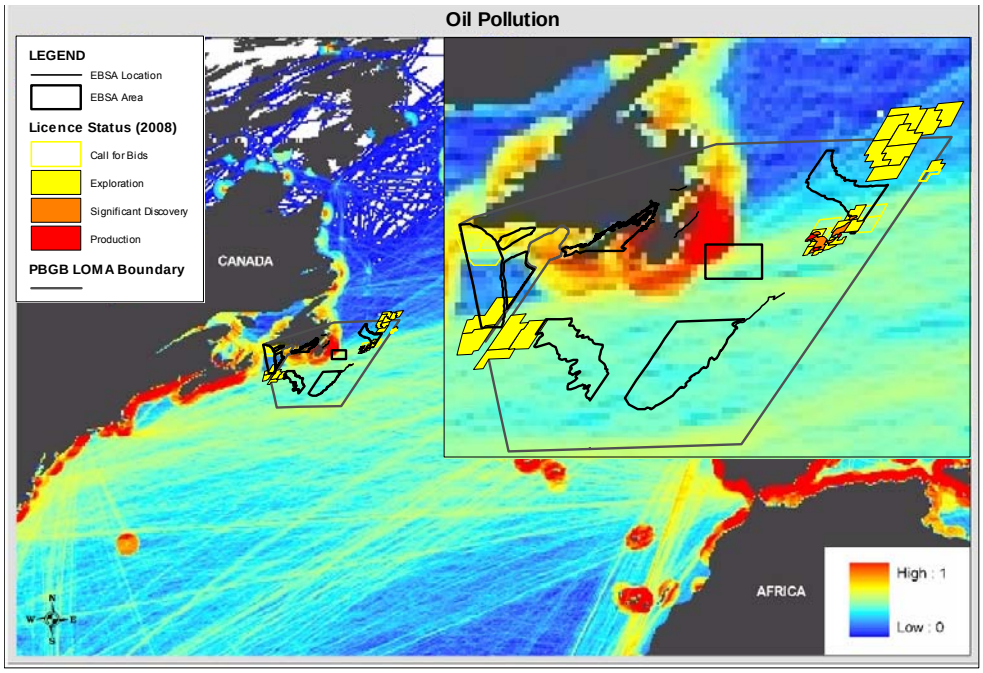


Figure 4. Global intensity of oil pollution, showing oil exploration licences and production facilities, adapted from (Halpern et al., 2008)

- 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.
- Activities that may be associated with exploration licences include seismic (considered as a separate stressor) and other geophysical surveys (taking core samples); drilling of wells (either exploration or delineation); and well abandonment. The primary discharge related to drilling of wells is drill cuttings. Water-based buds are usually used for the top sections of the well, with synthetic-based muds used for deeper sections of the well (Jacques Whitford, 2007).
- Drilling is scheduled to occur in 3 different exploration license areas within the EBSA, with additional drilling likely to occur in the parcels that have been delineated for 'calls for bids'. The C-NLOPB issues an official call for nominations annually, in the fall (Jacques Whitford, 2003; Jacques Whitford, 2007).
- Because there are three different areas ready to undergo exploration drilling within the EBSA, this factor will be scored in the high end of the range suggested by Halpern.

Score 8

<u>Magnitude of Interaction:</u> (5 x 4 x 10 x 8)/ 1000= 1.6

Sensitivity

Sensitivity to of the CP to acute impacts:

- Species may be impacted by the act of drilling on the seafloor and the discharges which occur as a result. Discharges associated with the 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 will be required to comply with applicable limits as set forth in the Offshore Waste Treatment Guidelines (OWTG) (Jacques Whitford, 2007).
- 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 $km)^3$ 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).
- Drilling Muds: ConocoPhillips is proposing to use Water Based Mud (WBM) with a Synthetic Based Mud (SBM) necessary for a portion of its drilling program. WBM have very small amounts of toxic components. These include biocides, corrosion inhibitors, and surfactants, which may account for only a small fraction of the total WBM composition but which contribute a significant fraction of total WBM toxicity. WBM will be directly discharged to the seafloor when drilling the initial sections of the hole, after that cuttings will be discharged from the rig at surface. WBMs have been detected up to 3km away from a drill site, but most trace metals were found between 250 to 500m. SBMs were detected at distances of 50 to 500m from well sites, however the effects are essentially limited to sessile benthic invertebrates. Toxicity studies by Payne et al. (2001) using American plaice on Hibernia drill cuttings found no acute toxicity in juvenile American plaice exposed for 30 days to Hibernia cuttings, approximating hydrocarbon concentrations typically found 200 to 500m from rigs in the North Sea (Payne et al., 2001). Most likely, drilling muds may elicit a startle response in fish resulting in these organisms moving away from the zone of influence. Drilling activities are unlikely to produce concentrations of heavy metals in muds and cuttings that are harmful to marine mammals (Jacques Whitford, 2007).

- Operational Discharge: Wastes and discharges from the 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 will 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).
- The two primary components of produced water that are of environmental concern are the aromatic hydrocarbons and PAHs. Hydrocarbon components are soluble in seawater and highly toxic to marine organisms, but there is minimal exposure risk given the rapid loss due to evaporation, absorption and sedimentation, biodegradation and photolysis. PAHs are less soluble but more persistent in the environment. The results of the 2004 White Rose Environmental Effects Monitoring Program concluded that metal and hydrocarbon body burdens for American plaice and snow crab were unaffected by project activity; there was no evidence of taint and health incidences for American plaice. Therefore, routine discharges are expected to have minimal environmental effects on fish and marine mammals (Jacques Whitford, 2007).
- Accidental Spills: During exploration drilling programs, the possible accidental events which may impact the environment, include blowouts and batch spills. For the proposed 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). Fish may suffer effects that range from direct physical effects to more subtle physiological and behavioural effects when exposed to oil. Reported physiological effects included abnormal gill function, increased liver enzyme activity, decreased growth, organ damage and increased disease or parasite loads. A hydrocarbon spill can affect local abundance and availability of phytoplankton and zooplankton. If fish eat contaminated zooplankton they will accumulate hydrocarbons themselves, but fish are also able to metabolize hydrocarbons and there is no potential for biomagnifications. Fish are not expected to remain in the area of a spill. Whales are not considered at high risk to the effects of oil exposure. However, whales present in the area could suffer sublethal effects through oiling of mucous membranes or the eyes if they swim through a slick. These effects are reversible and should not cause permanent damage. There is a possibility that the baleen whales could be contaminated with oil, thereby reducing filtration efficiency. Most marine mammals avoid oil spill areas, and any direct exposure to oil should be brief (Jacques Whitford, 2007).
- There is no information provided regarding drilling activity impacts on migration specifically. Some of the affects are potential stressors which may or may not occur (ie. well blowout), and the overall impact will be a function of how many drilling operations are ongoing at one time.
- Considering the range of activities and discharges from oil exploration drilling, multi-species migrations are likely to be impacted by disturbance and avoidance of the area, but probably not resulting in changes to migration patterns. However, there are

Score 3

Sensitivity of the CP to chronic impacts:

- Fish: American plaice and haddock are under moratorium in 3Ps. 2005 Plaice abundance estimate is 40.5 million (increase of 40% since 2004); haddock abundance is 1.6 million (increase of 36% since 2004); witch flounder abundance estimate is 5.4 million (down 22% since 2004); Atlantic cod abundance estimate is 4.5 million cod (lowest estimate in nine years of the survey) (McClintock, 2005). Redfish abundance has been constantly increasing since 2004, and large recruitments have therefore occurred in recent years in this area. However, there is a lack of data to estimate abundance (COSEWIC, 2008).
- Fish species include groundfish and pelagics- most of which reach sexual maturity at ages less than 10 years, produce large number of eggs or live young, and have stable population levels. Moratorium stocks in this EBSA include American plaice and haddock. Long-term affects of oil and gas drilling may impact migrations of these species by removing individuals, especially large spawners, and causing a change in behavior.
- Cetaceans are long-lived and have low reproductive rates, making them particularly vulnerable to exploitation and other population stress. For example, the annual rate of population increase in sperm whales has been estimated at approximately 1 percent (IWC, 2002). The blue whale is thought to live to 75 years, while the smaller minke whale, lives to 30 and 40 years and does not mature until 6 to 8 years (Templeman & Davis, 2006). Populations of cetaceans are reportedly low in the northwest Atlantic, and many populations are known to be vulnerable or endangered. Several species are in danger of extinction (Prideaux, 2003). Population trends in cetaceans are difficult to measure due to the imprecise nature of population estimates and limited availability of data (Templeman & Davis, 2006).
- The migration of many cetacean species is cyclical and predictable, coinciding with changes in season and the recurring changes in food availability. Overlapping migrations may occur, but specific populations may remain isolated from each other (Prideaux, 2003).
- SARA listed species include Blue whale (endangered), beluga whale, St. Lawrence estuary population (threatened), North Atlantic right whale (endangered), Fin whale (species of special concern), Harbour porpoise (threatened).
- Cetacean population estimates for the entire LOMA are listed in the table below (Templeman & Davis, 2006).
- Pinnipeds: Harp seals can live up to 30 years, reach sexual maturity at 4-6 years, and the Atlantic harp seal population is healthy and abundant; nearly triple what it was in the 1970s. The current estimated harp seal population remains stable and healthy at more than 5.5 million animals (Fisheries and Ocean Canada, 2009).

- From a hooded seal survey in 2005, it is estimated that the pup production from all herds is 120,100 and the total hooded seal population is 593,500.
- Grey seals generally live for 15 to 25 years. The grey herd seal population is currently estimated to be about 300,000 animals. Females reach sexual maturity at 3-5 years, males at 4-6 years (Seal Conservation Society & Seal, 2002).
- In contrast to many whale species, pinnipeds such as grey seals and harp seals have shown high population growth and long term resilience to anthropogenic impacts. For example, the grey seal population on the Scotian Shelf has been shown to increase nearly 12.5% annually over a 30 year period from the 1960s to early 1990s. Such high population growth rates have been linked to optimal environmental conditions (i.e., temperature, foraging conditions) that may not be typical in all years (Templeman & Davis, 2006).
- Currently, there are only exploration licences in the EBSA, no production licences. In the offshore area, exploration licences have the maximum nine-year term typically consisting of two consecutive periods of five years and four years. The interest owner is required to drill or spud and diligently pursue one exploratory well on or before the expiry date of Period I as a condition precedent to obtaining tenure to period II. Failure to drill or spud a well will result in reversion to Crown reserve of the licence. A drilling program that has resulted in a significant discovery entitles the interest owner to a Significant Discovery Licence, which is of no definite length (Jacques Whitford, 2003). Therefore, within the next 10 years there is the probability of many more drilling exercises within both the Laurentian Channel Sub-basin and the Sydney Basin. Long term exposure to drilling activity, discharges and possible blowouts could negatively impact multi-species migrations.
- This score chosen is an average value that represents all elements of the CP. The stressor of oil and gas drilling can impact populations in the long term, but this may not affect migrations. It is difficult to predict the long term affect of oil and gas drilling, but with 2 offshore areas, and many more potential parcels which may undergo exploration, there is a high likelihood that species in the Laurentian Channel and Slope EBSA will be affected by the activities associated with drilling. It is possible that migration routes will be altered, but the high productivity due to upwelling of the slope and shelf edge is one of the main reasons this area is so important for migration. Long term drilling activities may deter species from their usual routes, causing negative impacts. Therefore the score will be in the high category.
- Some components of the CP (Atlantic cod, haddock, south coast herring, and blue whale) are listed as depleted and rare species within the LOMA (**add 0.5 point**).

Score 7 + 0.5= 7.5

Common Name Scientific Name	Population and Conservation Status (COSEWIC)
Blue whale *Balaenoptera Musculus*	▪ at least 308 individuals in NW Atlantic ▪ Endangered (COSEWIC)
Humpback whale *Megaptera novaengilae*	▪ approximately 10,600 individuals in North Atlantic ▪ special concern (COSEWIC)
Fin whale *Balaenoptera physalus*	▪ ~2,200 in Northwest Atlantic ▪ special concern (COSEWIC)
Sei whale	▪ no estimate for Northwest Atlantic; 40,000-60,000 worldwide ▪ not evaluated (COSEWIC)
Minke whale	▪ ~3,800 Atlantic Canada; 800,000 worldwide ▪ under review (COSEWIC)
Sperm whale *Physeter macrocephalus*	▪ ~ 4,700 individuals from Gulf of St. Lawrence to Florida ▪ not evaluated (COSEWIC)
Northern bottlenose whale *Hyperoodon ampullatus*	▪ >40,000 in North Atlantic ▪ special concern (COSEWIC)
Short-beaked common dolphin *Delphinus delphis*	▪ ~ 30,000 individuals in northwest Atlantic ▪ not at risk (COSEWIC)
White-beaked dolphin *Lagenorthnchus albiorostris*	▪ unknown population estimate ▪ not at risk (COSEWIC)
Atlantic white-sided dolphin *Lagenorhynchus acutus*	▪ tens of thousands in NW Atlantic ▪ not at risk (COSEWIC)
Long-finned pilot whale *Globicephala melas*	▪ 15,000-25,000 in northwest Atlantic ▪ not at risk (COSEWIC)
Killer whale *Orcinus orca*	▪ no estimate for northwest Atlantic ▪ insufficient data (COSEWIC)
Harbour porpoise *Phocoena phocoena*	▪ unknown population in northwest Atlantic but likely >100,000 ▪ special concern (COSEWIC)

Table 1: Population estimates of cetaceans in the PBGB LOMA (Templeman & Davis, 2006)

Sensitivity of ecosystem to harmful impacts to the CP:

- The CP consists of at least thirteen species of cetaceans, five species of pinnipeds and 11 species of fish. Their role in the food web is complex as they range from top predators to small prey species.
- As large predators, marine mammals may play an important role in the structure and function of marine ecosystems through both direct and indirect impacts on prey populations
- Seals are opportunistic feeders, and consume a wide variety of prey species.
- The fish species in this area include full-time resident species, seasonal residents and occasional visiting species from areas further north and south. They are a main source

of food for larger predators and seabirds, and consume smaller fish, crustaceans and plankton.

- Because there is such a wide variety of species, and because patterns of movement are yearly cycles of which other species depend, this CP will score high. Migrations are a means by which a species meets its needs (feeding, mating, breeding, etc).
- Ecologically significant species in this CP include Atlantic cod >35cm, Greenland halibut <40cm and >40cm, capelin, harp seals, and cetaceans (**add 0.5 point**).

Score 9 + 0.5= 9.5

<u>Sensitivity:</u> (3 + 7.5 + 9.5)/3 = 6.7

<u>Risk of Harm:</u> MoI x S= 1.6 x 6.7 = 10.7

Certainty Checklist

Answer yes or no to all of the following questions. Record the number of NOs to the 9 questions, and record certainty according to the scale provided below:

1 No's = High certainty
2 - 3 No's = Medium certainty
≥ 4 No's = Low certainty

Y/N

Y Is the score supported by a large body of information?
Y Is the score supported by general expert agreement?
N Is the interaction well understood, without major information gaps/sources of error?
N Is the current level of understanding based on empirical data rather than models, anecdotal information or probable scenarios?
Y Is the score supported by data which is specific to the region, (EBSA, LOMA, NW Atlantic?
Y Is the score supported by recent data or research (the last 10 years or less)?
Y Is the score supported by long-term data sets (ten year period or more)?
N Do you have a reasonable level of comfort in the scoring/conclusions?
N Do you have a high level of confidence in the scoring/conclusions?

Certainty Score: Low

For interactions with Low certainty, underline the main factor(s) contributing to the uncertainty:

Lack of comprehensive data
Lack of expert agreement
Predictions based of future scenarios which are difficult to predict
Other (provide explanation)

Suggest possible research to address uncertainty.

- **Better understanding of distribution of cetaceans throughout the year**
- **Research on migration patterns for all species**
- **Long term impacts of oil and gas drilling to migrations of fish and cetaceans.**

Reference List

1. Canada-Newfoundland and Labrador Offshore Petroleum Board (2007). *ConocoPhillips Laurentian Subbasin Exploration Drilling Program Screening Report* CNLOPB.

2. CNLOPB (2009). Canada-Newfoundland and Labrador Offshore Petroleum Board. Internet [On-line]. Available: http://www.cnlopb.nl.ca/

3. COSEWIC (2008). *COSEWIC Status report on deepwater redfish/Acadian redfish complex in Canada*.

4. Fisheries and Ocean Canada (2009). Facts about Seals- 2008. Fisheries and Oceans Canada [On-line]. Available: http://www.dfo-mpo.gc.ca/fm-gp/seal-phoque/reports-rapports/facts-faits/facts-faits2008-eng.htm

5. Halpern, B. S., Walbridge, S., Selkoe, K. A., Kappel, C. V., Micheli, F., D'Agrosa, C. et al. (2008). A Global Map of Human Impact on Marine Ecosystems. *Science, 319*, 948-952.

6. IWC (2002). *Report of the Standing Working Group on Environmental Concerns*.

7. Jacques Whitford (2003). *Strategic Environmental Assessment Laurentian Subbasin*.

8. Jacques Whitford (2007). *Strategic Environmental Assessment Sydney Basin Offshore Area*.

9. McClintock, J. (2005). *Year Eight of the NAFO Subdivision 3Ps Fall GEAC Surveys: Catch Results for Atlantic Cod (Gadus morhua), American plaice (Hippoglossoides platessoides F.), Witch Flounder (Glyptosephalus synoglossus L.), and Haddock (Melanogrammus aeglefinus)* (Rep. No. Research Document 2005/072). Canadian Science Advisory Secretariat, Fisheries and Oceans Canada.

10. Payne, J., Andrews, C., Whitway, S., & Lee, K. (2001). Definition of Sediment Toxicity Zones around Oil Development Sites:Dose Response Relationships for Monitored Surrogates Microtox and Amphipods, Exposed to Hibernia Source cuttings containing a Synthetic Base Oil. *Can.Manuscr.Rep.Fish.Aquat.Sci., 2577*, 1-10.

11. Prideaux, M. (2003). *Conserving Cetaceans: The Convention on Migratory Species and its Relevant Agreements for Cetacean Conservation* Munich, Germany: WDCS.

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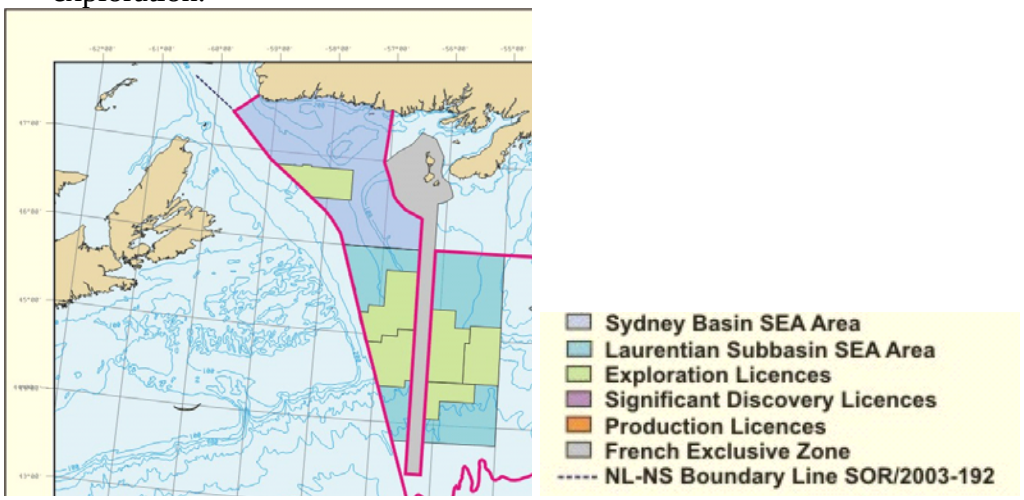
Multi-species migration in the Laurentian Channel and Slope

Seismic surveys

Magnitude of Interaction

Areal extent:

- Cabot Strait is an important migratory corridor for marine mammals moving in and out of the Gulf of St. Lawrence. Certain species of fish, cetaceans and pinnipeds move through the Laurentian Channel as part of their annual migration pattern. There is no map that adequately conveys the areal extent of these movements.
- The shelf edges and bank slope are often highly productive areas, and are therefore often critical locations for spawning and feeding fish, as well as birds and marine mammals (Jacques Whitford, 2003).
- Because of the wide variety of species, habitat requirements, and migration routes used by this CP, it can be assumed that the entire area of the EBSA is utilized, especially those areas near the shelf edge and slope.
- The two offshore oil and gas areas encompass the entire area of the EBSA (see Fig. 1). However, we will only consider the areas that currently have exploration licences, and parcels that have been delineated for future 'call for bids (see Fig. 2 and 3 below). Figure 4 shows that the entire 'exploration licence' area has been completely covered by seismic surveys. Therefore each exploration licence will undergo the same level of coverage (scored at 50% for oil and gas drilling). However, airgun arrays have been detected over 3000 km from their source (Fisheries and Oceans Canada, 2006), therefore the areal extent is much greater than simply the are delineated for exploration.



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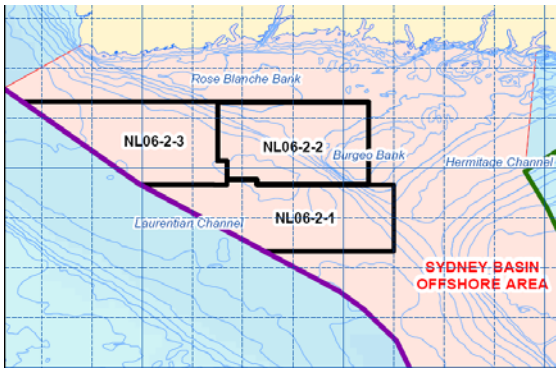


Figure 2. Sydney Basin Offshore Area, areas for call for bids (Jacques Whitford, 2007).

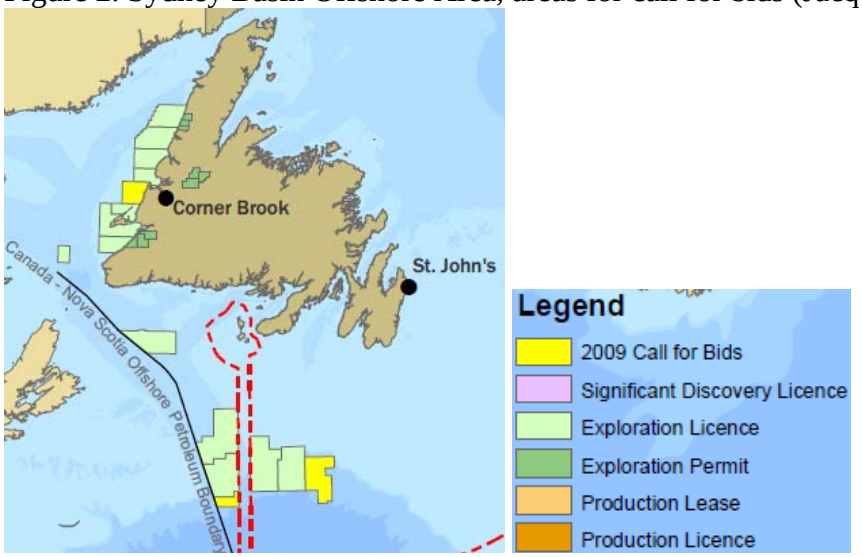


Figure 3. Laurentian Sub-basin Offshore Area, call for bids (CNLOPB, 2009)

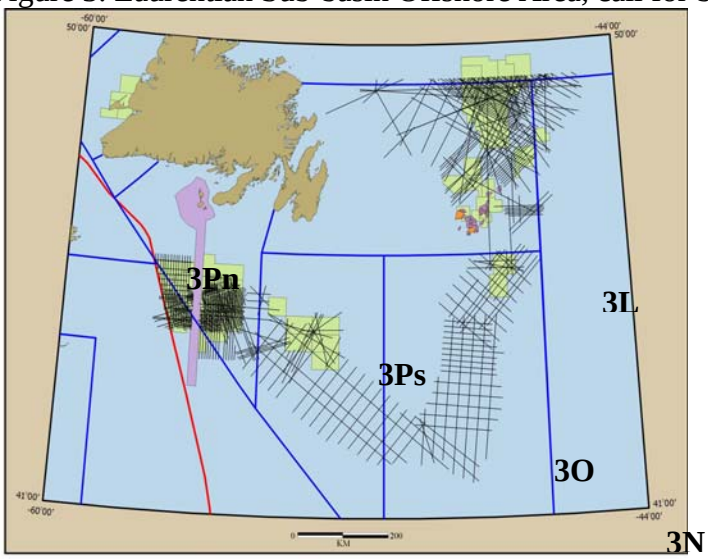


Figure 4. Spatial extent of seismic activity (2000- 2005) as well as the land holdings linked to the oil and gas sector on the Grand Banks study area defined (ORCA Inc., 2005).

- *For fish*: it has been documented that adult fish are frightened by the sound waves from seismic activity, and pelagic fish seem to be the most sensitive. The scare effect has been demonstrated in a radius of up to more than 30 km from the sound source.
- *For pinnipeds and cetaceans*: airgun arrays are usually audible over 50-75 km when used in water 25-50 m deep. Detection range can increase to over 100 km in deeper water or when propagation conditions are efficient (Hammill et al., 2001)
- Few detailed controlled studies have been conducted to examine impacts of oil and gas exploration activities on marine mammals. The few data 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).
- Coverage for exploration areas was scored at 50%, therefore seismic will be scored higher, in the high range, at 8.

Score 8

Contact:

- The wide range of species encompassed by this CP have varying distributions in the water column: groundfish near the bottom, pelagic fish in the water column, and cetaceans and pinnipeds found throughout the water column, but also spending time at the surface.
- 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 (500m to 8km in length) to record the reflected sound waves.

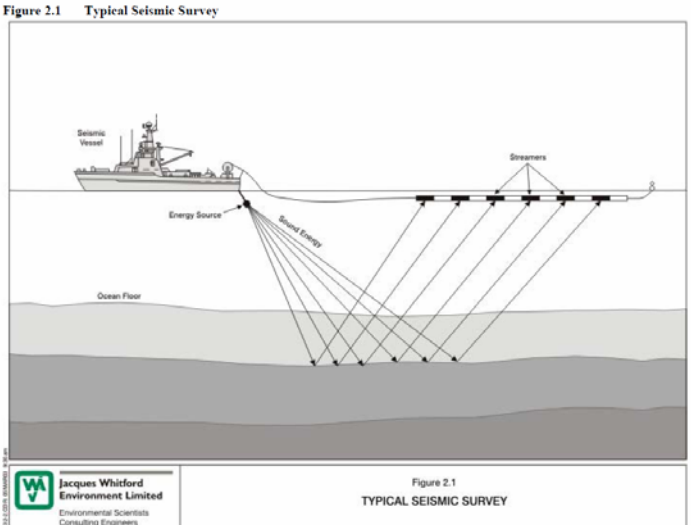


Figure 5. Typical seismic survey (Jacques Whitford, 2003).

- Since sounds are created at the surface, reach the seafloor, and bounce back to the surface, the entire water column can be impacted, or 100% of the water column, although received levels can be significantly lower near the surface, offering refuge to animals escaping dangerous or annoying sound levels below (The Whale and Dolphin Conservation Society, 2004).

Score 10

Duration:

- Most fish species are present in the Laurentian Channel and Slope EBSA during the winter. Most cetacean species are present in the summer. Pinnipeds are present from fall to spring. The exact timing of each different species' migration patterns are not well known, but when all species are considered together, migration is happening throughout the year in this EBSA.
- The length of time of a seismic survey varies, but usually ranges from a week to a month. A typical seismic survey lasts two to three weeks and covers a range of approximately 555 to 1110 km. The ship towing the array is typically 60 to 90 m long and moves through the water at speeds usually in the range of 8 to 10 km/h (4.5 to 5.5 knots). Airguns release compressed air every 6 to 10 seconds for a duration of 10 to 30 milliseconds per shot (Jacques Whitford, 2007).
- Each exploration licence area will be completely explored by seismic surveys, but this will usually occur when the licence is given, therefore it will not be repeated in most cases. Each new area in a 'call for bids' may also undergo seismic surveys.
- A seismic survey can take a month, and there could be one new exploration area per year, plus new areas which will become parcels for 'calls for bids'. Therefore, in the next 10 years, there could possibly be 2 months/year of seismic surveys undertaken.
- 2 months/12 months per year = 17%

Score 1.7

Intensity:

- We have no global map to show occurrence of seismic surveys, but the offshore oil industry is rapidly expanding in Newfoundland and Labrador.
- Expressed in km^2, there has been well over 1 million km^2 of seismic data acquired from the entire Newfoundland & Labrador offshore region (see Fig. 6) (ORCA Inc., 2005).
- Some seismic surveys have already occurred, and drilling is scheduled to occur in 3 different exploration license areas within the EBSA, with additional seismic likely to occur in the parcels that have been delineated for 'call for bids' (see Fig. 3). The CNLOPB issues an official call for nominations annually, in the fall (Jacques Whitford, 2007).
- Seismic surveys generate high intensity sounds with most of their energy concentrated at frequencies (5-300 Hz) relevant to balaenopterids. Current survey methods involve towing airgun arrays at approximately 2.6 m/s (5 knots), and firing the guns every 10-12 seconds. Over a 24 hour period a single vessel may discharge 10,000 shots. Airgun arrays have been detected over 3,000 km from their source (Fisheries and Oceans Canada, 2006).
- This EBSA falls within two Offshore Areas for oil and gas drilling (see Fig. 1), which is more than any other EBSA in the PBGB LOMA. Therefore, this EBSA has the highest intensity of seismic surveys currently within the LOMA.

- Because seismic surveys have occurred in several areas of the EBSA, and more are likely to occur within the next 10 years, the intensity score will be assigned from the 'high range'.

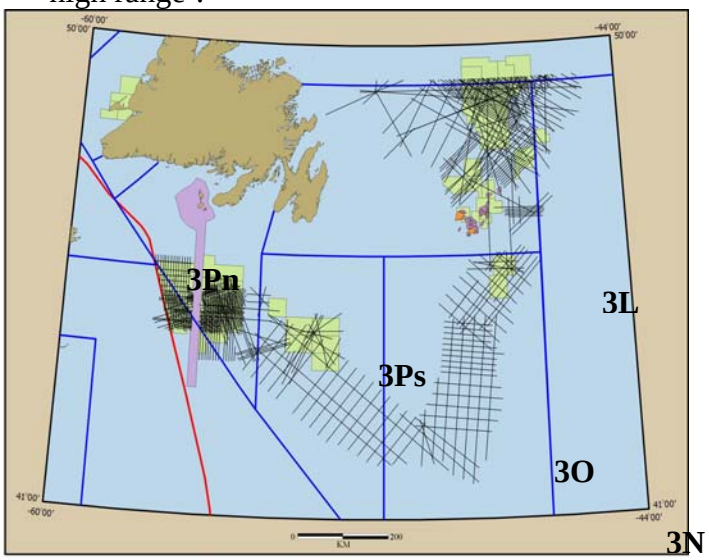


Figure 6. Spatial extent of seismic activity (2000- 2005) as well as the land holdings linked to the oil and gas sector on the Grand Banks study area defined (ORCA Inc., 2005).

Score 8

<u>Magnitude of Interaction:</u> (8x 10 x 1.7 x 8)/ 1000= 1.1

<u>Sensitivity</u>

Sensitivity of the CP to acute impacts:

- The long and widespread history of seismic surveys globally in marine environments with no documented fish or invertebrate kills, and only circumstantial evidence of associations with infrequent strandings of marine mammals and giant squid, suggest that seismic surveys with fairly routine mitigation measures in place are unlikely to pose high risk of mortality of marine organisms (Fisheries and Ocean Canada, 2004).
- Not all sound produced by seismic arrays will be audible to all species of marine mammals or fish. Some sounds will be above or below their hearing sensitivity ranges (Lawson & McQuinn, 2004). Seismic air gun arrays output a rather broadband low-frequency sound (i.e., not a single "tone" or "chord", but rather a noise composed of an undifferentiated range of tones). Peak output is generally in the range of 50Hz, with a secondary peak appearing in the 150-200Hz range, and continuing decreasing peaks up to almost 1kHz. In addition, the vessel is constantly moving, and the sound is 'ramped up' to increasing intensity, thereby being gradual enough to allow animals to avoid intense exposure (Cummings & Brandon, 2004).
- Noise from just a single seismic survey can flood through a region of almost 300,000km^2, raising noise levels 100 times higher, continuously for days at a time (Atlantic Whale Foundation, 2006).

- Immediate behavioral reactions to exposure to seismic sound have been widely documented in marine organisms, especially marine mammals (Fisheries and Ocean Canada, 2004).

1. Fish

Physical Effects

- The physiological effects will mainly affect younger life stages of fish such as eggs, larvae and fry (DNV, 2007).
- A number of studies reported sub-lethal effects on marine organisms, such as elevated stress-related chemicals, and damage to ears or other morphological structures. The potential for seismic sound to disrupt communication, detection of predators/prey, navigation and other functional uses of sound by fish has not been well studied.
- There are no documented cases of fish mortality upon exposure to seismic sound under field operating conditions, however the possibility of undetected fish kills cannot be eliminated. Overall, exposure to seismic sound is considered *unlikely* to result in direct fish mortality (Fisheries and Ocean Canada, 2004).
- Rise times are too slow and peak pressures too low to cause serious injury, except perhaps to fish that were within a few meters of the airgun at the time of release. Prior to coming close to an airgun, it is likely that most fish would be driven away by the approaching noise source. At slightly longer ranges, non-lethal injuries may occur, such as hearing loss, hemorrhaging of the eyes, swimbladder rupture, or stunning. Depending on the size of the airgun array and the position of the fish relative to the vessel, injuries to eyes and internal organs would occur only within a few tens of meters of the seismic vessel, with lesser symptoms such as hearing damage, possibly out to a few kilometers (Jacques Whitford, 2003).
- It has been documented that adult fish are frightened by the sound waves from seismic activity, and pelagic fish seem to be the most sensitive. The scare effect has been demonstrated in a radius of up to more than 30 km from the sound source. If fish that are on their way to the spawning grounds are exposed to this type of noise, or if they are exposed to the noise during the actual spawning event, the effects can have an impact on the fish's spawning success. Exposed fish may expend more energy on the spawning journey than fish that are not interrupted, and the spawning itself may be more or less deferred in time or displaced in space.

Behavioral Effects

- There is high likelihood of obtaining the following effects in some fish exposed to seismic sound- startle response; change in swimming patterns (potentially including change in swimming speed, and directional orientation); change in vertical distribution. These effects are expected to be short-term, with duration of effect less than or equal to the duration of exposure, are expected to vary between species and individuals, and be dependant on properties of received sound. The ecological significance of such effects is expected to be low, except where they influence reproductive activity (Fisheries and Ocean Canada, 2004).
- Attraction to subsurface structures and lights and avoidance due to noise or other disturbances may also occur (Jacques Whitford, 2003)

2. Marine mammals

Physical Effects

- Potential effects of human-made sound on marine mammals may be categorized as directly harmful physiological effects on individuals, or behavioral effects or masking. However, the effects depend partly on which frequency range they can hear in. Beluga whales have relatively poor hearing at the low frequencies used in seismic surveys. Among others, sperm whales, dolphins and porpoises appear to be most sensitive to sounds above 10 kHz, and are capable of detecting frequencies as high as 200 kHz. Moderate high frequency sounds are used in communication between individuals or groups, while the highest frequencies are used for echo localization. Seals also produce sounds under water, but these are restricted to clicking and barking sounds in the frequency range from somewhat lower than 1 to 4 kHz. Harbor seals, can perceive sounds at frequencies as high as 180 kHz, while their sensitivity is low for sounds above 60 kHz (DNV, 2007).

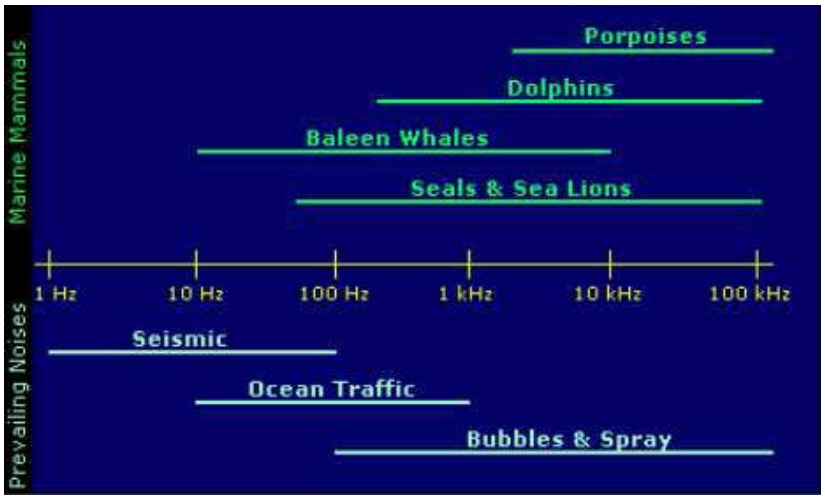


Figure 7. Approximate frequency range for communication on the part of marine mammals - the upper part of the figure, and common background noise in the sea ("prevailing noises") - lower part of the figure (DNV, 2007)

- There are no documented cases of marine mammal mortality upon exposure to oil and gas exploration seismic surveys (Fisheries and Ocean Canada, 2004).
- Hearing is the most important sense for cetaceans, and the ability to hear well is vital in all key aspects of their lives including finding food, navigating and social interactions. Any reduction in hearing ability - whether by physical damage or masking by other sound - may seriously compromise the viability of individuals and, therefore, populations (Prideaux, 2003)
- Chronic noise may result in population level changes in both short and long-term behaviour, while acute sounds may result in hearing damage leading to drastically reduced fitness or death. Noise is therefore a potential threat to individuals, the population, and the habitat of these species. While few data are available to assess physiological responses of marine mammals to anthropogenic noise, observed effects include both temporary and permanent hearing threshold shifts, the production of stress hormones, and tissue damage, likely due to air bubble formation or as a result

- Exposure to intense active sonar causes the compressed nitrogen in the animal's tissue to form large bubbles, causing decompression sickness. Decompression also occurs when cetaceans ascend very quickly after hearing the sonar noise. Symptoms include internal bleeding, pain, damage to vital organs and even death (Atlantic Whale Foundation, 2006).
- Increases in strandings have been linked to increases in man-made noise production. Pilot whales, a species that often strands in the Gulf would appear to be particularly vulnerable (Hammill et al., 2001).
- There are thousands documented incidents of cetacean standings many of which may be linked to military sonar activity. The unexpected noise disorientates the animals. This theory is supported by researchers who found gas bubble lesions in the organs stranded cetaceans caused by rapid decompression (Atlantic Whale Foundation, 2006).

Behavioral Effects

- Direct behavioral effects include: displacement and migratory diversion, changes in dive and respiratory patterns, changes in social behavior, changes in vocalization patterns. These effects may result in reduced communications efficiency, reduced echolocation efficiency, hampered passive acoustic detection of prey, hampered passive acoustic detection of predators, hampered avoidance of anthropogenic threats (such as ship strikes), hampered parental care or bonding (Fisheries and Ocean Canada, 2004).
- There is documented displacement and migratory diversion in some marine mammal species exposed to seismic sound. The duration of these effects may or may not extend beyond the duration of exposure. The effects are expected to vary between contexts, species, gender and age class, and individuals, and be dependant on the properties of received sound. The ecological significance of such effects is expected to be low, but may be higher if they:
  • displace feeding marine mammals from areas where there are no alternates,
  • displace marine mammals from resting areas where there are no alternates,
  • displace marine mammals from breeding or nursery areas, or
  • divert migrating animals from routes for which their alternate routes either do not exist or would incur substantially greater costs to traverse (Fisheries and Ocean Canada, 2004).
- In summary, exposure to seismic sound can result in displacement and/or migratory diversion in some marine mammals, but this effect is species, individual, and contextually-related. The ecological significance of such effects is unknown, but there are conditions under which the worst-case scenarios could be high (Fisheries and Ocean Canada, 2004).
- Humpback whales off Newfoundland exposed to explosions showed little behavioral reaction to the noise- no decreased residency, no change in overall movements, no change in general behavior. However, it soon became evident that these humpback whales had a higher incidence than elsewhere in Newfoundland of becoming

Current Regulations

- The "safety zone" defined for marine mammal protection is designated to be 500 m. Contractors for the Laurentian Sub-basin shall shut down the seismic array if a marine mammal listed as **endangered** (as per SARA – Schedule 1) including the northern right whale, and Blue whale, is observed within 500 m of the airgun array during ramp-up procedures and when the array is active (Canada-Newfoundland and Labrador Offshore Petroleum Board, 2007).
- 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 create consistent and clear academic/industrial seismic applications and when finalized will establish the environmental protection rules that must be followed when conducting seismic work in Canada's marine environment. The document incorporates many of the mitigation measures currently being employed in Newfoundland and Labrador waters.
- The *Statement of Canadian Practice* notes that seismic testing conducted utilizing the mitigation measures identified is not expected to cause any significant adverse environmental effects. However, seismic sounds in the marine environment are not completely without consequence. The Statement notes that the extent of scientific understanding of the potential effects of seismic varies depending on the issue and supports the ongoing acquisition of additional scientific knowledge.
- The federal government and provinces are also developing a Memorandum of Understanding (MOU) to formalize their partnership and the process that will be followed to complete, implement and make future amendments to the *Statement of Canadian Practice*. The statement, when finalized will be given effect by regulations under Canada's *Oceans Act*, the *Canada Oil and Gas Operations Act*, the federal and provincial versions of the Nova Scotia and Newfoundland and Labrador Accord Acts, as well as other provincial statutes (Action Team for Cod Recovery, 2005).
- Seismic surveys can affect fish, pinnipeds and cetaceans in different ways. Very little information is available as to how the impacts affect migration specifically, and little evidence of physical damage to tissues. Due to the wide range of species in the CP, and the wide range of effects that can occur from seismic surveys, and the potential severity of those affects, the score assigned will be in the medium range. This would be scored 'high' if there were more evidence of mortality from seismic surveys.

Score 6

Sensitivity of the CP to chronic impacts:

- The possible longer-term consequences of these short-term behavioral changes are debated among experts. The debate is largely speculative and there is little empirical basis to determine the likelihood of the full chain of events which would lead to serious longer-term consequences of the short-term behavioral reactions (Fisheries and Ocean Canada, 2004).

- A literature review by DFO scientists in 2004 indicated that information was incomplete to varying degrees in essentially all areas related to impacts of seismic sound on marine ecosystems. The literature on experiments and field observations of marine mammals exposed to sound stimuli is more extensive than the literature on effects on other types of marine organisms, and therefore likely to provide a more complete (but still partial) basis for setting thresholds (Fisheries and Ocean Canada, 2004).
- *Fish*: the severity of impact at the population level may be higher for an effect like auditory masking, if it occurs, because masking has the potential to affect a very large geographical area for low frequency sounds. Masking also may have few immediately observable signs that impacts are occurring, so mitigation may be less likely to be triggered than with individual mortalities due to trauma, (which have limited geographical extent and are more easily observable) (Fisheries and Ocean Canada, 2004).
- The duration of these effects may or may not extend beyond the duration of exposure, are expected to vary between species and individuals, and be dependant on the properties of received sound. The ecological significance of such effects is expected to be low, except when they may lead to a dispersion of spawning aggregations or deflection from migration paths (Fisheries and Ocean Canada, 2004).
- *Marine mammals and pinnipeds*: there have been no studies of the potential for seismic sound to induce chronic effects, such as immunosuppression or reduced fecundity, in marine mammals. Therefore, it is *unknown* if exposure to seismic sound can result in such chronic effects on marine mammals. Especially when dealing with SARA-listed species, detrimental effects suffered by one individual can translate into detrimental effects on the population (Fisheries and Ocean Canada, 2004).
- It is likely to take 10 to 30 years to notice small but significant 1-5% annual declines in population (Cummings & Brandon, 2004).
- Cetaceans: SARA listed species include: Blue whale (endangered), beluga whale, St. Lawrence estuary population (threatened), North Atlantic right whale (endangered), Fin whale (species of special concern), Harbour porpoise (threatened).
- The population status of cetaceans in the PBGB LOMA are shown in Table 1 below.
- Atlantic cod, haddock, south coast herring, and blue whale are listed as depleted and rare species within the LOMA (**add 0.5 point**).
- The behavioural and physiological impacts of seismic surveys are better studied and more obvious. Few chronic impacts have been discovered for fish or marine mammals. Long term impacts to migration routes could have severe consequences, but there is little evidence to prove that this would occur. Therefore this factor is scored in the low range.

Score 2 + 0.5 = 2.5

Common Name Scientific Name	Population and Conservation Status (COSEWIC)
Blue whale *Balaenoptera Musculus*	▪ at least 308 individuals in NW Atlantic ▪ Endangered (COSEWIC)
Humpback whale *Megaptera novaengilae*	▪ approximately 10,600 individuals in North Atlantic ▪ special concern (COSEWIC)
Fin whale *Balaenoptera physalus*	▪ ~2,200 in Northwest Atlantic ▪ special concern (COSEWIC)
Sei whale	▪ no estimate for Northwest Atlantic; 40,000-60,000 worldwide ▪ not evaluated (COSEWIC)
Minke whale	▪ ~3,800 Atlantic Canada; 800,000 worldwide ▪ under review (COSEWIC)
Sperm whale *Physeter macrocephalus*	▪ ~ 4,700 individuals from Gulf of St. Lawrence to Florida ▪ not evaluated (COSEWIC)
Northern bottlenose whale *Hyperoodon ampullatus*	▪ >40,000 in North Atlantic ▪ special concern (COSEWIC)
Short-beaked common dolphin *Delphinus delphis*	▪ ~ 30,000 individuals in northwest Atlantic ▪ not at risk (COSEWIC)
White-beaked dolphin *Lagenorthnchus albiorostris*	▪ unknown population estimate ▪ not at risk (COSEWIC)
Atlantic white-sided dolphin *Lagenorhynchus acutus*	▪ tens of thousands in NW Atlantic ▪ not at risk (COSEWIC)
Long-finned pilot whale *Globicephala melas*	▪ 15,000-25,000 in northwest Atlantic ▪ not at risk (COSEWIC)
Killer whale *Orcinus orca*	▪ no estimate for northwest Atlantic ▪ insufficient data (COSEWIC)
Harbour porpoise *Phocoena phocoena*	▪ unknown population in northwest Atlantic but likely >100,000 ▪ special concern (COSEWIC)

Table 1: Population estimates of cetaceans in the PBGB LOMA (Templeman & Davis, 2006)

Sensitivity of ecosystem to harmful impacts to the CP:

- The CP consists of at least thirteen species of cetaceans, five species of pinnipeds and 11 species of fish. Their role in the food web is complex as they range from top predators to small prey species.
- As large predators, marine mammals may play an important role in the structure and function of marine ecosystems through both direct and indirect impacts on prey populations
- Seals are opportunistic feeders, and consume a wide variety of prey species.
- The fish species in this area include full-time resident species, seasonal residents and occasional visiting species from areas further north and south. They are a main source

of food for larger predators and seabirds, and consume smaller fish, crustaceans and plankton.

- Because there is such a wide variety of species, and because patterns of movement are yearly cycles of which other species depend, this CP will score high. Migrations are a means by which a species meets its needs (feeding, mating, breeding, etc).
- Ecologically significant species in this CP include Atlantic cod >35cm, Greenland halibut <40cm and >40cm, capelin, harp seals, and cetaceans (**add 0.5 point**).

Score 9 + 0.5= 9.5

<u>Sensitivity:</u> (6 + 2.5+ 9.5)/3 = 6.0

<u>Risk of Harm:</u> MoI x S= 1.1 x 6= 6.6

Certainty Checklist

Answer yes or no to all of the following questions. Record the number of NOs to the 9 questions, and record certainty according to the scale provided below:

1 No's = High certainty
2 - 3 No's = Medium certainty
≥ 4 No's = Low certainty

Y/N

N Is the score supported by a large body of information?
N Is the score supported by general expert agreement?
N Is the interaction well understood, without major information gaps/sources of error?
N Is the current level of understanding based on empirical data rather than models, anecdotal information or probable scenarios?
Y Is the score supported by data which is specific to the region, (EBSA, LOMA, NW Atlantic?
Y Is the score supported by recent data or research (the last 10 years or less)?
Y Is the score supported by long-term data sets (ten year period or more)?
N Do you have a reasonable level of comfort in the scoring/conclusions?
N Do you have a high level of confidence in the scoring/conclusions?

Certainty Score: **Low**

For interactions with Low certainty, underline the main factor(s) contributing to the uncertainty:

Lack of comprehensive data
Lack of expert agreement
Predictions based of future scenarios which are difficult to predict
Other (provide explanation)

Suggest possible research to address uncertainty.

- **Better understanding of distribution of cetaceans throughout the year**
- **Research on migration patterns for all species**
- **Long term impacts seismic surveys to migrations of fish and cetaceans.**

Reference List

1. Action Team for Cod Recovery (2005). *A Strategy for the Recovery and Management of Cod Stocks in Newfoundland and Labrador*.

2. Atlantic Whale Foundation (2006). Atlantic Whale Foundation. Atlantic Whale Foundation [On-line]. Available: http://www.whalenation.org/index.asp

3. Canada-Newfoundland and Labrador Offshore Petroleum Board (2007). *ConocoPhillips Laurentian Subbasin Exploration Drilling Program Screening Report* CNLOPB.

4. CNLOPB (2009). Canada-Newfoundland and Labrador Offshore Petroleum Board. Internet [On-line]. Available: http://www.cnlopb.nl.ca/

5. Cummings, J. & Brandon, N. (2004). *Sonic Impact: A Precautionay Assessment of Noise Pollution from Ocean Seismic Suveys* Greenpeace.

6. DNV (2007). *Effects of seismic surveys on fish, fish catches and sea mammals* (Rep. No. 2007-0512).

7. Fisheries and Ocean Canada (2004). *Review of Scientific Information on Impacts of Seismic Sound on Fish, Invertebrates, Marine Turtles and Marine Mammals*.

8. Fisheries and Oceans Canada (2006). Recovery Strategy for Blue, Fin, and Sei Whales (Balaenoptera musculus, B. physalus, and B. borealis) in Pacific Canadian Waters. *Species at risk Act Recovery Strategy Series,* 1-53.

9. Hammill, M., Lesage, V., Dube, Y., & Measures, L. N. (2001). *Oil and gas exploration in the Southeastern Gulf of St. Lawrence: A review of information on pinnipeds and cetaceans in the Area* (Rep. No. Research Document 2001/115).

10. Jacques Whitford (2003). *Strategic Environmental Assessment Laurentian Subbasin*.

11. Jacques Whitford (2007). *Strategic Environmental Assessment Sydney Basin Offshore Area*.

12. Lawson, J. & McQuinn, I. (2004). *Review of the Potential Hydrophysical-related Issues in Canada, Risks to Marine Mammals, and Monitoring and Mitigation Strategies for Seismic Activities* (Rep. No. Research Document 2004/121). Canadian Science Advisory Secretariat, Fisheries and Oceans Canada.

13. ORCA Inc. (2005). *Grand Banks Environmental Overview Report: Part D - Human Use* Prepared for: Dr. Robert S. Gregory, Environmental Sciences Division, Fisheries and Oceans Canada, St. John's, NL.

14. Prideaux, M. (2003). *Conserving Cetaceans: The Convention on Migratory Species and its Relevant Agreements for Cetacean Conservation* Munich, Germany: WDCS.

15. Templeman, N. D. & Davis, M. B. (2006). *Placentia Bay-Grand Banks Ecosystem Overview and Assessment Report (DRAFT)* Newfoundland & Labrador: Fisheries and Oceans Canada.

16. The Whale and Dolphin Conservation Society (2004). *Oceans of Noise*.

17. Todd, S., Stevick, P., Lien, J., Marques, F., & Ketten, D. (1996). Behavioural effects of exposure to underwater explosions in humpack whales. *Can.J.Zool., 74,* 1661-1672.

Multi-species (fish, cetacean, pinniped) migration in the Laurentian Channel and Slope

Vessel traffic

Magnitude of Interaction

Areal extent:

- Cabot Strait is an important migratory corridor for marine mammals moving in and out of the Gulf of St. Lawrence. Certain species of fish, cetaceans and pinnipeds move through the Laurentian Channel as part of their annual migration patterns. There is no map that adequately conveys the areal extent of these movements.
- The shelf edges and bank slope are often highly productive areas, and are therefore often critical locations for spawning and feeding fish, as well as birds and marine mammals (Jacques Whitford, 2003).
- Because of the wide variety of species, habitat requirements, and migration routes used by this CP, it can be assumed that the entire area of the EBSA is utilized, especially those areas near the shelf edge and slope.
- The Cabot Strait links trans-Atlantic shipping routes to the St. Lawrence Seaway and the Great Lakes, with over 6,000 commercial vessel transits annually (Templeman, 2007).

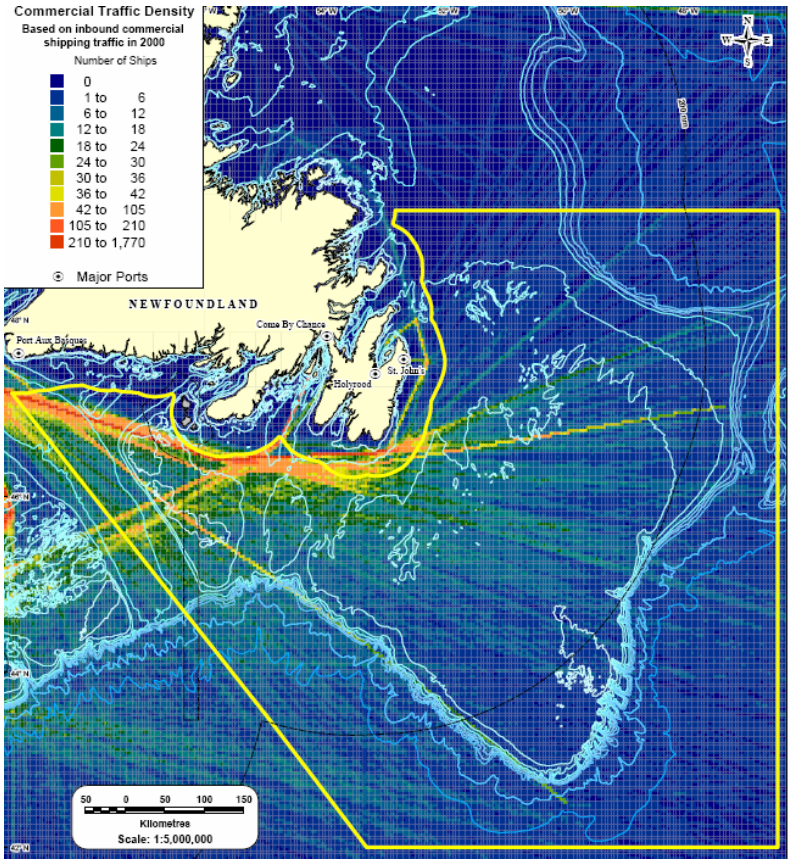


Figure 1. Commercial shipping, traffic density (from ECAREG data) (Fisheries and Oceans Canada, 2007). ECAREG is a mandatory reporting system for all commercial

vessels over 500t (or carrying pollutants or dangerous cargo) transiting within Canada's 12 nautical mile territorial sea. The ECAREG system **does not** include information on vessels transiting through Canada's Exclusive Economic Zone (Breeze & Fenton, 2007).

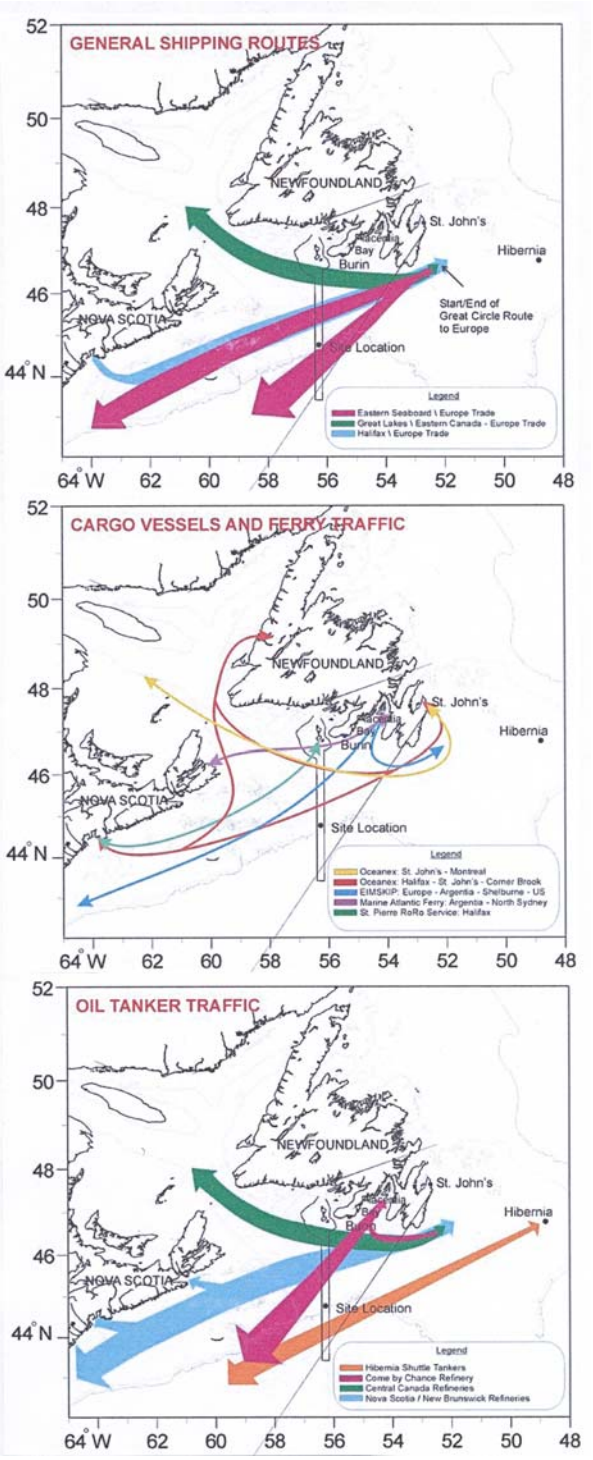


Figure 2. General shipping routes (Templeman, 2007)

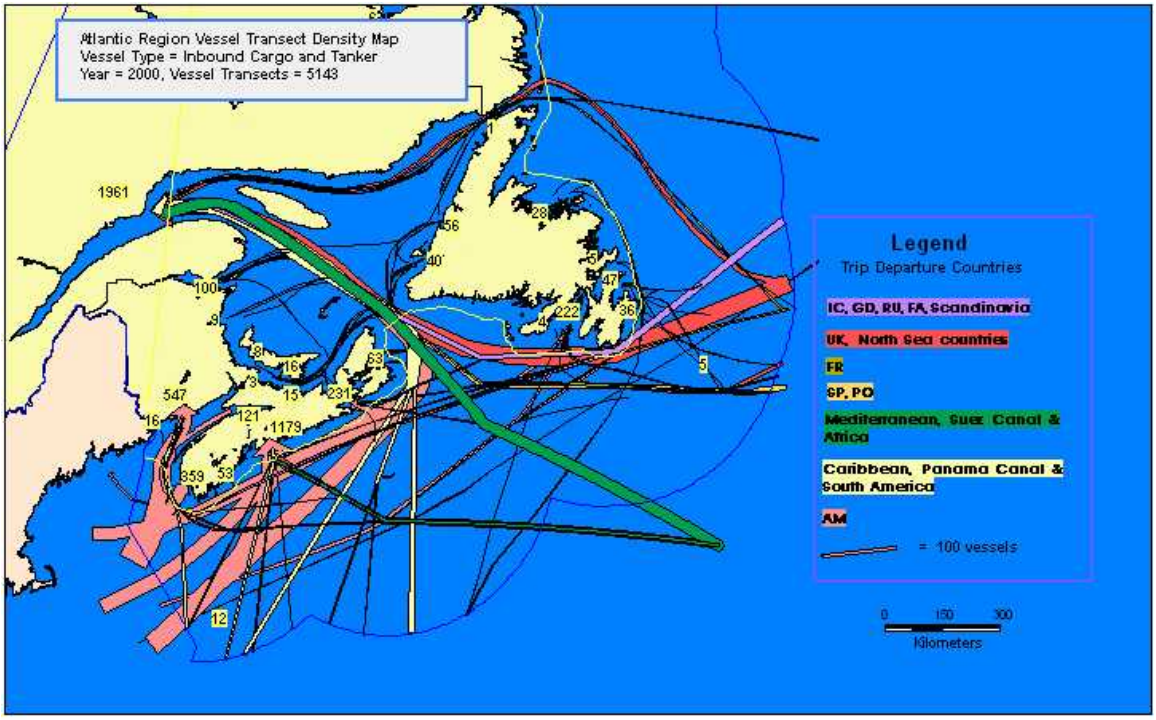


Figure 3. 2000 ECAREG inbound vessel transect density (Maritime Innovation, 2005)

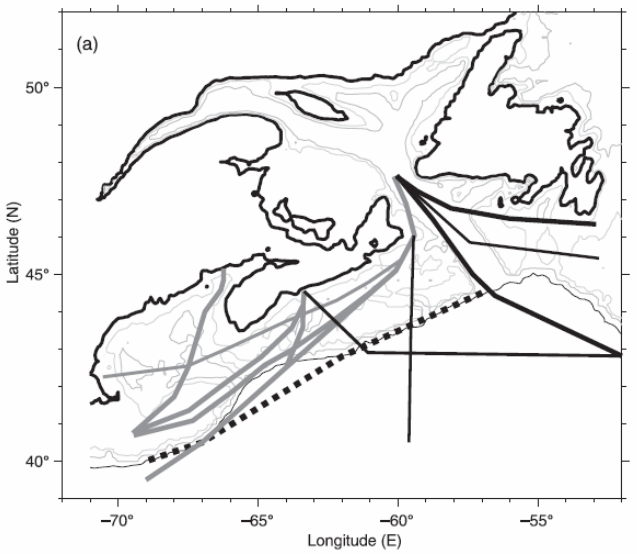


Figure 4. Principal vessel corridors on the Scotian Shelf, as derived from vessel transect density and endpoint exchange maps. The shaded lines denote traffic coming to or from the US. The broken line is an offshelf corridor considered as an alternate ballast water exchange zone (Brinkman, 2006).

- The main shipping lanes between Newfoundland and the Maritime provinces pass through this EBSA. The Laurentian Channel is the main route for ships entering and leaving the Gulf of St. Lawrence and the St. Lawrence seaway. The Laurentian

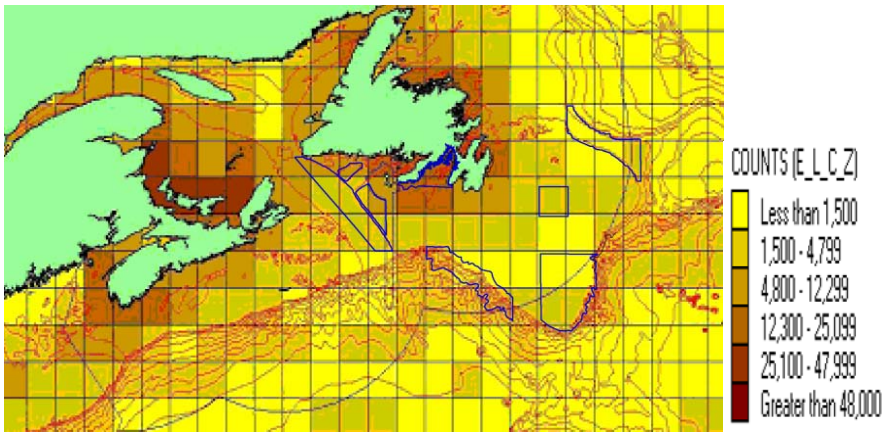


Figure 5. Annual vessel transits for all vessel types combined (merchant, fishing, cruise ships) (Pelot & Wootton, 2004).

- 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 - 300m (The Whale and Dolphin Conservation Society, 2004). This shows that the 'areal extent' can often be greater than the actual traffic route.
- The images above show that shipping occurs throughout the entire EBSA, but to varying degrees. Ships use similar tracks, but each ship may vary its route. Since vessels (commercial, industrial, fishing, recreational, cruise) can be found throughout the area of the EBSA, and the CP can be found throughout the EBSA, overlap between the two is estimated at 100%.

Score 10

Contact:

- The wide range of species encompassed by this CP have varying distributions in the water column: groundfish near the bottom, pelagic fish in the water column, and cetaceans and pinnipeds also found throughout the water column, and also spending time at the surface.
- In the northern hemisphere, shipping noise is the dominant source of background noise between 10 to 200 Hz. Ships are responsible for underwater noise that often propagates for distances of dozens to hundreds of kilometers, especially at frequencies <100 Hz in deep water (The Whale and Dolphin Conservation Society, 2004).
- Specifically, the propagation path from the source of vessel noise, primarily the propeller, to the whale's ear can be complicated. Variation in the temperature, salinity and pressure of sea water causes sound to refract. As a sound wave passes up or down through horizontal layers of sea water with different properties, it will tend to refract vertically. In the case of a whale at the surface in a deep water environment (more than 200 m) where sound at the surface is refracted downwards, a direct propagation

- Vessel traffic produces noise at the surface which propagates to various depths depending on characteristics of the water and bathymetry. Fish make up 1/3 of the CP- groundfish are most common in this EBSA, and live mostly on/near the seafloor. Pinnipeds and cetaceans move throughout the water column and spend considerable time at the surface. Considering vessel traffic noise is most prevalent in the upper portions of the water column, the degree of contact with the CP will be moderate because most fish are likely not affected, and pinnipeds and cetaceans are only periodically at the surface.

Score 5

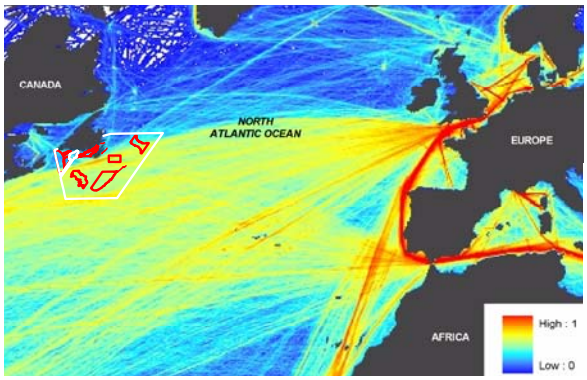
Duration:

- Most fish species are present in the Laurentian Channel and Slope EBSA during the winter. Most cetacean species are present in the summer. Pinnipeds are present from fall to spring. The exact timing of each different species' migration patterns is not well known, but when all species are considered together, migration is happening throughout the year in this EBSA.
- 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 & Wootton, 2004).
- Since vessels use the area in all months of the year, and some component of the CP is present in all months of the year, temporal overlap is scored at 100%.

Score 10

Intensity:

- In the northern hemisphere, shipping noise is the dominant source of background noise between 10 to 200 Hz (Fisheries and Oceans Canada, 2006). One study noted that noise from a supertanker (at 6.8 Hz) could be detected 139-463 km away (The Whale and Dolphin Conservation Society, 2004).
- Major types of vessel traffic within the LOMA include tankers (oil, chemical), cargo vessels (bulk, general, container), commercial fishing vessels, passenger vessels (ferries, cruise ships, tour boats), and a variety of recreational and working vessels (yachts, speed boats, research vessels, Coast Guard and Fisheries patrol vessels, pilots & tug boats, etc.). Small inshore fishing boats (<35') make up close to 90% of fishing vessels in the region (Fisheries and Oceans Canada, 2002).



Red	High
Orange	Medium-high
Yellow	Medium
Light Blue	Medium-low
Dark Blue	Low

Figure 6. Commercial shipping activity in PBGB LOMA (Halpern et al., 2008).

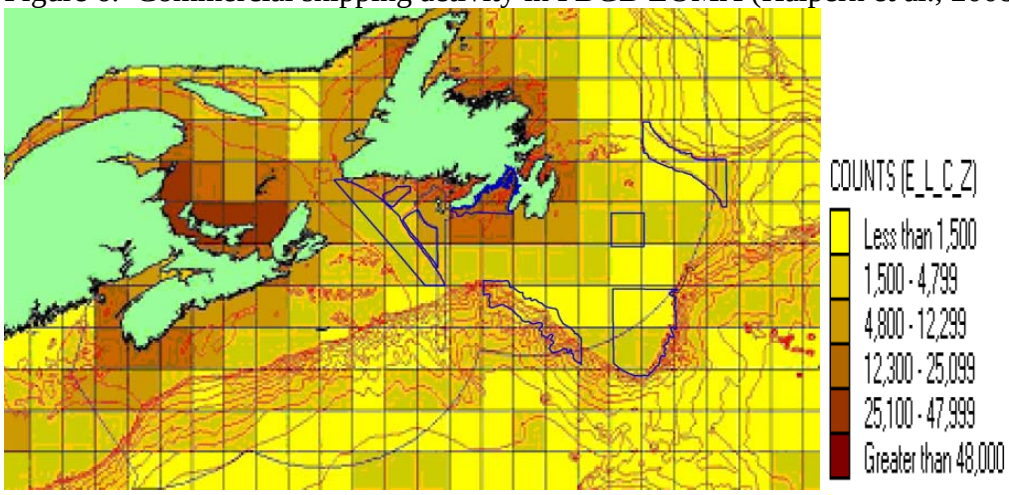


Figure 7. Annual vessel transits for all vessel types combined (merchant, fishing, cruise ships) (Pelot & Wootton, 2004).

- From May 2002 to April 2003 there were a total of 3,801 vessel trips through the Laurentian Sub-basin area. The average number of trips per month over that period was 317 (Jacques Whitford, 2003)
- The main shipping lanes between Newfoundland and the Maritime provinces pass through this EBSA. 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 and Slope EBSA have between 4,800-12,299 total vessel transits in an average year (Pelot & Wootton, 2004). This places the EBSA in 'medium-low intensity' range of shipping in the LOMA.
- Additional vessel traffic will occur when exploration drilling begins in the EBSA (scheduled for November 2009). The drilling rig will be supported by three vessels of 12-15,000 HP. There will be, on average, two trips per week between the base and the platform. Personnel and light supplies will be transported to and from the drilling rig via twin-engine, offshore-rated helicopters. Flights would occur approximately six times per week (Jacques Whitford, 2007).
- The medium-low range of intensity would be about a 4 on the methodology scale.

Score 4

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

Sensitivity

Sensitivity of the CP to acute impacts:

- By far the most dominant source of marine noise is shipping (Cummings & Brandon, 2004). 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).
- Noise from ships dominates marine waters and emanates from the ships' propellers, machinery, the hulls passage through the water, and the increasing use of depth sounders. Most shipping has a low frequency range i.e. less than 1kHz that coincides with the frequencies used, in particular, by baleen whales for communication and other biologically important activities. In general, older vessels produce more noise than newer ones and larger vessels produce more than smaller ones (The Whale and Dolphin Conservation Society, 2004).
- Although, typically, shipping produces frequencies below 1 kHz, small leisure craft generate sound from 1 kHz, up to 50 kHz range which has the potential to impact toothed whales. Propellers on these vessels tend to cause some cavitation which generates higher frequencies of noise, and these higher frequencies could be disturbing smaller cetaceans that would appear to be more sensitive to high frequency sound. 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 - 300m. Quieter, faster boats caused more disturbance than slower larger boats, as noise emitted by high speed boats rises above ambient levels only a short time before closest contact, thereby provoking a 'startle' reaction (The Whale and Dolphin Conservation Society, 2004).

Type of vessel	Frequency (kHz)	Source level (dB re 1?Pa)	Reference
650cc Jetski	0.8-50.0	75-125	Evans and Nice 1996
Rigid inflatable	6.3	152	Malme *et al.* 1989
7m outboard motor boat	0.63	156	Malme *et al.* 1989
Fishing boat	0.25-1.0	151	Greene 1985
Fishing trawler	0.1	158	Malme *et al.* 1989
Tug pulling empty barge	0.037 1.0	166 164	Buck and Chalfant 1972; Miles *et al.* 1989

	5.0	145	
Tug pulling loaded barge	1.0 5.0	170 161	Miles *et al.* 1989
34m (twin diesel engine) workboat	0.63	159	Malme *et al.* 1989
Tanker (135m)	0.43	169	Buck and Chalfant 1972;
Tanker (179m)	0.06	180	Ross 1976;
Supertanker (266m)	0.008	187	Thilele and Ødengaard
Supertanker (340m)	0.007	190	1983
Supertanker (337m)	0.007	185	
Containership (219m)	0.033	181	Buck and Chalfant 1972;
Containership (274m)	0.008	181	Ross 1976;
Freighter (135m)	0.041	172	Thilele and Ødengaard 1983

Table 1: A summary of frequencies produced by shipping and their source levels (The Whale and Dolphin Conservation Society, 2004).

- Vessel traffic could pose a risk to migration, especially for cetacean and pinnipeds, as it is a source of noise (collisions considered under 'Ship Strikes' below) which impacts different species to varying degrees. This chronic noise likely reduces the ability of large whales to maintain contact with others, potentially reducing mating and foraging opportunities (Payne, 2004). The noise from these vessels is at a frequency capable of masking whale calls (Richardson *et al.* 1995). The degree to which such acoustic pollution may, or already has, degraded habitat located near commercial shipping lanes has not been determined (Fisheries and Oceans Canada, 2006).
- It has been suggested that some hearing impairment has led to the deaths of sperm and humpback whales in industrial areas as they are unable to detect potential threats e.g. boat traffic and fishing gear (The Whale and Dolphin Conservation Society, 2004).
- Baleen whales rely on sound primarily for social communication. Whales may also use sound for predator detection, orientation, navigation, and possibly prey detection. Underwater noise has the potential to disrupt these behaviours. Acute sounds may result in hearing damage leading to drastically reduced fitness or death (Fisheries and Oceans Canada, 2006). Dolphins can often be stranded as a result of disorientation caused by noise pollution (Atlantic Whale Foundation, 2006).
- While few data are available to assess physiological responses of marine mammals to anthropogenic noise, observed effects include both temporary and permanent hearing threshold shifts, the production of stress hormones, and tissue damage, likely due to air bubble formation or as a result of resonance phenomena. The impact on marine mammals is thus a function of the length of exposure, loudness, frequency, and nature of the sound (Fisheries and Oceans Canada, 2006)
- Detectable effects include: respiration rate, swim speed, vocalizations, dive times, dive depth, residence times, distribution, movement relative to sound source, heart rate (Weilgart & Whitehead, 2002).
- Non-detectable effects (unless dramatic) include: birth rate (miscarriage rate, pregnancy rate, birth defects, mating rate, rate of finding mates, lactation rate, changes in mating dynamics), death rate (injury, disease, morbidity; vulnerability to

- The Laurentian Channel is a main shipping route in the PBGB LOMA with medium-low traffic density. Effects of noise from ship traffic are more prevalent for cetaceans than groundfish. These impacts rarely end in death, but decrease their fitness and can alter normal behaviour. Because the impacts are more common in only one component of the CP, and because these impacts are not known to result in death, the score assigned is in the moderate range.

Score 5

Sensitivity to chronic impacts

- It is estimated that background underwater noise levels have increased an average of 15 dB in the past 50 years throughout the world's oceans (Fisheries and Oceans Canada, 2006).
- The distant shipping noise adds to the constant ambient noise level in the marine environment. There has been a large increase in ambient noise in recent years, particularly in the Northern Hemisphere and this has implications for cetaceans. For example, Wiggins (2001) observed that blue whales (*Baleanoptera musculus*) vary the intensity of their sound production level in response to varying ambient noise levels (The Whale and Dolphin Conservation Society, 2004).
- Chronic noise may result in population level changes in both short and long-term behaviour. Noise is therefore a potential threat to individuals, the population, and the habitat of these species (Fisheries and Oceans Canada, 2006)
- Chronic exposure to moderate levels of noise is likely to be causing more significant biological impacts than occasional exposures to extremely loud noise (Cummings, 2007).
- Noise is clearly biologically significant if it induces long-term abandonment of an area important for feeding, breeding or rearing the young, as it may lead to reduced fecundity, carrying capacity, or both. Consequences will not become apparent until more research is conducted into the long-term effects of noise pollution.
- Sensitization occurs, when, for example, an animal has been exposed to a painful level of noise from a particular source, causing it to avoid the source. Habituation occurs when the stimulus is no longer novel although adverse consequences may still be associated with it. Gradual deafness might easily be misinterpreted as a growing tolerance or habituation to noise (The Whale and Dolphin Conservation Society, 2004).

- Sound at any level can cause hearing damage by decreasing auditory sensitivity. One of the most common mild traumatic effects is a threshold shift. The auditory threshold of a sound is the minimum level of intensity at which a sound can be heard. After this level of auditory trauma, the threshold becomes higher and hearing sounds becomes more difficult. Threshold shifts may be temporary (TTS), or can be permanent with greater intensities of noise. Multiple or longer periods of exposure to noise levels causing TTS can also cause permanent threshold shifts (PTS). These threshold shifts are caused by hair cell fatigue, hair cell damage or nerve degeneration (The Whale and Dolphin Conservation Society, 2004).
- It is recognized that noise and disturbance lead to an increase in activity of glands producing these hormones. Increases in these hormone levels are usually associated with changes in behaviour, such as increased aggression, changes in respiration patterns or altered social behaviour. However, noise-induced stress may be present but does not necessarily cause overt changes in behaviour (The Whale and Dolphin Conservation Society, 2004).
- Prolonged noise-induced stress can lead to debilitation, e.g., in fish and invertebrates, prolonged exposure can induce infertility, pathological changes in digestive and reproductive organs and reduced growth. Prolonged exposure to high levels of noise and the resultant chronic activation of stress-related hormonal complexes could lead to harmful effects in cetaceans, for example:
  - Arteriosclerosis
  - Nutritional problems
  - Stomach ulceration
  - Suppression of reproductive function
  - Reduction in resistance to infection
  - Decrease in life expectancy
- Significant, physiological impacts repeatedly go undetected, as we don't have the ability to detect and assess them. Even carcasses are very rarely encountered at sea, as they sink relatively quickly (The Whale and Dolphin Conservation Society, 2004).
- Existing instruments for mitigation: The Law of the Sea Convention (LOSC) is the most promising global treaty with potential for the regulation of ocean noise, on account of (a) its definition of pollution including "energy" and (b) its intention to address pollution from all sources. MARPOL too offers possibilities, assuming that the scope of Art 1(1) could be extended to include energy or noise; even then, pressure to introduce an equivalent of Art 2(3)(b)(ii) is likely to be strong.
- Cetaceans: SARA listed species include: Blue whale (endangered), beluga whale, St. Lawrence estuary population (threatened), North Atlantic right whale (endangered), Fin whale (species of special concern), Harbour porpoise (threatened).
- Cetacean population estimates for the entire LOMA are listed in the Ecosystem Overview Report (Templeman & Davis, 2006), and many of these species have low populations, such that impacts to a small number may have consequences for the entire population.
- Atlantic cod, haddock, south coast herring, and blue whale are listed as depleted and rare species within the LOMA (**add 0.5 point**).
- The score chosen is an average value that represents all elements of the CP. The stressor of vessel traffic noise can impact populations in the long term, but this may

Score 2.5

Sensitivity of ecosystem to harmful impacts to the CP:

- The CP consists of at least thirteen species of cetaceans, five species of pinnipeds and 11 species of fish. Their role in the food web is complex as they range from top predators to small prey species.
- As large predators, marine mammals may play an important role in the structure and function of marine ecosystems through both direct and indirect impacts on prey populations.
- Seals are opportunistic feeders, and consume a wide variety of prey species.
- The fish species in Grand Banks includes full-time resident species, seasonal residents and occasional visiting species from areas further north and south. They are a main source of food for larger predators and seabirds, and consume smaller fish, crustaceans and plankton.
- Ecologically significant species in this CP include Atlantic cod>35cm, Greenland halibut <40cm and >40cm, capelin, harp seals, and cetaceans (**add 0.5 point**).
- Because there is such a wide variety of species, and because patterns of movement are yearly cycles of which other species depend, this CP will score high. Migrations are a means by which a species meets its needs (feeding, breeding, etc) therefore these movements are crucial to the ecosystem.

Score 9 + 0.5= 9.5

<u>Sensitivity:</u> (5 + 2.5+ 9.5)/3 = 5.7

<u>Risk of Harm:</u> MoI x S= 2 x 5.7 = 11.4

<u>Certainty Checklist</u>

Answer yes or no to all of the following questions. Record the number of NOs to the 9 questions, and record certainty according to the scale provided below:

1 No's = High certainty
2 - 3 No's = Medium certainty
≥ 4 No's = Low certainty

Y/N

N Is the score supported by a large body of information?
N Is the score supported by general expert agreement?
N Is the interaction well understood, without major information gaps/sources of error?
N Is the current level of understanding based on empirical data rather than models, anecdotal information or probable scenarios?
Y Is the score supported by data which is specific to the region, (EBSA, LOMA, NW Atlantic?
Y Is the score supported by recent data or research (the last 10 years or less)?
Y Is the score supported by long-term data sets (ten year period or more)?
N Do you have a reasonable level of comfort in the scoring/conclusions?
N Do you have a high level of confidence in the scoring/conclusions?

Certainty Score: **Low**

For interactions with Low certainty, underline the main factor(s) contributing to the uncertainty:

Lack of comprehensive data
Lack of expert agreement
Predictions based of future scenarios which are difficult to predict
Other (provide explanation)

Suggest possible research to address uncertainty.

- **Better understanding of distribution of cetaceans throughout the year**
- **Research on migration patterns for all species**
- **Long term impacts of vessel traffic to migrations of fish and cetaceans.**

Reference List

1. Atlantic Whale Foundation (2006). Atlantic Whale Foundation. Atlantic Whale Foundation [On-line]. Available: http://www.whalenation.org/index.asp

2. Breeze, H. & Fenton, D. G. (2007). Designing management measures to protect cold-water corals off Nova Scotia, Canada. *Bulletin of Marine Science, 81,* 123-133.

3. Brinkman, D. (2006). Risk Assessment Model for Dispersion of ballast Water organisms in Sheld Sea. Can.J.Fish.Aquat.Sci. 63, 2748-2759.
Ref Type: Journal (Full)

4. Cummings, J. (2007). *Ocean Noise: What we learned in 2006* (Rep. No. AEI Spotlight Report). The Acoustic Ecology Institute.

5. Cummings, J. & Brandon, N. (2004). *Sonic Impact: A Precautionay Assessment of Noise Pollution from Ocean Seismic Suveys* Greenpeace.

6. Fisheries and Oceans Canada (2002). Statistical Services - Commercial Licenses - Vessels Information. Fisheries and Oceans Canada [On-line]. Available: http://www.dfo-mpo.gc.ca/communic/statistics/commercial/licensing/vessels_info/vessels02_e.htm

7. Fisheries and Oceans Canada (2006). Recovery Strategy for Blue, Fin, and Sei Whales (Balaenoptera musculus, B. physalus, and B. borealis) in Pacific Canadian Waters. *Species at risk Act Recovery Strategy Series,* 1-53.

8. Fisheries and Oceans Canada The Grand Banks of Newfoundland: Atlas of Human Activities. *The Grand Banks of Newfoundland: Atlas of Human Activities,* (in press).

9. Halpern, B. S., Walbridge, S., Selkoe, K. A., Kappel, C. V., Micheli, F., D'Agrosa, C. et al. (2008). A Global Map of Human Impact on Marine Ecosystems. *Science, 319,* 948-952.

10. Jacques Whitford (2003). *Strategic Environmental Assessment Laurentian Subbasin*.

11. Jacques Whitford (2007). *Strategic Environmental Assessment Sydney Basin Offshore Area*.

12. Maritime Innovation (2005). *Marine Traffic Surveys* (Rep. No. Gros Cacouna LNG Terminal).

13. Nowacek, D. P., Johnson, M. P., & Tyack, P. L. (2003). North Atlantic right whales (*Eubalaena glacialis*) ignore ships but respond to alerting stimuli. *Proc.R.Soc.Lond.B, 271,* 227-231.

14. Payne, R. S. (2004). *Long-range communication in large whales, ocean noise and synergistic impacts* (Rep. No. Submitted at the IWC 56 meeting, July 2004). IWC.

15. Pelot, R. & Wootton, D. (2004). *Maritime traffic distribution in Atlantic Canada to support an evaluation of a Sensitive Sea Area proposal* (Rep. No. 2004-05). Maritime Activity & Risk Investigation Network.

16. Templeman, N. D. (2007). *Placentia Bay-Grand Banks Large Ocean Management Area Ecologically and Biologically Significant Areas* (Rep. No. 2007/052). Canadian Science Advisory Secretariat Research Document, Fisheries and Oceans Canada.

17. Templeman, N. D. & Davis, M. B. (2006). *Placentia Bay-Grand Banks Ecosystem Overview and Assessment Report (DRAFT)* Newfoundland & Labrador: Fisheries and Oceans Canada.

18. The Whale and Dolphin Conservation Society (2004). *Oceans of Noise*.

19. Weilgart, L. & Whitehead, H. (2002). *The threat of underwater noise on whales: management in light of scientific limitations*.

Summary Table: Multi-species migration in the Laurentian Channel and Slope

Key Activity/Stressor	a	c	d	i	**MoI** (a x c x d x i) / 1000	as	cs	es	**S** (as+cs+es) / 3	**Risk of Harm**	Certainty
Bottom trawl	7.3	5	10	4	**1.5**	5	2.5	9.5	**5.7**	**8.6**	**Low**
Oil & gas drilling	5	4	10	8	**1.6**	3	7.5	9.5	**6.7**	**10.7**	**Low**
Vessel traffic	10	5	10	4	**2**	5	2.5	9.5	**5.7**	**11.4**	**Low**
Seismic survey	8	10	1.7	8	**1.1**	6	2.5	9.5	**6.0**	**6.6**	**Low**
Cumulative CP Score										**37.3**	