

Seabird aggregation, feeding, nesting, & refuge in Placentia Bay Extension

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

Background Information

Seabirds are an important component of the marine ecosystem, playing a role as high level predators and also in nutrient cycling. The rich, diverse, feeding and breeding grounds of Placentia Bay attract a wide variety of marine birds to the area. The number of cliffs, sea stacks and islands throughout the bay provide appropriate nesting habitat and the cold Labrador Current that influences the bay supports a rich assortment of prey including plankton, capelin, and other small fish and invertebrates. Observations of seabird species in Placentia Bay have included twenty-seven species (ORCA Inc., 2005), and numerous nesting colonies (Community Resource Services Ltd & Jacques Whitford Environment Ltd, 2001). Large stocks of capelin that breed in the inshore zone in summer are the principal prey of the large breeding populations of gannets, auks, murre, Atlantic puffins, dovekies, guillemots and kittiwakes (Lock et al., 1994; Carscadden et al., 2002). Some of these marine bird species can be found all year round, while others migrate annually from the arctic or south of Newfoundland to breed or feed (Lock et al., 1994).

Newfoundland is the breeding centre for many species of seabirds. Aviaries on the Avalon Peninsula and northeast coast of Newfoundland support the abundance and diversity of seabirds on the Grand Banks (Templeman & Davis, 2006). There are seabird breeding colonies throughout Placentia Bay with the most significant being the Cape St. Mary's Ecological Reserve. Other breeding colonies with varying numbers of breeding pairs exist throughout the bay. Seabird colonies in Newfoundland are occupied from April to September (Lock et al., 1994).

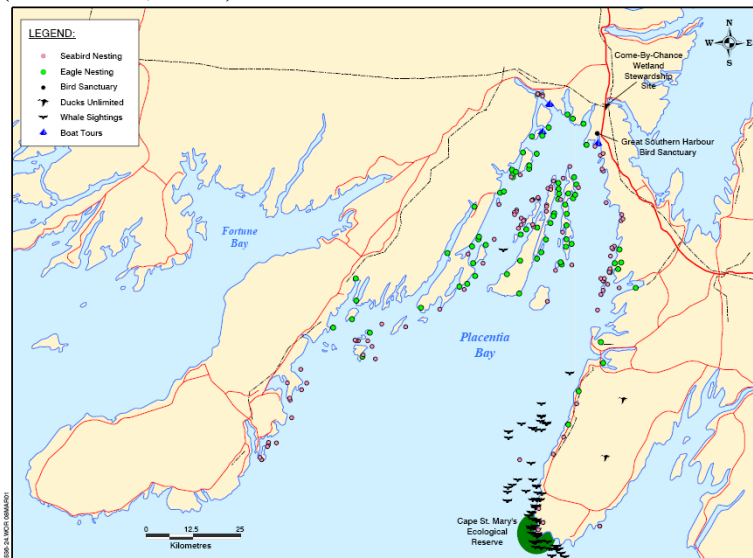


Figure 4.10 Seabird and Eagle Nesting Sites, Ducks Unlimited Sites, Bird Reserves, Whale Sightings and Boat Tour Operators

Figure 1. Seabird and eagle nesting sites in Placentia Bay (NL Refinery Ltd, 2007).

The Cape St. Mary's reserve is 64 km² in size, including a 54 km² marine portion. The reserve is a nesting area for approximately 24,000 Northern gannets, 20,000 black-legged kittiwakes, 20,000 common murre, 2,000 thick-billed murre, 100 pairs of razor-bills, 60 pairs of black guillemots and some double crested and great cormorants and northern fulmars. The gannet colony is the biggest in Atlantic Canada and the third biggest in North America (BirdLife International, 2002; Lock et al., 1994; Mercer & Willcott, 2005).

The population sizes of all seabird species remained stable or increased in recent years, with the exception of gulls. Increasing populations of seabirds are related in part to their lessened mortality from gillnets since the closures of the groundfish moratorium beginning in 1992, whereas declining populations of gulls can be related to reduced food availability from fishery discards and offal. This food limitation has led gulls to switch much of their foraging effort from scavenging to predation on seabird adults and chicks before capelin arrive inshore (Carscadden et al., 2002). Black-legged kittiwakes suffered breeding failure during the early 1990s owing to a suite of factors, including the late arrival of capelin inshore and predation by gulls, but numbers of breeders were not affected (Carscadden et al., 2002; Chardine et al., 1999). Auks and gannets did not suffer breeding failures because they could dive and catch capelin and other small fish at greater depths (Carscadden et al., 2002). Stocks of seabird forage fish such as capelin and herring are currently increasing in Atlantic Canada, and fisheries for both species are conservative (Chardine et al., 1999).

Gannets and auk species are long lived (16-20 years), start breeding late (4-6 years) and lay only one egg/year. They are generally thought to mate for life, returning to same nesting site each year. There are 20,000 breeding pairs of gannets in the North Atlantic, and more than 1 million breeding common murres in eastern North America. Northwest Atlantic thick-billed murres breed largely in the eastern Canadian Arctic and over-winter on the Grand Banks and coastal waters of Newfoundland.

Scoping

Gillnets (bottom):

In shallow inshore waters, bottom gillnets take a high bycatch of seabirds, particularly birds that regularly dive below the surface to feed. Fisheries bycatch killed an estimated 22,070 common murres annually in eastern Newfoundland in the early 1980s, but the gillnet fishery is now much reduced, and bycatch is less than 10% of those former levels (Wiese & Robertson, 2004). The EBSA is still subjected to moderate intensity of bottom gillnets (lumpfish, cod, winter flounder). **Screened in.**

Gillnets (pelagic):

In shallow inshore waters, pelagic gillnets take a high bycatch of seabirds. Fisheries bycatch killed an estimated 22,070 common murres annually in eastern Newfoundland in the early 1980s, but the gillnet fishery is now much reduced, and bycatch is less than 10% of those former levels (Wiese & Robertson, 2004). Boat traffic near surface gear can also force fleeing birds into the nets as they try to dive to avoid the vessel. Fishing of pelagic species such as herring, salmon and mackerel is minimal in Placentia Bay (Community Resource Services Ltd & Jacques Whitford Environment Ltd, 2001), and mobile gear such as seines are more frequently used. **Screened out.**

Longline:

Baited hooks such as longlines attract and capture many species of seabird, but longline fisheries are minimal in Placentia Bay. **Screened out.**

Seine (pelagic):

Seabirds are not highly vulnerable to purse seines, and fishing of pelagic species such as herring, and capelin which would use this gear is currently minimal in Placentia Bay (Community Resource Services Ltd & Jacques Whitford Environment Ltd, 2001). **Screened out.**

Seabird hunt:

Large numbers of murre are harvested each winter in Placentia Bay, and although the hunt is considered sustainable, it is a major source of mortality. The targeted species are common and thick-billed murre, although razor-billed murre, dovekie, guillemot and puffin may be taken as bycatch. The Placentia Bay area is located within Murre/Turr Hunting Zone 3, with an open season extending from November 25 to March 10. The *Newfoundland and Labrador Migratory Birds Hunting Regulations* outlines a daily bag limit of 20 murre and a possession limit of 40 murre (Canadian Wildlife Service, 2003). Murre can be legally hunted from a power boat, (Schreiber & Burger, 2001) and lead shot is allowed. Since Placentia Bay is part of a larger hunting area, statistics specific to the bay for the number of birds taken is not available.

Surveys and field studies beginning in the late 1970s, estimated the annual kill in NL to be 600,000 to 900,000 birds (95% thick-billed murre, 5% common murre). Fifty percent of the harvest was first year birds, but the percentage of adults increased through the season. This harvest was considered unsustainable and needed to be reduced by 50% to maintain a stable population. As a result, in 1993-94, CWS developed a Murre Harvest Management Plan, using a combination of public education, bag limits, and a shorter hunting season (reducing proportion of adult (breeding) birds which resulted in a harvest reduction of 50%) (Chardine, 1999). The total harvest is now estimated at 250,000 - 300,000, and although the harvest in Placentia Bay is unknown, an estimate of 25,000 would be precautionary. There may be an additional mortality of wounded birds which are not retrieved. Murre (colloquially known as turrs) are primarily hunted around Point Lance but are also hunted throughout the Bay.

Several species of sea ducks (eiders, oldsquaw, and scooters) are also harvested, but these are not considered under this CP. Thick-billed murre is also subjected to extensive summer and winter hunting in Greenland (Robertson et al., 2006; Wiese & Robertson, 2004). **Screened in.**

Other coastal alteration-Wind farms:

Collisions of birds with wind turbine generators have often been identified as an issue of concern. The problem has primarily been identified in relation to mountain passes where large raptors ride the updrafts along the mountainside and inadvertently venture into the turbine rows. Also, the earlier turbine tower designs used latticed towers, which were attractive to raptors as perching locations. During take-off from the towers, raptors would be carried by the draft into the rotor of downwind-operated turbines. Today's wind turbines are essentially upwind machines (i.e. the rotor is upwind from the tower) and are mounted on tubular towers which offer no opportunity for birds to perch. Furthermore, large turbines have reduced rotor tip speeds and rotating speeds (26 to 36 rpm), which reduces the likelihood of bird collisions. A recent review of bird impact studies in Europe and the United States indicate bird-turbine interactions resulting in mortality represent relatively minor

occurrences (Jacques Whitford Environment Ltd, 2002). On-land wind farms such as the one proposed by DeWind at St. Lawrence are not a significant source of harm to seabirds, because seabirds spend almost all of their time over water or on nesting sites on cliffs and rocky coastal outcrops, and do not perch on high towers. **Screened out.**

Vessel traffic:

A major shipping lane passes through the east side of Placentia Bay serving the Come by Chance Oil refinery, the NL Transshipment Terminal and the Ferry Terminal at Placentia as well as other sites. Total annual vessel movements in Placentia Bay in 2004 totalled 8,286 including 1,276 oil tankers, 62 chemical tankers, 522 cargo ships, 2,046 tug boats 1,501 ferry movements, and 1,589 fishing boats and other vessels under 20m. (Transport Canada, 2007).

Frequent disturbance by vessel traffic can cause stress, interrupt feeding, disturb nesting activity, and drive fleeing birds into fixed gear such as gillnets, leading to increased mortality. Small, loud vessels such as speed boats, which can operate in shallow areas near nesting colonies are of greatest concern. Nesting colonies are scattered throughout most coastal areas of the bay, largely along unpopulated islands and inaccessible cliffs. Since the EBSA encompasses a 7,398km² area, 8286 vessel transits annually corresponds to 1.1 transit/km²/year, or 0.003 transits/ km²/day. Clearly some areas will have many more transits than other areas, and the summer season is likely to be busier than the winter (NS ferry and many fishing vessels do not operate in winter), but even so, this level of vessel traffic density is not expected to cause significant disturbance to seabirds within Placentia Bay. **Screened out.**

Ship strikes:

A major shipping lane passes through the east side of Placentia Bay serving the Come by Chance Oil refinery, the NL Transshipment Terminal and the Ferry Terminal at Placentia as well as other sites. Total annual vessel movements in Placentia Bay in 2004 totalled 8,286 including 1,276 oil tankers, 62 chemical tankers, 522 cargo ships, 2,046 tug boats 1,501 ferry movements, and 1,589 fishing boats and other vessels under 20m. (Transport Canada, 2007). Ship strikes are not a major source of direct mortality of seabirds as they are generally able to avoid vessels by diving or flying. **Screened out.**

Eco-tourism:

Cape St. Mary's bird sanctuary is the primary eco-tourist attraction in Placentia Bay, but the land-based viewing sites are well monitored and do not appear to negatively affect the birds – to the contrary, they offer protection by preventing harassment, restricting motorized vehicles, dogs, etc. (Community Resource Services Ltd & Jacques Whitford Environment Ltd, 2001). Three tour-boat operators, based out of North harbour, Woody Island and Arnold's Cove, offer whale and bird watching tours and there are guided kayaking tours from Spanish Room (Community Resource Services Ltd & Jacques Whitford Environment Ltd, 2001). Considering the large size of the bay, this level of activity is minimal, and impacts are not considered significant. **Screened out.**

Oil pollution:

Placentia Bay is considered the most likely area in Canada for a large oil spill (Brander-Smith et al., 1990). Major sources of oil pollution within the EBSA include port activity (oil

transshipment, storage, refuelling), chronic discharge related to vessel traffic (bilge, ballast, 2-stroke outboard motors) and urban runoff (storm drains, sewers, river runoff).

Birds are especially susceptible to direct contact with oil, with diving birds being the most susceptible. Most birds that come in contact with oil subsequently die since the presence of oil on a bird's feathers can destroy their waterproofing, insulating, and buoyancy capability, leading to hypothermia or drowning. Those that do not die from hypothermia or drowning may die from ingestion of significant quantities of oil during preening (Templeman & Davis, 2006). The illegal release of oil into the marine environment from vessel engine room spaces is thought to be responsible for over 90% of deaths due to oil pollution in seabirds. Chronic ship-source oil pollution is estimated to have killed an average of 300,000 seabirds between 1998 and 2000. Thick-billed murres that overwinter on the Grand Banks made up 67% of this kill (Wiese & Robertson, 2004). Seabirds are highly mobile, and nesting colonies on the Avalon Peninsula and adjacent areas including Placentia Bay, support the abundance and diversity of seabirds on the Grand Banks (Templeman & Davis, 2006). **Screened in.**

Fishplant effluent:

There are 12 fish plants in Placentia Bay although they are not all active throughout the year. Herring gulls and other related species often scavenge food at fish plant outfalls and may be affected by cleaners and disinfectants that are discharged, but is not considered a key source of harm. Most other seabirds (gannets, murres, puffins, petrels, etc) pursue live prey and would not be likely to be affected. **Screened out.**

Sewage:

There are 111 municipal sewage outfalls in Placentia Bay, serving approximately 35,000 residents. Effluent is discharged to coastal waters, for the most part untreated (109 untreated). Several species of gulls and ducks are commonly seen feeding at sewage outfalls (Fisheries and Oceans Canada, 2005b), and may be adversely affected by a variety of toxic compounds, drugs, and litter which are discharged, but given the large size of the bay and relatively small human population, this is not considered a key source of harm. Most other seabirds (gannets, murres, puffins, petrels, etc) pursue live prey and would not likely be affected. **Screened out.**

Persistent organic pollutants (POPs):

Seabirds tend to accumulate persistent organic pollutants such as PCBs, DDT and other organochlorine compounds. Since many organochlorine compounds are lipophilic and persistent, they are readily bio-accumulated in animals with significant lipid reserves. Biota at northern latitudes are exposed to many chemical residues that are transported there via air and ocean currents through a process called long range transport, that is, compounds that evaporate at latitudes with higher mean air temperatures, condense when they reach the colder temperatures of the north. In this way, contaminants from distant sources may be deposited into northern oceans. Once there, most of these compounds are not easily broken down and therefore persist in the environment for many years. (Braune et al., 2001). In the Arctic, high trophic-level marine species including seabirds have been shown to carry high levels of many environmental contaminants (Braune et al., 2001). Long-lived fish-eating species such as puffins, murres, dovebies, gannets, and guillemots tend to have higher levels of contaminants than plankton feeders such as petrels. Birds like murres, puffins, dovebies

and guillemots which lay only one egg/year, tend to deposit higher levels of contaminants in their one egg (Schreiber & Burger, 2001).

There is little data on contaminants in seabirds in Placentia Bay, but one would expect that long-lived seabirds, particularly those which spend part of their life cycle in the far north (thick-billed murre, black guillemot), would be most affected. Although this is not considered a key source of harm, monitoring of contaminant levels in over-wintering thick-billed murre is recommended as an indicator of ecosystem health and to ensure that contaminant levels are below Health Canada guidelines, given that this is a harvested species. Seabirds, by virtue of their position in the food chain, can be used as an indicator of the health of marine ecosystems through an assessment of the extent of chemical contamination in the birds. **Screened in.**

Ghost nets:

Since the 1960s when non-biodegradable synthetic ropes, buoys and netting gradually replaced traditional biodegradable materials, lost fishing nets known as ghost nets, have become a serious threat to marine ecosystem health. Ghost nets can continue to fish for years, capturing tonnes of fish, lobster and crab, marine mammals. In shallow coastal waters lost nets tend to become rapidly filled with dead fish, and sink, becoming snagged on the bottom where they are a serious threat to bottom dwelling species. Gillnets are considered to be the major source of ghost nets in Placentia Bay. Gillnets were used extensively in the inshore groundfish fishery, and for pelagic species such as salmon. Following closure of the cod and salmon fisheries in the 1990s, use of gillnets decreased substantially, but are still used for herring, mackerel, lumpfish, winter flounder, and a limited cod fishery. Various initiatives have been launched to try to retrieve ghost nets. One such project in Placentia Bay, recovered 60 nets that contained lumpfish, seal, redfish, flounder, lobster and 30,000 lbs. of rotting cod (CBC News, 2000). The current extent of the problem is unknown, but is probably not a major problem for seabirds which spend most of their time at or near the water surface. **Screened out.**

Litter:

DFO marine debris surveys of beaches in Placentia Bay found significant accumulations of marine debris on southwest facing beaches (Fisheries and Oceans Canada, 2005a). Plastic was the most common material and fishing-related items such as ropes, buoys, netting, buckets were also common (Pink, 2004). Plastics contribute disproportionately to the overall impact of marine litter for a number of reasons (Algalita Marine Research Foundation, 2002; Mato et al., 2001; Moore et al., 2001). The use of plastic has grown rapidly over the last 50 years and it is now the world's most used material, but the very qualities that make plastic popular (cheap, light, waterproof, durable) are the same qualities that cause problems for marine ecosystems (Derraik, 2002).

Major impacts on seabirds from marine litter relate to ingestion and entanglement. Plastic cannot be digested, or used as a source of food by any living creature, but unfortunately, many animals mistake plastic for food. Scientists have documented the consumption of plastic by 177 marine species, including 111 seabird species (The Marine Debris Team,

2005). Breeding birds can regurgitate plastic accumulated in their digestive tracts as they feed their nestlings, transferring the problem to the most vulnerable life stages (Algalita Marine Research Foundation, 2002; Derraik, 2002). Other harmful effects from ingested plastic include blockage of gastric enzyme secretion, diminished feeding stimulus, lowered steroid hormone levels, delayed ovulation and reproductive failure, internal injury and death following blockage of the intestinal tract (Derraik, 2002). **Screened in.**

Other contaminants (Lead):

Lead is a potent poison which is considered a significant environmental contaminant and public health concern, largely because its high toxicity and widespread use has resulted in significant incidences of poisoning throughout history. (Environment Canada, 1999b). Some organic lead compounds can be transported in the air for considerable distances, before being deposited through precipitation, and are readily absorbed through the skin, and can enter the food chain.

Because of health concerns, lead in gasoline, plumbing, and other household products has been dramatically reduced in recent years, and since the phase out of leaded gas, the metal mining, smelting, and refining industry has become the major source of environmental lead pollution in Canada. Blood lead concentration in humans is the best index of lead exposure and results clearly show that blood lead levels are higher in city dwellers than those in rural areas (WHO, 1977). Current sources of lead include historic lead mines in Placentia Bay (Martin, 1983), some fishing gear, ship repair, and the lead shot used in bird hunting. Approximately two percent of waterfowl in North America are estimated to die each year as a result of lead poisoning, largely from ingesting lead shot, and sinkers (Environment Canada, 1999a).

No fat-soluble lead compounds are common in the marine environment, and except in highly contaminated nearshore areas, lead is considered less problematic in the ocean than in terrestrial and freshwater environments. Lead levels in harbour sediments were monitored in eleven harbours in Placentia Bay between 1976 and 2002, largely in association with harbour dredging programs and the Argentinia Naval base clean up. Six out of the eleven sites showed either a low or moderate level, but contamination is not thought to be severe or extensive, and is unlikely to be a key source of harm to the CP (Fisheries and Oceans Canada, 2005b). **Screened out.**

Sea-level rise:

Seabirds generally nest near the ocean on rocky islands or coastal cliffs that are inaccessible to land predators such as foxes. Many species return to the same sites year after year, and nesting sites for some colonies may be limiting. Sea-level rise, particularly in combination with increased storm events, may reduce available nesting habitat for some species, or increase mortality of chicks. Although the predicted rise of approximately 0.9-8.8cm over the next 10 years may not have a serious affect, sea-level rise may be a significant stressor over the longer term for some colonies. **Screened out.**

Increased storm events:

Seabirds generally nest near the ocean on rocky islands or coastal cliffs that are inaccessible to land predators such as foxes. Many species return to the same sites year after year, and nesting sites for some colonies may be limiting. Increased storm events, particularly in combination with sea-level rise, may reduce available nesting habitat for some species, or increase mortality of chicks. Increased storm events are not expected to cause serious mortality over the next ten years, but may be a significant stressor over the longer term for some colonies. **Screened out.**

Green crab:

The invasive Green crab was discovered in Placentia Bay in 2007 and appears to be spreading rapidly. These small crabs are aggressive and may displace native crabs, and prey on shellfish and small fish, competing with some seabirds for food. Green crabs may also provide a source of food for seabirds, and therefore the overall impact on seabirds is not considered harmful. **Screened out.**

Harmful algal blooms:

Incidents of harmful algal blooms (HABs) are increasing world-wide, and incidents within Placentia Bay have increased correspondingly. Harmful algal blooms of concern in the LOMA include toxic PSP, ASP, DSP, Spirolides, Yessotoxin and Pectenotoxin. PSP (paralytic shellfish poisoning) is among the most toxic HAB, with small quantities leading to rapid paralysis and death. HABs can accumulate in the foodchain leading to mortality of marine organisms at all trophic levels including zooplankton, fish, seabirds and marine mammals (Agriculture and Consumer Affairs, 2004; Sindermann, 2003). Species at the top of the foodchain such as piscivorous fish, sea birds, and marine mammals are also vulnerable, as are baleen whales that consume large quantities of small pelagic fish and invertebrates. **Screened in.**

Disease organisms (bird flu):

Birds are susceptible to various forms of flu, but outbreaks resulting in high mortality in wild birds are extremely rare. Avian influenza viruses are found most commonly in water birds (ducks and geese), shorebirds and gulls, but these natural viruses seem to have little impact on wild birds, and domestic poultry flocks are most at risk. Newfoundland and Labrador birds are monitored for bird flu as part of a national strategy and so far virulent forms have not been found (Dr. Hugh Whitney, Provincial Veterinarian, Government of Newfoundland and Labrador, Animal Health, Brookfield Road, P.O. Box 7400, St. John's, NL, A1E 3Y, pers. comm.). **Screened out.**

Key Activities/Stressors

- Gillnets (bottom)
- Seabird hunt
- Oil pollution
- Litter
- POPs
- HABs

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Seabird aggregation, feeding, nesting, and refuge in Placentia Bay Extension

Gillnet (bottom)

Magnitude of Interaction

Areal extent:

- Seabird colonies are distributed throughout coastal areas of Placentia Bay, and nesting and overwintering seabirds utilized the entire bay for feeding and refuge. The area occupied by the CP is therefore considered to be the entire area of the EBSA, 7398km².
- Gillnet fisheries make up 62% of the total landings within the EBSA. Geo-referenced fishing locations are available for vessels over 35ft (see figure below) with major fisheries in Placentia Bay targeting Greenland halibut, skate, monkfish, and cod.

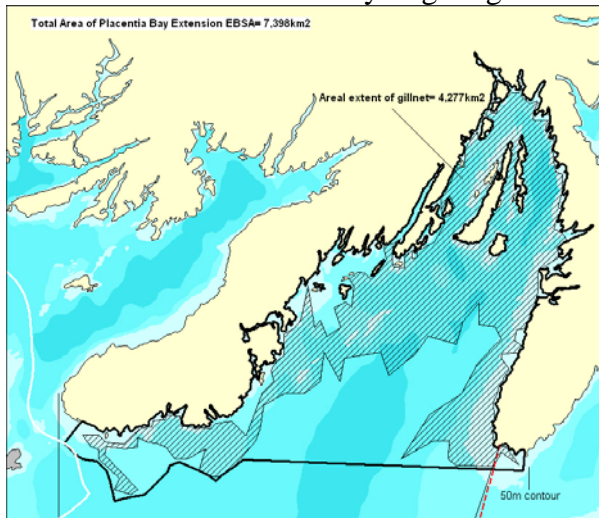


Figure 1. Areal extent of gillnet fisheries (vessels > 35ft) in Placentia Bay Extension EBSA, 1998-2007 (Fisheries and Oceans Canada, 2008).

- Areal extent of gillnet (4,277km²)
- For vessels over 35ft, the estimated area of overlap is $(4,277 \text{ km}^2 / 7398 \text{ km}^2) = 57.8\%$.
- For vessels under 35ft, there is also a significant inshore gillnet fishery, largely targeting cod, lumpfish and winter flounder. The distribution of these fisheries is shown below:



Figure 2. Distribution of Lumpfish, Winter Flounder, and Atlantic Cod Gillnet Fisheries in Placentia Bay from 1984-2000 (Community Resource Services Ltd & Jacques Whitford Environment Ltd, 2001).

- Based on this information we have estimated an area of overlap of 65%.

Score 6.5

Contact:

- The Qualitative Fishing Gear Score (Fisheries and Oceans Canada, 2007) for contact is low (1-25% of the time) between bottom gillnets in 3Ps, and coastal seabirds.
- Fisheries bycatch, largely from gillnets, killed an estimated 22,070 common murrelets annually in eastern Newfoundland in the early 1980s, but the gillnet fishery is now much reduced, and bycatch is less than 10% of those former levels (Wiese, F. K. & Robertson, J., 2004).
- High entanglement rates have been reported for pursuit-diving seabirds, especially murrelets, which make up a substantial portion of the total seabird biomass. Estimates of seabird bycatch are highest in biological “hot spots” where seabird foraging and fishing effort coincide (Davoren, G. K., 2007).
- Based on this information we have selected a high score within the low range.

Score 3.5

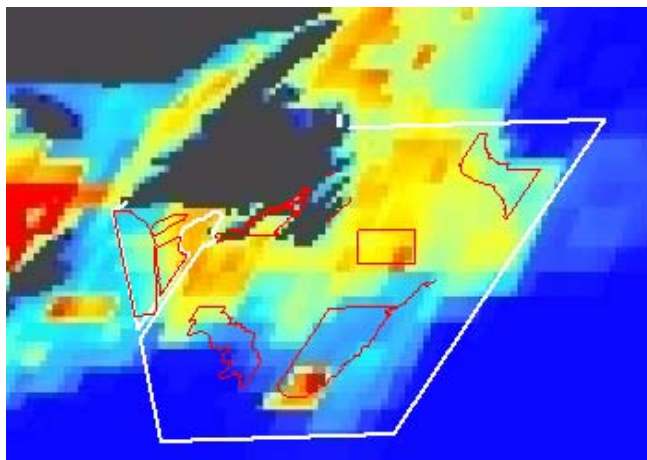
Duration:

- Seabirds utilize Placentia Bay all year long.
- Gillnet fishing occurs from May 1 to Feb 28 (10 months of the year), for an average annual duration of 83% within the area occupied by the CP.

Score 8.3

Intensity:

- Halpern *et al.* (2008) have developed maps showing the global intensity of several anthropogenic stressors including a range of fisheries (Figure 3). These maps can be used to provide guidance in scoring the intensity of a stressor in relation to maximum (100%) intensity in a global context, in accordance with the scale provided below.
- Halpern’s global maps for demersal non-destructive fisheries with high bycatch, which includes gillnets, is shown in the figure below:



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

Figure 3. Global Intensity for demersal non-destructive fisheries with high bycatch, which includes gillnets (Halpern, B. S. et al., 2008).

- This image shows a medium (yellow) intensity for Placentia Bay relative to global levels, for a score range of 40% to 60%.
- Since gillnet fisheries account for 62% of the total landings in the EBSA, and gillnets have historically been the dominant gear used in Placentia Bay, we have selected the highest score in the global range.

Score 6

Magnitude of Interaction (6.5 x 3.5 x 8.3 x 6)/1000 = 1.1

Sensitivity

Sensitivity of the CP to acute impacts:

- The Quantitative Fishing Gear Score (Fisheries and Oceans Canada, 2007) for *harm* is high (75-100% of the time) for bottom gillnets in 3Ps, and coastal seabirds.
- Fisheries bycatch, largely from gillnets, killed an estimated 22,070 common murrelets annually in eastern Newfoundland in the early 1980s, but the gillnet fishery is now much reduced, and bycatch is less than 10% of those former levels (Wiese, F. K. & Robertson, J., 2004).
- High entanglement rates have been reported for pursuit-diving seabirds, especially murrelets, which make up a substantial portion of the total seabird biomass. Estimates of bycatch are highest in biological “hot spots” where seabird foraging and fishing effort coincide, amounting to as much as 1.7% of the breeding population in the EBSA (Davoren, G. K., 2007).
- Studies conducted between 2001 and 2003 found that 2,000-7,000 murrelets and over 2,000 shearwaters were captured in Newfoundland and Labrador gillnet fisheries. Significant numbers of gannets, northern fulmars, cormorants, razorbills, puffins, black guillemots and dovekies were also captured (Benjamins, S., Kulka, D. W., & Lawson, J., 2008).
- Fishing tends to be concentrated in areas of high productivity where seabirds also aggregate.
- Non-diving birds (terns, gulls, petrels) are less susceptible to entanglement in gillnets.
- Heavy ship traffic within the EBSA may increase vulnerability by forcing fleeing birds into nets.
- We have selected a score within the high range.

Score 9

Sensitivity of the CP to chronic impacts:

- The anticipated mortalities from gillnets are substantially less than those resulting from the sustainable hunt, and populations of all diving species are considered stable.
- Fishing peaks in the summer months (LGL Ltd., 2007; NL Refinery Ltd, 2007) during the peak nesting period for seabirds, so loss of dependent young is likely, and mortality of breeding adults is more detrimental to the population than mortality of over-wintering birds, where immature birds make up about 50%.
- Seabirds are typically long-lived, mature late in life, have low fecundity (Benjamins, S., Kulka, D. W., & Lawson, J., 2008), and incidental mortality, particular of breeding adults, can have significant impacts on the population.

- We have therefore selected a score at the high end of the moderate range.

Score 7.5

Sensitivity of ecosystem to harmful impacts to the CP:

- Seabirds are an important component of the marine ecosystem, playing a role as high level predators and also in nutrient cycling.
- Large stocks of capelin that breed in the inshore zone in summer are the principal prey of the large breeding populations gannets, auks (murrelets, Atlantic puffins, dovekies, and guillemots) and kittiwakes (Carscadden, J. E., Montevecchi, W. A., Davoren, G. K., & Nakashima, B. S., 2002; Lock, A. R., Brown, R. G. B., & Gerriets, S. H., 1994). If prey is scarce near the colonies, it will have a direct effect on feeding chicks and, ultimately, on their survival- these birds cannot simply pick up and move (Rose, G. A., 2007).
- The most significant colony is located at the Cape St. Mary's Bird Sanctuary. The reserve is a nesting area for approximately 24,000 Northern gannets, 20,000 black-legged kittiwakes, 20,000 common murrelets, 2,000 thick-billed murrelets, 100 pairs of razor-bills, 60 pairs of black guillemots and some double crested and great cormorants and northern fulmars. Its gannet colony is the biggest in Atlantic Canada and the third biggest in North America. Other breeding colonies with varying numbers of breeding pairs exist throughout the bay (Lock, A. R., Brown, R. G. B., & Gerriets, S. H., 1994).
- Seabirds, by virtue of their position in the food chain, can be used as an indicator of the health of marine ecosystems. Studies of seabirds can provide indications of significant changes in prey availability and ecosystem changes. Information about oceanographic and food web shifts can be gathered from surface-feeding predators like kittiwakes, that are expected to be highly sensitive to variation in sea surface temperature and from generalist and opportunistic avian predators with broad diets, like gannets. There are numerous examples of specialist predators, such as common murrelets, providing information about changes in prey condition that reflect bottom-up effects. These sorts of indications from seabirds can be most informative when they concern forage species that play pivotal energy transfer roles in marine food webs, and that tend to be overexploited and understudied (Montevecchi, W., 2007).
- The social and economic value of seabirds is also significant – bird watching is one of the world's most popular hobbies, and bird watching contributes significantly to ecotourism in the EBSA. The Cape St. Mary's Ecological Reserve hosts thousands of visitors during the peak of the season. Seabird hunting is also an important cultural activity.

Score 8

Sensitivity: $(9 + 7.5 + 8)/3 = 8.2$

Risk of Harm: $1.1 \times 8.2 = 9.0$

Certainty Checklist

Answer yes or no to all of the following questions. Record the number of NO's 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?
- Y Is the current level of understanding based on empirical data rather than models, anecdotal information or probable scenarios?
- N Is the score supported by data which is specific to the region, (EBSA, LOMA, NW Atlantic)?
- N Is the score supported by recent data or research (the last 10 years or less)?
- N Is the score supported by long-term data sets (ten years or more) from multiple surveys (5 years or more)?
- Y 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:

Reference List

1. Benjamins, S., Kulka, D. W., & Lawson, J. (2008). Incidental catch of Seabirds in Newfoundland and Labrador gillnet fisheries, 2001-2003. *Endang. Species Res., preprint*.
2. Carscadden, J. E., Montevecchi, W. A., Davoren, G. K., & Nakashima, B. S. (2002). Trophic relationships among capelin (*Mallotus villosus*) and seabirds in a changing ecosystem. *ICES Journal of Marine Science*, 59, 1027-1033.
3. Community Resource Services Ltd & Jacques Whitford Environment Ltd (2001). *Socio-Economic Overview of Placentia Bay, Newfoundland*.
4. Davoren, G. K. (2007). Effects of Gill-Net Fishing on Marine Birds in a Biological Hotspot in the Northwest Atlantic. *Conservation Biology*, 21, 1032-1045.
5. Fisheries and Oceans Canada (2007). Draft proceedings of the Workshop on Qualitative Risk Assessment of Fishing Gears. In Government of Canada.
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Ref Type: Data File
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9. Lock, A. R., Brown, R. G. B., & Gerriets, S. H. (1994). *Gazetteer of Marine Birds in Atlantic Canada: an atlas of seabird vulnerability to oil pollution*. Atlantic Region: Canadian Wildlife Service, Environment Canada.
10. Montevecchi, W. (2007). Binary dietary responses of northern gannets *Sula bassana* indicate changing food web and oceanographic conditions. *Mar.Ecol.Prog.Ser.*, 352, 220.
11. NL Refinery Ltd (2007). *Environmental Impact Statement - NL Refinery Project* (Rep. No. Volume 4).
12. Rose, G. A. (2007). *Cod: The Ecological History of the North Atlantic Fisheries*. Breakwater Books.

13. Wiese, F. K. & Robertson, J. (2004). Assessing Seabird Mortality from Chronic Oil Discharges at Sea. *Journal of Wildlife Management*, 68, 627-638.

Seabird aggregation, feeding, nesting, and refuge in Placentia Bay Extension

Seabird hunt

Magnitude of Interaction

Areal extent:

- Seabirds are widely distributed within the EBSA throughout the year, with many species nesting during the summer on coastal cliffs and islands throughout the bay as shown on Figure 1 below.

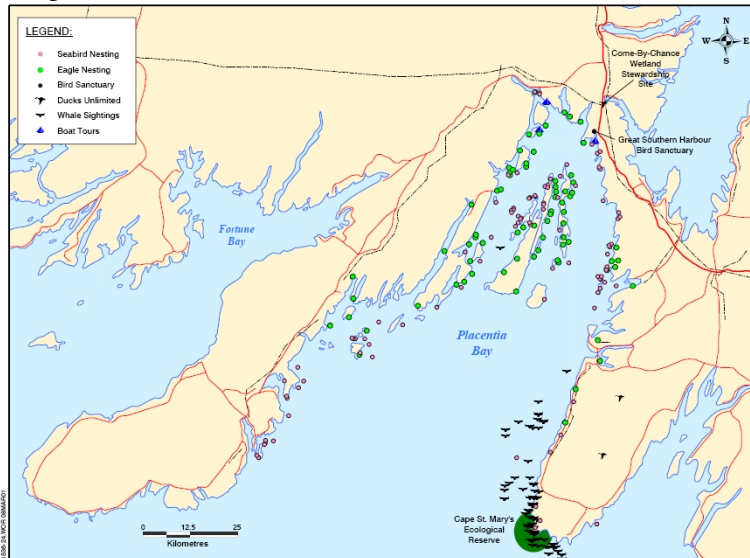


Figure 1. Documented seabird nesting sites (purple dots) in Placentia Bay (Community Resource Services Ltd & Jacques Whitford Environment Ltd, 2001).

- Seabirds are highly mobile and feeding occurs throughout the bay wherever prey is numerous, so the entire EBSA is considered to be the area occupied by the CP.
- The seabird hunt takes place throughout the area occupied by the CP.

Score 10

Contact:

- The hunt is a directed harvest of a component of the CP (Score 100% for the targeted component)
- The targeted species are common and thick-billed murres, although razor-billed murres, dovekies, guillemots and puffins may be taken as bycatch. In Placentia Bay, the harvest consists of up to 30% common murres, and the remainder is mostly thick-billed murres (Greg Robertson, Research Scientist, Canadian Wildlife Service, 6 Bruce Street, Mount Pearl NF A1N 4T3, pers. comm.).
- Although 27 species of seabirds have been observed in Placentia Bay (Mercer, D. & Willcott, T., 2005), the targeted species are among the most common and make up a significant proportion of the CP (Davoren, G. K., 2007; Lock, A. R., Brown, R. G. B., & Gerriets, S. H., 1994; Robertson, G. J., Storey, A. E., & Wilhelm, S. I., 2006a).

- Many common species, including gannets, terns, petrels and gulls are not impacted significantly, although all over-wintering birds within the EBSA are likely to be disturbed by the activity since the hunt is generally conducted by high powered speed boats/shot guns.
- The hunt targets only over-wintering birds -summer nesting colonies are not directly affected.
- We have therefore selected a low score within the high range.

Score 8

Duration:

- Seabirds occupy the EBSA throughout the year although the dominant species may vary with the season and availability of prey.
- The hunting season is Nov 28-March 10 (for Zone 3 which includes Placentia Bay) or 102 days/365days = about 28% of the time occupied by the CP.

Score 2.8

Intensity:

- Newfoundland and Labrador is the only region in Canada where hunting of murre is permitted, and one of the few regions in the world. The north Atlantic population of thick-billed murre is also subjected to extensive summer and winter hunting in Greenland (Robertson, G. J., Storey, A. E., & Wilhelm, S. I., 2006a; Robertson, G. J., Storey, A. E., & Wilhelm, S. I., 2006b; Wiese, F. K. & Robertson, J., 2004).
- The total annual Newfoundland and Labrador harvest is estimated at 250,000 - 300,000 murre, and the Greenland hunt takes an equivalent amount. Together, these two hunts make up 95% of the murre harvested world-wide (Greg Robertson, Research Scientist, Canadian Wildlife Service, 6 Bruce Street, Mount Pearl NF A1N 4T3, pers. comm.).
- On a global level, the intensity of the hunt is clearly among the highest in the world.

Score 10

Magnitude of Interaction: (10 x 8 x 2.8 x 10)/1000 = 2.2

Sensitivity

Sensitivity of the CP to acute impacts:

- The total Newfoundland and Labrador harvest is currently estimated at 250,000 - 300,000 (Chardine, J. W. Colins B. T. Elliot R. D. Levesque H. and Ryan P. C., 1999), and although the harvest in Placentia Bay is unknown, an estimate of 25,000 would be precautionary. There may be an additional mortality of wounded birds which are not retrieved, and all over-wintering birds in the area will be disturbed by the hunting activity. Several species of sea ducks (eiders, oldsquaw, and scooters) are also harvested, but these are not considered under this CP.
- Murre can be legally hunted from a power boats, (Schreiber, E. & Burger, J., 2001), and as a result over-wintering murre are highly vulnerable to the hunt.

- Within the region, thick-billed murres make up 95% of the harvest and common murres 5%, but in Placentia Bay, common murres make up to 30% of the harvest (Greg Robertson, Research Scientist, Canadian Wildlife Service, 6 Bruce Street , Mount Pearl NF A1N 4T3, pers. comm.).
- Other auk species such as razor-billed murres, dovekies, guillemots and puffins may be taken as bycatch. Although 27 species of seabirds have been observed in Placentia Bay (Mercer, D. & Willcott, T., 2005), the targeted species are among the most common and make up a significant proportion of the seabird biomass in the region (Davoren, G. K., 2007; Lock, A. R., Brown, R. G. B., & Gerriets, S. H., 1994; Robertson, G. J., Storey, A. E., & Wilhelm, S. I., 2006a).
- Other components of the CP (gannets, petrels, gulls, etc) which use Placentia Bay in the summertime as nesting, feeding and refuge are not affected.
- Because the target species is harvested in large numbers, and makes up a significant proportion of the seabird aggregations within the EBSA, we have selected a score at the low end of the high range.

Score 8

Sensitivity of the CP to chronic impacts:

- Murres make up a high percentage of over-wintering seabird population and a smaller but significant percentage of nesting seabirds in Placentia Bay.
- Surveys and field studies beginning in the late 1970s estimated that the annual kill in NL to be 600,000 to 900,000 birds. First year birds made up 50% of the harvest, but the percentage of adults increased through the season. This harvest was considered unsustainable and needed to be reduced by 50% to maintain a stable population. As a result, in 1993-94, the Canadian Wildlife Service developed a *Murre Harvest Management Plan*, using a combination of public education, bag limits, and a shorter hunting season (reducing proportion of adult (breeding) birds which resulted in a harvest reduction of 50%) (Chardine, J. W. Colins B. T. Elliot R. D. Levesque H. and Ryan P. C., 1999).
- The thick-billed murre populations are subjected to the Greenland hunt, with an equivalent harvest (Greg Robertson, Research Scientist, Canadian Wildlife Service, 6 Bruce Street , Mount Pearl NF A1N 4T3, pers. comm.).
- Although this is a managed/monitored hunt and is considered to be sustainable, with murre populations said to be stable or increasing, this level of annual mortality clearly affects the population, and although the activity has been significantly reduced since 1993-94 with the development of a Murre Harvest Management Plan, the thick-billed murre population will likely take several decades to return to a pre-hunt population.
- Lead shot is permitted, and injured birds which retain lead shot may suffer from chronic lead poisoning. Approximately two percent of waterfowl in North America are estimated to die each year as a result of lead poisoning, largely from ingesting lead shot, and sinkers (Environment Canada, 1999). The use of lead shot is a particular concern in freshwater environments, and its use is now banned for hunting waterfowl in Canada.
- Since this is a managed hunt which maintains a stable population, targeting mainly immature birds, and a significant component of the CP including nesting colonies, are not impacted, chronic impacts are considered moderate in spite of the high mortality rates.

Score 6

Sensitivity of ecosystem to harmful impacts to the CP:

- Seabirds are an important component of the marine ecosystem, playing a role as high level predators and also in nutrient cycling. The rich, diverse, feeding and breeding grounds of Placentia Bay attract a wide variety of marine birds to the area. The number of cliffs, sea stacks and islands throughout the bay provide appropriate for nesting habitat and the cold Labrador Current that influences the bay supports a rich assortment of prey including plankton, capelin, and other small fish and invertebrates. Observations of seabird species in Placentia Bay have included 27 species, and numerous nesting colonies (Community Resource Services Ltd & Jacques Whitford Environment Ltd, 2001). Large stocks of capelin that breed in the inshore zone in summer are the principal prey of the large breeding populations gannets, auks (murres, Atlantic puffins, dovekies, and guillemots) and kittiwakes (Carscadden, J. E., Montevecchi, W. A., Davoren, G. K., & Nakashima, B. S., 2002; Lock, A. R., Brown, R. G. B., & Gerriets, S. H., 1994). If prey is scarce near the colonies, it will have a direct effect on feeding chicks and, ultimately, on their survival- these birds cannot simply pick up and move (Rose, G. A., 2007).
- The most significant colony is located at the Cape St. Mary's Bird Sanctuary. The reserve is a nesting area for approximately 24,000 Northern gannets, 20,000 black-legged kittiwakes, 20,000 common murres, 2,000 thick-billed murres, 100 pairs of razor-bills, 60 pairs of black guillemots and some double crested and great cormorants and northern fulmars. The gannet colony is the largest in Atlantic Canada and the third largest in North America. Other breeding colonies with varying numbers of breeding pairs exist throughout the bay (Lock, A. R., Brown, R. G. B., & Gerriets, S. H., 1994).
- Seabirds, by virtue of their position in the food chain, can be used as an indicator of the health of marine ecosystems. Studies of seabirds can provide indications of significant changes in prey availability and ecosystem changes. Information about oceanographic and food web shifts can be gathered from surface-feeding predators like kittiwakes, that are expected to be highly sensitive to variation in sea surface temperature and from generalist and opportunistic avian predators with broad diets, like gannets. There are numerous examples of specialist predators, such as common murres, providing information about changes in prey condition that reflect bottom up effects. These sorts of indications from seabirds can be most informative when they concern forage species that play pivotal energy transfer roles in marine food webs and that tend to be overexploited and understudied (Montevecchi, W., 2007).
- The social and economic value of seabirds is also significant – bird watching is one of the world's most popular hobbies, and bird watching contributes significantly to ecotourism in the EBSA. The Cape St. Mary's Ecological Reserve hosts thousands of visitors during the peak of the season. Seabird hunting is also an important cultural activity.

Score 8

Sensitivity: $(8+6 +8) /3 = 7.3$

Risk of Harm: $2.2x 7.3 = 16.1$

Certainty Checklist

Answer yes or no to all of the following questions. Record the number of NO's 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?
- Y 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 years or more) from multiple surveys (5 years or more)?
- Y 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: Medium

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:

Reference List

1. Carscadden, J. E., Montevecchi, W. A., Davoren, G. K., & Nakashima, B. S. (2002). Trophic relationships among capelin (*Mallotus villosus*) and seabirds in a changing ecosystem. *ICES Journal of Marine Science*, 59, 1027-1033.
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4. Davoren, G. K. (2007). Effects of Gill-Net Fishing on Marine Birds in a Biological Hotspot in the Northwest Atlantic. *Conservation Biology*, 21, 1032-1045.
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8. Montevecchi, W. (2007). Binary dietary responses of northern gannets *Sula bassana* indicate changing food web and oceanographic conditions. *Mar.Ecol.Prog.Ser.*, 352, 220.
9. Robertson, G. J., Storey, A. E., & Wilhelm, S. I. (2006b). Local Survival Rates of Common Murres Breeding in Witless Bay, Newfoundland. *Journal of Wildlife Management*, 70, 584-587.
10. Robertson, G. J., Storey, A. E., & Wilhelm, S. I. (2006a). Local Survival Rates of Common Murres Breeding in Witless Bay, Newfoundland. *Journal of Wildlife Management*, 70, 584-587.
11. Rose, G. A. (2007). *Cod: The Ecological History of the North Atlantic Fisheries*. Breakwater Books.
12. Schreiber, E. & Burger, J. (2001). *Biology of Marine Birds*.
13. Wiese, F. K. & Robertson, J. (2004). Assessing Seabird Mortality from Chronic Oil Discharges at Sea. *Journal of Wildlife Management*, 68, 627-638.

Seabird aggregation, feeding, nesting, and refuge in Placentia Bay Extension

Oil pollution

Magnitude of Interaction

Areal extent:

- Seabirds are widely distributed within the EBSA throughout the year, with many species nesting during the summer on coastal cliffs and islands throughout the bay as shown on Figure 1 below.

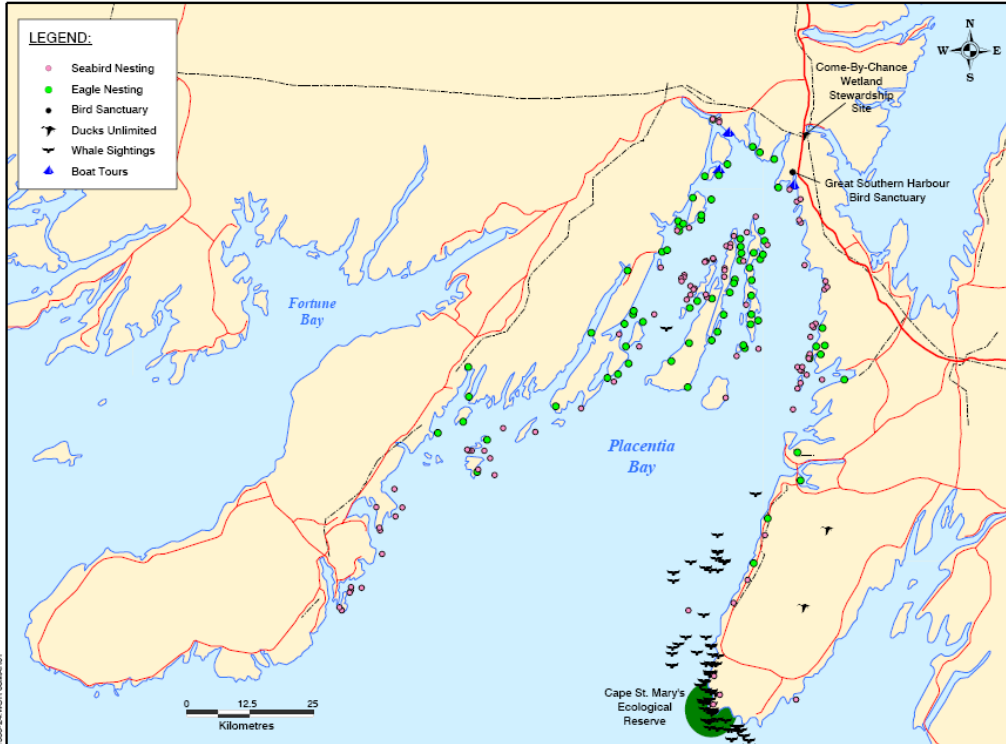


Figure 1. Documented Seabird Nesting Sites (purple dots) in Placentia Bay (Community Resource Services Ltd & Jacques Whitford Environment Ltd, 2001).

- Seabirds are highly mobile and feeding occurs throughout the bay wherever prey is numerous, so the entire EBSA is considered to be the area occupied by the CP.
- Oil pollution is considered a chronic stressor which is not restricted to a specific area, and therefore we have estimated of areal extent (high, medium, low) based on the pollution potential of the area.
- In the early 1990's, the Brander-Smith Final Report, *Public Review Panel on Tanker Safety and Marine Spills Response Capability*, identified Placentia Bay as the marine area with the highest potential for an oil-related environmental accident in Canada (Brander-Smith, D., Therrien, D., & Tobin, S., 1990). Since this time, industrial activity within Placentia Bay has grown significantly and the offshore oil industry has continued to expand.
- Major sources of oil pollution within the EBSA include port activity (oil transshipment, storage, refueling), chronic discharge related to vessel traffic (bilge, ballast, 2-stroke outboard motors) and urban runoff (storm drains, sewers, river

- Based on the pollution potential of the area (high) and existing data, we have estimated the areal extent in the high range.

Score 9

Contact:

- Seabirds spend much of their time on the sea surface, and many species dive through the surface layer to feed. Oil is lighter than water, and hydrophobic, and so tends to form a slick at the sea surface where likelihood of contact with birds is high.
- Seabirds also rest on the sea surface and are attracted to oil slicks, which give the appearance of quiet areas of water.
- Based on this we have selected a score of 100%.

Score 10

Duration:

- Major sources of oil pollution within the EBSA include port activity (oil transshipment, storage, refueling), chronic discharge related to vessel traffic (bilge, ballast, 2-stroke outboard motors) and urban runoff (storm drains, sewers, river runoff).
- Oil pollution is considered a chronic stressor that occurs every year, but intermittently, and therefore we have selected a score in the medium range which reflects its persistence in the environment and the frequency of the associated activities.
- We have selected a score towards the high end of the medium range, since oil is moderately persistent in coastal areas such as the EBSA, and the frequency of activities such as shipping, refueling and oil transshipments, which are associated with oil pollution are high.

Score 7.5

Intensity:

- Halpern *et al.* (2008) has developed a map showing the global intensity of marine pollution based on the relative density of major pollution sources including shipping, and port activity/population density (Figure 2) (Halpern, B. S. et al., 2008).

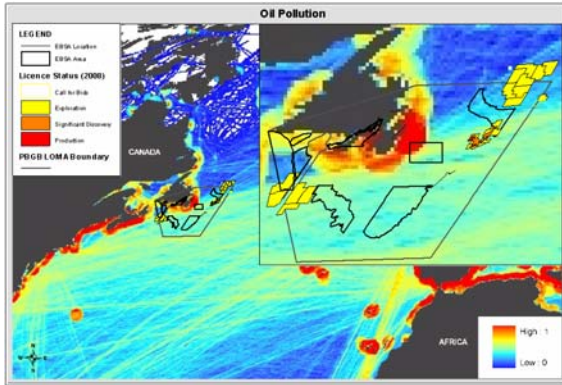


Figure 2. Sources of oil pollution within the PBGB LOMA (adapted from Halpern, B. S. et al., 2008).

- Based on this map, on a global scale, the EBSA is located in a high risk area in relation to oil pollution (80-100%), and this is confirmed by local data.

Score 9

Magnitude of Interaction $(9 \times 10 \times 7.5 \times 9)/1000 = 6.1$

Sensitivity

Sensitivity of the CP to acute impacts:

- Seabirds are highly sensitive to direct contact with oil. Most birds that come in contact with oil subsequently die since the presence of oil on a bird's feathers can destroy their waterproofing, insulating, and buoyancy capability, leading to hypothermia or drowning. Those that do not die from hypothermia or drowning may die from ingestion of significant quantities of oil during preening (Templeman, N. D. & Davis, M. B., 2006). Even a small amount of oil, a spot no bigger than a quarter, may be enough to kill a seabird.
- When oil pollution occurs in areas where large numbers of seabirds aggregate, mass mortalities can result. It is estimated that 300,000 seabirds are killed by chronic oil pollution in the NW Atlantic (Wiese, F. K. & Ryan, P. C., 2003).
- The illegal release of oil into the marine environment from vessel engine room spaces is thought to be responsible for over 90% of deaths due to oil pollution in seabirds. Chronic ship-source oil pollution is estimated to have killed an average of 300,000 seabirds between 1998 and 2000. Thick-billed murres that overwinter on the Grand Banks made up 67% of this kill (Wiese, F. K. & Robertson, J., 2004).
- A large oil spill in Placentia Bay during the breeding period could result in mass mortalities of seabirds.

Score 10

Sensitivity of the CP to chronic impacts:

- Chronic impacts include toxicity, and population level effects due to mass mortalities.
- A bird's immediate response to oiling is to preen itself to try to restore the feathers' waterproofing. If the weather is warm, and the bird is not heavily oiled it may

- Pelagic birds such as auks, gannets and fulmars, which spend most of their time on the water and dive in pursuit of prey, are most vulnerable to oil pollution (Lock, A. R., Brown, R. G. B., & Gerriets, S. H., 1994).
- Pelagic birds take the longest time to reach maturity, as breeding may not begin until at least four years of age (Wiese, F., 2002; World Wildlife Fund, 2002). They also have the smallest clutch size, usually only one egg per year (Fisheries and Oceans Canada, 2007). Consequently, seabirds do not have the reproductive capacity to rapidly recover from population reductions (Barrett R.T., Lorentsen S-H. & Anker-Nilssen T., 2006; Lock, A. R., Brown, R. G. B., & Gerriets, S. H., 1994).
- The breeding distribution of pelagic birds increases their vulnerability to oil because they breed at relatively few, large colonies (Wiese, F., 2002). Nesting seabirds tend to be concentrated in a relatively small area, often with a large percentage of the breeding population of a species in one colony, and they are therefore more vulnerable to population level impacts from a significant oil spill.
- Seabirds are highly mobile, and nesting colonies on the Avalon Peninsula and adjacent areas including Placentia Bay, support the abundance and diversity of seabirds on the Grand Banks (Templeman, N. D. & Davis, M. B., 2006). Mass mortalities in Placentia Bay would have widespread impacts.
- Based on this information, we have selected a score of 8.

Score 8

Sensitivity of ecosystem to harmful impacts to the CP:

- Seabirds are an important component of the marine ecosystem, playing a role as high level predators and also in nutrient cycling. The rich, diverse, feeding and breeding grounds of Placentia Bay attract a wide variety of marine birds to the area. The number of cliffs, sea stacks and islands throughout the bay provide appropriate nesting habitat and the cold Labrador Current that influences the bay supports a rich assortment of prey including plankton, capelin, and other small fish and invertebrates. Observations of seabird species in Placentia Bay have included 27 species (ORCA Inc., 2005), and numerous nesting colonies (Community Resource Services Ltd & Jacques Whitford Environment Ltd, 2001). Large stocks of capelin that breed in the inshore zone in summer are the principal prey of the large breeding populations gannets, auks (murre, Atlantic puffins, dovekies, and guillemots) and kittiwakes (Carscadden, J. E., Montevecchi, W. A., Davoren, G. K., & Nakashima, B. S., 2002; Lock, A. R., Brown, R. G. B., & Gerriets, S. H., 1994). If prey is scarce near the colonies, it will have a direct effect on feeding chicks and, ultimately, on their survival- these birds cannot simply pick up and move (Rose, G. A., 2007).
- The most significant colony is located at the Cape St. Mary's Bird Sanctuary. The reserve is a nesting area for approximately 24,000 Northern gannets, 20,000 black-legged kittiwakes, 20,000 common murre, 2,000 thick-billed murre, 100 pairs of razor-bills, 60 pairs of black guillemots and some double crested and great

- Seabirds, by virtue of their position in the food chain, can be used as an indicator of the health of marine ecosystems. Studies of seabirds can provide indications of significant changes in prey availability and ecosystem changes. Information about oceanographic and food web shifts can be gathered from surface-feeding predators like kittiwakes, which are expected to be highly sensitive to variation in sea surface temperature and from generalist and opportunistic avian predators with broad diets, like gannets. There are numerous examples of specialist predators, such as common murre, providing information about changes in prey condition that reflect bottom up effects. These sorts of indications from seabirds can be most informative when they concern forage species that play pivotal energy transfer roles in marine food webs and that tend to be overexploited and understudied (Montevecchi, W., 2007).
- The social and economic value of seabirds is also significant – bird watching is one of the world’s most popular hobbies, and bird watching contributes significantly to ecotourism in the EBSA. The Cape St. Mary’s Ecological Reserve hosts thousands of visitors during the peak of the season. Seabird hunting is also an important cultural activity.

Score 8

Sensitivity: $(10 + 8 + 8)/3 = 8.7$

Risk of Harm: $6.1 \times 8.7 = 53$

Certainty Checklist

Answer yes or no to all of the following questions. Record the number of NO's 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?
- Y Is the interaction well understood, without major information gaps/sources of error?
- Y 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)?
- N Is the score supported by recent data or research (the last 10 years or less)?
- N Is the score supported by long-term data sets (ten years or more) from multiple surveys (5 years or more)?
- Y 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: Medium

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:

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Seabird aggregation, feeding, nesting, and refuge in Placentia Bay Extension

Litter

Magnitude of Interaction

Areal extent:

- Seabirds are widely distributed within the EBSA throughout the year, with many species nesting during the summer on coastal cliffs and islands throughout the bay as shown on Figure 1 below.

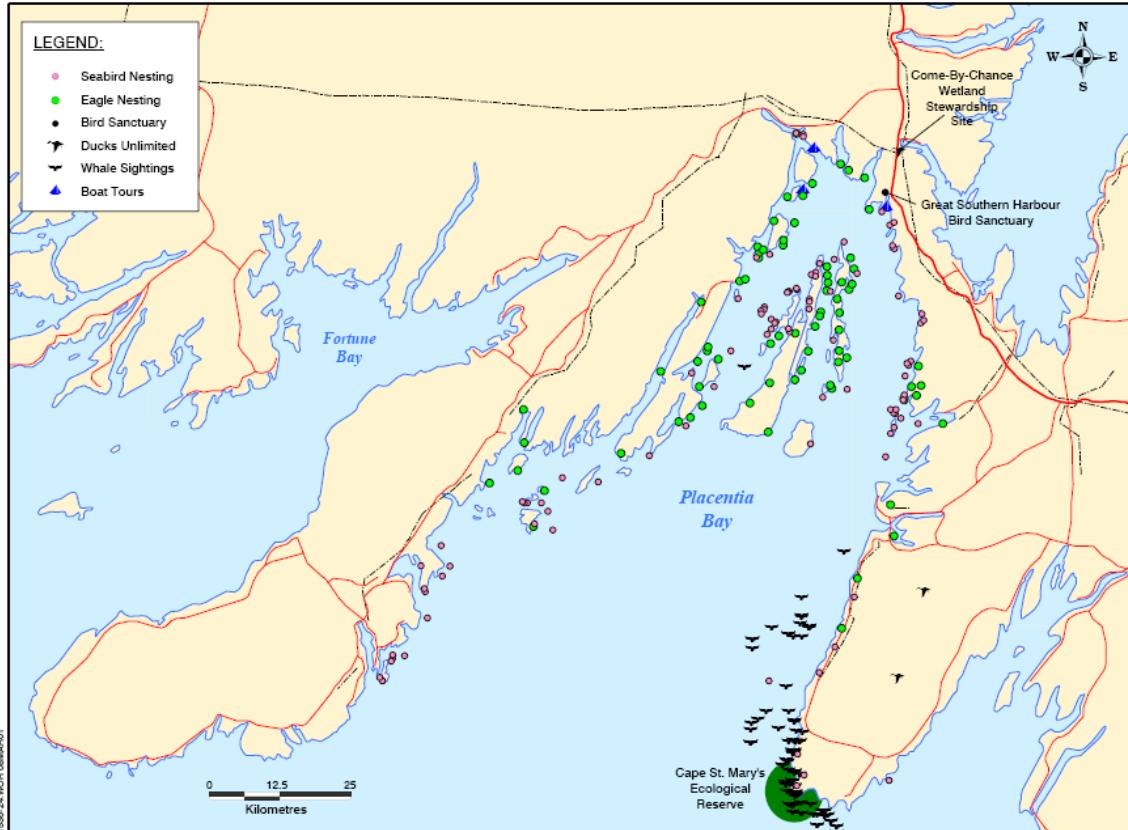


Figure 1. Documented seabird nesting sites (purple dots) in Placentia Bay (Community Resource Services Ltd & Jacques Whitford Environment Ltd, 2001).

- Seabirds are highly mobile and feeding occurs throughout the bay wherever prey is numerous, so the entire EBSA is considered to be the area occupied by the CP.
- It is estimated that 6.4 million tonnes of garbage go into the world's oceans every year (Keep Sweden Tidy Foundation, 2003). In coastal areas, up to 80% of marine debris comes from the land, blowing and washing off beaches and carried to the sea by rivers, sewage systems, and storm drains. The remaining 20% is lost or discarded from boats and ships of all types and sizes (Federal-Provincial-Territorial Committee on NPA, 2000).
- Marine litter within Placentia Bay comes from many sources, including vessels, surface currents, and land-based sources which can be related to population density. Average annual marine traffic density in the EBSA is considered high (Pelot & Wootton, 2004).

- Beach surveys conducted in 2004 in Placentia Bay revealed large accumulations of plastic debris on southwest facing beaches of the bay where they are deposited by prevailing southwest winds and counterclockwise currents (Fisheries and Oceans Canada, 2005).
- Biologists at the Cape St. Mary's Ecological Reserve report that the use of plastic debris as nesting material has increased in gannet nests in recent years (Tony Power, Manager of Cape St. Mary's Ecological Reserve, Parks & Natural Areas Division, Department of Environment and Conservation, Government of Newfoundland and Labrador, 33 Reid's Lane, Deer Lake, NL, A8A 2A3, pers. comm.).
- Based on the pollution potential of the area (moderate to high) and existing data for the area which indicates a moderate to high level of pollution, we have estimated the areal extent at the low end of the high range.

Score 8

Contact:

- Plastic particles and scraps of ropes, netting, six pack rings and related materials persist in the marine environment, and float in surface waters. Floating plastic debris has a high degree of contact with seabirds which spend much of their time on the sea surface, both feeding and resting.
- Marine debris also accumulates on shorelines and beaches where seabirds collect nesting material, and species such as gulls spend considerable time feeding on spawning capelin or scavenging organic debris which accumulates in areas where plastic debris also collects.
- Numerous studies worldwide show that marine debris affects a high percentage of seabird species (Derraik, 2002; The Marine Debris Team, 2005).
- Based on this information, seabird contact with marine litter is considered to be high.

Score 9

Duration:

- Seabirds are present in the EBSA throughout the year, although dominant species may vary with the season.
- Litter is considered a chronic stressor which occurs every year, and so is given a score in the medium range. Since marine litter is persistent, consisting largely of plastic debris, and sources of litter (land-based activities, fishing boats, ships and winds/currents) are present throughout the year, we have selected a score at the top of the medium range.

Score 7

Intensity:

- Halpern *et al.* (2008) have developed maps showing the global intensity of several anthropogenic stressors including ocean pollution (Figure 2). 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.

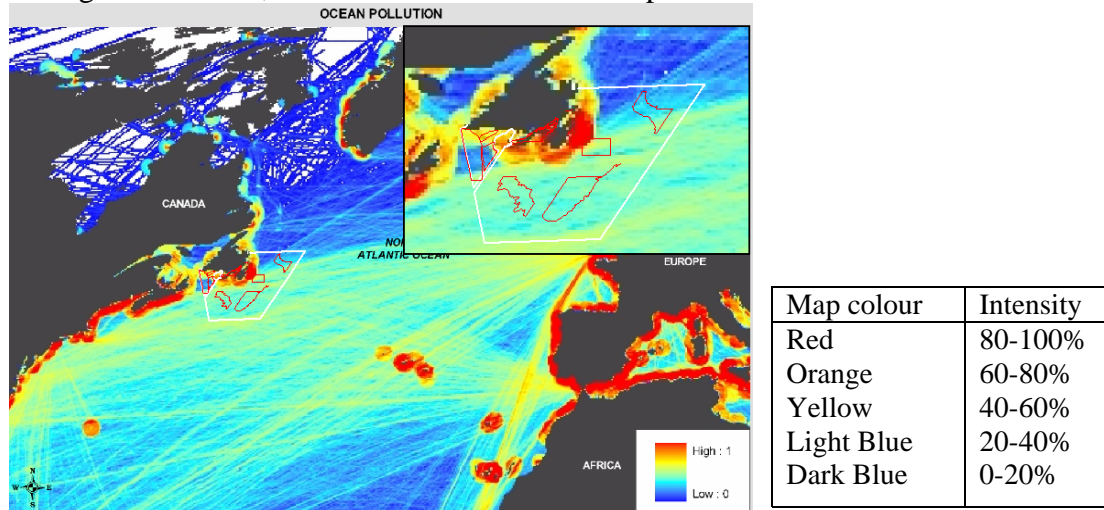


Figure 2. Global Intensity of Ocean Pollution (adapted from (Halpern *et al.*, 2008))

- (Halpern *et al.*, 2008) shows a high (red) intensity relative to global levels for a score range of 80% to 100%.
- We have selected the median score within the range.

Score 9

Magnitude of Interaction: $8 \times 9 \times 7 \times 9/1000 = 4.5$

Sensitivity:

Sensitivity of the CP to acute impacts:

- Major impacts on seabirds from marine litter relate to ingestion and entanglement (Derraik, 2002).
- Plastics contribute disproportionately to the overall impact of marine litter for a number of reasons (Algalita Marine Research Foundation, 2002; Mato *et al.*, 2001; Moore *et al.*, 2001). The use of plastic has grown rapidly over the last 50 years and it is now the world's most used material, but the very qualities that make plastic popular (cheap, light, waterproof, durable) are the same qualities that cause problems for marine ecosystems (Derraik, 2002).
- In 2003, in a study of the ecology of Northern Fulmars at Cape Vera, one of the most remote colonial seabird nesting sites in the High Arctic, determined that about 30% of the birds at the colony have plastic garbage in their digestive systems, something never observed in studies in the 1970s (Environment Canada, 2009).
- Plastic cannot be digested, or used as a source of food by any living creature, but unfortunately, many animals mistake plastic for food. Scientists have documented the consumption of plastic by 177 marine species, including 111 seabird species (The Marine

Debris Team, 2005). Surface feeding seabirds such as petrels, fulmars and shearwaters are most vulnerable to ingestion of floating plastic, as they tend to feed at the sea surface and often mistake floating plastic for food items. Diving birds such as murre and gannets may be slightly less vulnerable, but may also ingest litter accidentally or through the food chain as they feed on fish that have ingested litter. Ingested plastic can clog the digestive tract leading to rapid death.

- Breeding birds can regurgitate plastic accumulated in their digestive tracts as they feed their nestlings, transferring the problem to the most vulnerable life stages (Algalita Marine Research Foundation, 2002; Derraik, 2002).
- Other harmful effects from ingested plastic include blockage of gastric enzyme secretion, diminished feeding stimulus, lowered steroid hormone levels, delayed ovulation and reproductive failure, internal injury and death following blockage of the intestinal tract (Derraik, 2002).
- Entanglement can also be a serious problem, particularly in relation to fishing debris such as rope, netting and monofilament line. Entanglement generally results in acute mortality. Use of marine litter, particularly rope and fishing line, as nesting materials can lead to entanglement of the adults or the chicks. Biologists at the Cape St. Mary's Ecological Reserve report that the use of plastic debris as nesting material has increased in gannet nests in recent years (pers.com.Tony Power, 2009).
- Some species of seabirds are highly vulnerable to marine litter, while other species are less vulnerable. Acute mortality is considered significant, but low to moderate in severity. We have therefore selected a score of 3.5

Score 3.5

Sensitivity of the CP to chronic impacts:

- Ingested plastic has a significant chronic impact on seabirds. Pieces of plastic are often retained in the digestive tract for years, reducing appetite and feeding capacity (The Marine Debris Team, 2005). Reduced food consumption in turn limits the bird's ability to lay down fat deposits, thus reducing fitness (Derraik, 2002). Foamed plastics such as styrofoam are extremely buoyant, and when ingested, may affect the bird's buoyancy, making it difficult to dive.
- Plastic debris can also be a source of PCBs and other contaminants. Contaminant such as styrene can leach from the plastic itself, and plastic can also act as a carrier for hydrophobic contaminants (Derraik, 2002; Mato et al., 2001).
- Entanglement in plastic debris, especially fishing-related debris is also a serious problem for seabirds and other marine animals, and can result in injury from abrasive or cutting action of attached debris, reduced fitness and increased energetic costs (Derraik, 2002).
- Since the use of plastics continues to increase, so does the amount of plastics polluting the marine environment. Numerous studies show that the ingestion of plastics by seabirds has significantly increased in recent years (Derraik, 2002).
- Most seabirds are relatively long-lived with a high age of maturity. As a result, adult birds can regurgitate plastic accumulated in their digestive tracts as they feed their nestlings, and so for species which produce only one chick/year, a single chick can receive the entire year's accumulation from two parents. Depending on the species, age of maturity may range from 3 to 6 years, and therefore the first brood may receive 3-6

- The population sizes of all seabird species remained stable or increased in recent years, with the exception of gulls. Increasing populations of seabirds are related in part to their lessened mortality from gillnets since the closures of the eastern Canadian cod fishery in 1992, whereas declining populations of gulls can be related to reduced food availability from fishery discards and offal. This food limitation has led gulls to switch much of their foraging effort from scavenging to predation on seabird adults and chicks before capelin arrive inshore (Carscadden et al., 2002). Black-legged kittiwakes suffered breeding failure during the early 1990s owing to a suite of factors, including their inability to dive to capture capelin, the late arrival of capelin inshore and predation by gulls, but numbers of breeders were not affected (Chardine et al., 1999) (Carscadden et al., 2002). Auks and gannets did not suffer breeding failures because they could dive and catch capelin and other small fish at depth (Carscadden et al., 2002).
- Current mortality rates related to marine litter are thought to be low relative to other sources of mortality and may have minimal effect on the population, but this is a chronic and growing problem which adds to the cumulative impacts on the CP, and reduces reproductive success and survival rates, and therefore the chronic sensitivity is considered to be moderate.

Score 5

Sensitivity of ecosystem to harmful impacts to the CP:

- Seabirds are an important component of the marine ecosystem, playing a role as high level predators and also in nutrient cycling. The rich, diverse, feeding and breeding grounds of Placentia Bay attract a wide variety of marine birds to the area. The number of cliffs, sea stacks and islands throughout the bay provide appropriate nesting habitat and the cold Labrador Current that influences the bay supports a rich assortment of prey including plankton, capelin, and other small fish and invertebrates. Observations of seabird species in Placentia Bay have included 27 species (ORCA Inc., 2005), and numerous nesting colonies (Community Resource Services Ltd & Jacques Whitford Environment Ltd, 2001). Large stocks of capelin that breed in the inshore zone in summer are the principal prey of the large breeding populations gannets, auks (murres, Atlantic puffins, dovekies, and guillemots) and kittiwakes (Carscadden et al., 2002; Lock et al., 1994). If prey is scarce near the colonies, it will have a direct effect on feeding chicks and, ultimately, on their survival; these birds cannot simply pick up and move (Rose, 2007).
- The most significant colony is located at the Cape St. Mary's Bird Sanctuary. The reserve is a nesting area for approximately 24,000 Northern gannets, 20,000 black-legged kittiwakes, 20,000 common murres, 2,000 thick-billed murres, 100 pairs of razor-bills, 60 pairs of black guillemots and some double crested and great cormorants and northern fulmars. Its gannet colony is the biggest in Atlantic Canada and the third biggest in North America. Other breeding colonies with varying numbers of breeding pairs exist throughout the bay (Lock et al., 1994).

- Seabirds, by virtue of their position in the food chain, can be used as an indicator of the health of marine ecosystems. Studies of seabirds can provide indications of significant changes in prey availability and ecosystem changes. Information about oceanographic and food web shifts can be gathered from surface-feeding predators like kittiwakes, that are expected to be highly sensitive to variation in sea surface temperature and from generalist and opportunistic avian predators with broad diets, like gannets. There are numerous examples of specialist predators, such as common murre, providing information about changes in prey condition that reflect bottom up effects. These sorts of indications from seabirds can be most informative when they concern forage species that play pivotal energy transfer roles in marine food webs and that tend to be overexploited and understudied (Montevecchi, 2007).
- The social and economic value of seabirds is also significant – bird watching is one of the world’s most popular hobbies, and bird watching contributes significantly to ecotourism in the EBSA. The Cape St. Mary’s Ecological Reserve hosts thousands of visitors during the peak of the season. Seabird hunting is also an important cultural activity.

Score 8

Sensitivity: $(3.5 + 5 + 8)/3 = 5.5$

Risk of Harm: $4.5 \times 5.5 = 24.8$

Certainty Checklist

Answer yes or no to all of the following questions. Record the number of NO's 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?
- Y Is the current level of understanding based on empirical data rather than models, anecdotal information or probable scenarios?
- N 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)?
- N Is the score supported by long-term data sets (ten years or more) from multiple surveys (5 years or more)?
- Y 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:

Seabird colonies can be used as an indicator of marine litter and other ecosystem stressors. Nesting area for a variety of species such as storm petrels, gulls and gannets should be monitored and dead chicks surveyed for accumulated plastic litter in their digestive systems.

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Seabird aggregation, feeding, nesting, and refuge in Placentia Bay Extension

Persistent organic pollutants (POPs)

Background Information

Persistent organic pollutants (POPs) are a large group of organic chemicals, mostly compounds containing chlorine, that are both toxic and slow to break down. POPs are typically insoluble in water and so tend to accumulate in marine sediments or animal fat. As they are slow to break down, and difficult to excrete, concentrations can magnify as they are passed up the foodchain, reaching highest levels in long-lived predators at the top of the foodchain such as marine mammals, polar bears, eagles, large fish and humans. Many of these compounds are highly volatile, and so atmospheric transport from distant sources is a major contributor. On entering the environment, POPs can cause harmful alterations in the physiological functions of plants and animals including deformities, tumours, birth defects, and death. POPs of greatest concern include organochlorine pesticides such as DDT, mirex, chlordane, endrin, methoxychlor and toxaphene, industrial chemicals such as polychlorinated biphenyls (PCBs), polybrominated diphenyl ethers (PBDEs) and hexachlorobenzene (HCB), and products of combustion such as dioxins and furans.

Polychlorinated Biphenyls (PCBs) are synthetic chlorinated compounds that are almost insoluble in water and tend to sink to the bottom sediments, as they are denser than water. PCBs are extremely stable, meaning that they are highly resistant to chemical attack or degradation by natural processes in the environment. PCBs were first produced in 1881 and first manufactured on a large scale in 1929 to meet a variety of industrial and chemical uses. The major use of the chemical has been as a coolant and insulator for electric capacitors and transformers. On a smaller scale, PCBs have also been used as hydraulic and heat transfer fluids and in some electrical appliances. Previous to the 1970's, PCBs were also used as a surface coating for carbonless copy paper, washable wall coverings, upholstery fabrics, plasticizers in sealants, caulking, synthetic resins, rubbers, paint pigments, waxes and asphalts, and as flame retardants in lubricating oils. However, in the 1970s, concern rose over the environmental impact of PCBs as a result of their persistence and volatility, which has greatly contributed to their widespread presence in the environment. Bioaccumulation of PCBs is a well-documented phenomenon (Kelly, B. C., Ikonomou, M. G., Blair, J. D., Morin, A. E., & Gobas, F. A, 2007). Once in the environment, PCBs can be accumulated by various life forms and the contamination magnifies while passing up the food chain. This led to their gradual replacement, and eventually resulted in a North American ban in 1977, on the manufacture, importation, and most non-electrical applications of PCBs. Electrical applications of PCBs are still in use but are now being phased out, and stringent requirements for handling, storage and disposal have been specified.

Magnitude of Interaction

Areal extent:

- Seabirds are widely distributed within the EBSA throughout the year, with many species nesting during the summer on coastal cliffs and islands throughout the bay as shown on Figure 1 below.

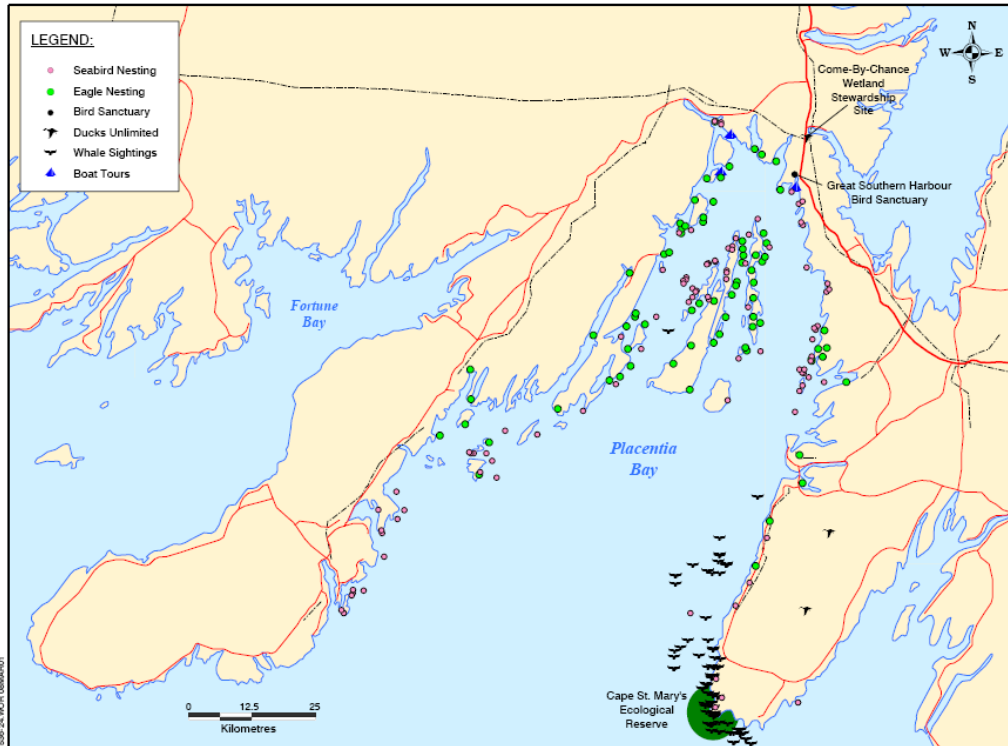


Figure 1. Documented seabird nesting sites (purple dots) in Placentia Bay (Community Resource Services Ltd & Jacques Whitford Environment Ltd, 2001)

- Seabirds are highly mobile and feeding occurs throughout the bay wherever prey is numerous, so the entire EBSA is considered to be the area occupied by the CP.
- Persistent organic pollutants are a large complex group of organic chemicals, mostly compounds containing chlorine, that are both toxic and slow to break down and difficult (and expensive) to monitor.
- Major sources of contamination in Placentia Bay may include the former US Naval Base at Argentia, past and present industrial activity including shipping, and long range transport from industrial areas of Canada, the US and beyond. Once these chemicals enter the environment they are persistent and bioaccumulate in the foodchain.
- POPs are considered a chronic stressor and areal extent is therefore estimated based on the pollution potential of the area and local data.
- Although Placentia Bay is one of the most industrialized areas of the LOMA, the bay is well flushed and by global standards is quite clean. Researchers have found that contaminant levels are generally low, but moderate levels of some POPs have been detected in seabirds, harbour seals, and fish (Pierce, R. C., Whittle, D. M., & Bramwell, J. B. ed., 1998; Musial, C. J. & Uthe, J. F., 1983; Elliot, J. E. et al., 1992; Khan, R. A., 2003; Sjare, B., Lebeof, M., & Veinott, G., 2005) in Placentia Bay specifically and throughout the region.
- Based on the pollution potential of the area (moderate) and existing data for the area, we have estimated the areal extent in the moderate range.

Score 6

Contact:

- Once in the environment, POPs accumulate in the foodchain or in sediments, and contact with long-lived piscivorous (fish eating) species such as gannets, auks (murre, Atlantic puffins, dovebies, and guillemots) fulmars and kittiwakes is high as a result. Other components of the CP include various species of gulls, and storm petrels. Petrels feed on plankton and are relatively low on the trophic scale, while gulls are largely scavengers and consume a range of available food, including fish waste from the fishing and fish processing industries. Gulls also feed on capelin, particularly during beach spawning, and any other organic material available on beaches, at landfill sites, sewage outfalls, etc. They are also common predators of smaller seabird adults and chicks before capelin arrive inshore (Carscadden, J. E., Montevecchi, W. A., Davoren, G. K., & Nakashima, B. S., 2002).
- Since a high proportion of the CP feeds at a high trophic level, we have selected a score at the low end of the high range.

Score 8

Duration:

- Seabirds are present in the EBSA throughout the year, although dominant species may vary with the season.
- POPs are considered a chronic stressor which is present throughout the year, and so is given a score in the medium range. Since POPs are persistent, and bioaccumulate in the foodchain, we have selected a score at the top of the medium range.

Score 7

Intensity:

- Halpern *et al.* (2008) have developed maps showing the global intensity of several anthropogenic stressors including ocean pollution (Figure 2).

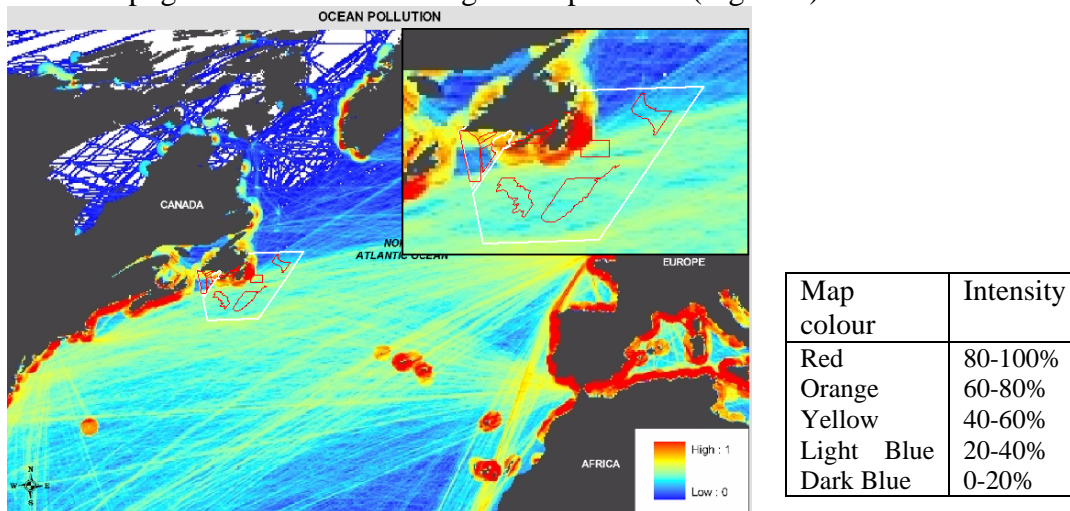


Figure 2. Global intensity of ocean pollution (adapted from (Halpern, B. S. et al., 2008)).

- This map can be used to provide guidance in scoring the intensity of a stressor in relation to maximum (100%) intensity in a global context, in accordance with the scale in Figure 2.
- Figure 2 shows a high (red) intensity relative to global levels for a score range of 80% to 100%.
- We have selected the low score within the high range since the available local data shows moderate levels of POPs in Placentia Bay.

Score 8

Magnitude of Interaction: $(6 \times 8 \times 7 \times 8)/1000 = 2.7$

Sensitivity

Sensitivity of the CP to acute impacts:

- Persistent organic pollutants (POPs) are a large group of organic chemicals, and their acute and chronic impacts vary widely depending on the species and the concentration of the contaminant, but generally the chronic impacts are of greatest concern, since chemicals that have shown high acute toxicity to vertebrates were generally not approved for widespread usage.
- Over the past 20 years PCBs have increasingly polluted marine food webs, and are prevalent in seabirds (Derraik, J. G. B., 2002). PCBs lead to reproductive disorders or death, they increase risk of diseases and alter hormone levels.
- Levels of other organochlorine pesticides are generally reported to be low in Newfoundland and Labrador waters (Pierce, R. C., Whittle, D. M., & Bramwell, J. B. ed., 1998) with the exception of toxaphene, which was found to be widely distributed in Canadian east coast fish (Musial, C. J. & Uthe, J. F., 1983). Similarly, high levels of toxaphene have been reported in petrel eggs from Newfoundland (Elliot, J. E. et al., 1992).
- Although Placentia Bay is one of the most industrialized areas of the LOMA, the bay is well flushed and by global standards, is quite clean. Harbour seals are also long-lived and feed on fish and the bioaccumulation of POPs can be a significant problem. Sjare *et al.* (2005) found that Newfoundland and Labrador harbour seals were less contaminated with POPs than seals in the St. Lawrence Estuary, but similar to those from the southern Gulf of St. Lawrence. It is likely that the same trend exists for seabirds in the area. Mirex and PCB concentrations were 5-10 times less than levels found in St. Lawrence Estuary population, while DDTs and Chlordanes were 2-5 times less in NL seals (Sjare, B., Lebeof, M., & Veinott, G., 2005).
- Contaminant levels are still considered significant, but since there is no comprehensive regional monitoring program for POPs, the extent of the problem in seabirds is difficult to estimate, and there is no indication that acute mortality is significant, particularly in comparison to other major sources of mortality such as the sea bird hunt, oil pollution and fishing gear.

Score 1

Sensitivity of the CP to chronic impacts:

- Though the adverse affects of POPs may not always be apparent, chronic effects may be significant as they bioaccumulate in the food chain, and can have a detrimental effect even at very low levels (Derraik, J. G. B., 2002). Top level predators such as fish-eating seabirds are at greatest risk.
- Chronic impacts documented in fish-eating birds include eggshell thinning, depressed thyroid and immune functions, increased risk of disease, altered hormone levels, developmental or behavioural changes, reproductive failure and embryo deformities and mortality (Derraik, J. G. B., 2002; Environment Canada, 2001).
- Adult seabirds can pass on accumulated contaminants to their young. Since most sea birds are relatively long-lived with a high age of maturity, and many species have only one chick per year, significant concentrations of contaminants can be passed from one generation to the next. North American populations of many piscivorous seabirds dwindled to dangerously low numbers due to the impacts of DDT in the 1970s, largely as a result of reproductive failure due to eggshell thinning (Holm, L et al., 2007).
- The population sizes of all seabird species in Newfoundland remained stable or increased in recent years, with the exception of gulls, which declined. These changes related largely to changes in the fishery (Chardine, J. W., Diamond, A. W., Elliot, R. D., & Lock, A. R., 1999).
- Although there is little information available on the chronic impacts of POPs on seabirds in Placentia Bay, since populations appear to be stable, chronic impacts are considered to be low relative to other major sources of mortality, but are of greater concern then acute impacts.

Score 3

Sensitivity of ecosystem to harmful impacts to the CP:

- Seabirds are an important component of the marine ecosystem, playing a role as high level predators and also in nutrient cycling. The rich, diverse, feeding and breeding grounds of Placentia Bay attract a wide variety of marine birds to the area. The number of cliffs, sea stacks and islands throughout the bay provide appropriate nesting habitat and the cold Labrador Current that influences the bay supports a rich assortment of prey including plankton, capelin, and other small fish and invertebrates. Observations of seabird species in Placentia Bay have included 27 species (ORCA Inc., 2005), and numerous nesting colonies (Community Resource Services Ltd & Jacques Whitford Environment Ltd, 2001). Large stocks of capelin that breed in the inshore zone in summer are the principal prey of the large breeding populations gannets, auks (murre, Atlantic puffins, dovekies, and guillemots) and kittiwakes (Carscadden, J. E., Montevecchi, W. A., Davoren, G. K., & Nakashima, B. S., 2002; Lock, A. R., Brown, R. G. B., & Gerriets, S. H., 1994). If prey is scarce near the colonies, it will have a direct effect on feeding chicks and, ultimately, on their survival- these birds cannot simply pick up and move (Rose, G. A., 2007).
- The most significant colony is located at the Cape St. Mary's Bird Sanctuary. The reserve is a nesting area for approximately 24,000 Northern gannets, 20,000 black-legged kittiwakes, 20,000 common murre, 2,000 thick-billed murre, 100 pairs of razor-bills, 60 pairs of black guillemots and some double crested and great cormorants and northern

- Seabirds, by virtue of their position in the food chain, can be used as an indicator of the health of marine ecosystems. Studies of seabirds can provide indications of significant changes in prey availability and ecosystem changes. Information about oceanographic and food web shifts can be gathered from surface-feeding predators like kittiwakes that are expected to be highly sensitive to variation in sea surface temperature and from generalist and opportunistic avian predators with broad diets, like gannets. There are numerous examples of specialist predators, such as common murre, providing information about changes in prey condition that reflect bottom up effects. These sorts of indications from seabirds can be most informative when they concern forage species that play pivotal energy transfer roles in marine food webs and that tend to be overexploited and understudied (Montevecchi, W., 2007).
- The social and economic value of seabirds is also significant – bird watching is one of the world's most popular hobbies, and bird watching contributes significantly to ecotourism in the EBSA. The Cape St. Mary's Ecological Reserve hosts thousands of visitors during the peak of the season. Seabird hunting is also an important cultural activity.

Score 8

Sensitivity: $(1+3+8)/3 = 4$

Risk of Harm: $2.7 \times 4 = 10.8$

Certainty Checklist

Answer yes or no to all of the following questions. Record the number of NO's 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?
- Y 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)?
- N Is the score supported by long-term data sets (ten years or more) from multiple surveys (5 years or more)?
- Y 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:

Because they are long-lived, abundant top predators, and relatively easy to locate at regular nesting site, seabirds are an excellent indicator of marine ecosystem health in local areas such as Placentia Bay or for the LOMA as a whole and should be used in regular monitoring programs.

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Seabird aggregation, feeding, nesting, and refuge in Placentia Bay Extension

Harmful Algal Blooms- HABs

Magnitude of Interaction

Areal extent:

- Seabirds are widely distributed within the EBSA throughout the year, with many species nesting during the summer on coastal cliffs and islands throughout the bay as shown on Figure 1.

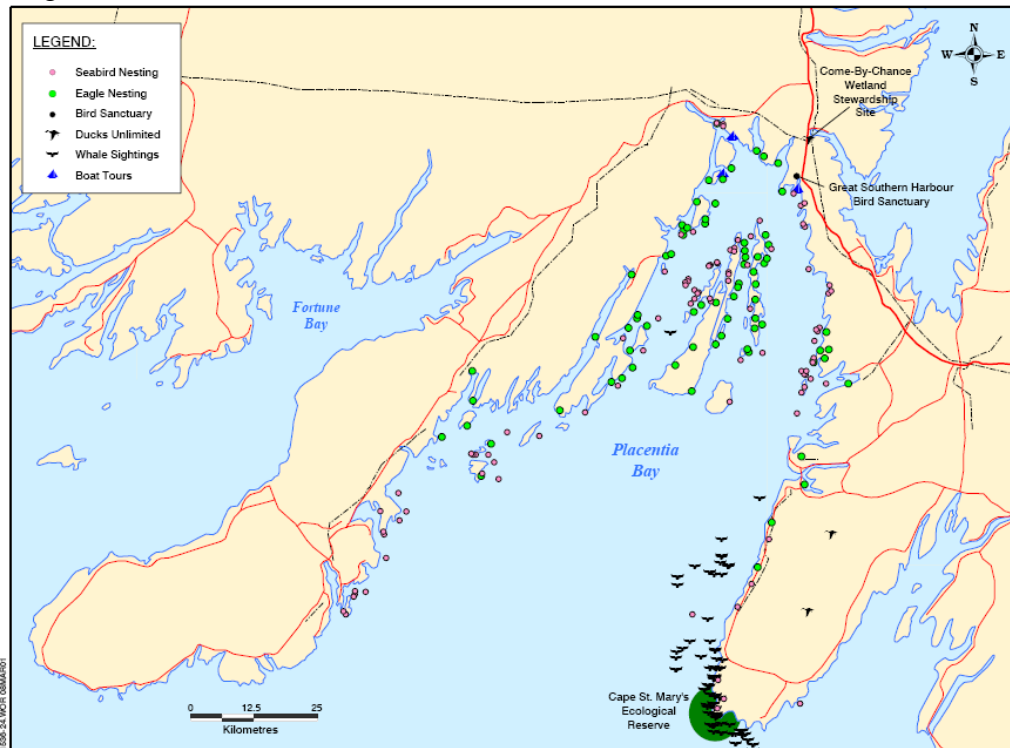


Figure 1. Documented seabird nesting sites (purple dots) in Placentia Bay (Community Resource Services Ltd & Jacques Whitford Environment Ltd, 2001)

- Seabirds are highly mobile and feeding occurs throughout the bay wherever prey is numerous, so the entire EBSA is considered to be the area occupied by the CP.
- HABs are considered to be a chronic stressor, and are frequently associated with nutrient enrichment in inshore areas.
- The last 20 years have seen a drastic increase in harmful algal blooms worldwide, including Placentia Bay. Figure 2 shows the incidents of harmful algal blooms in Atlantic Canada in 2007.

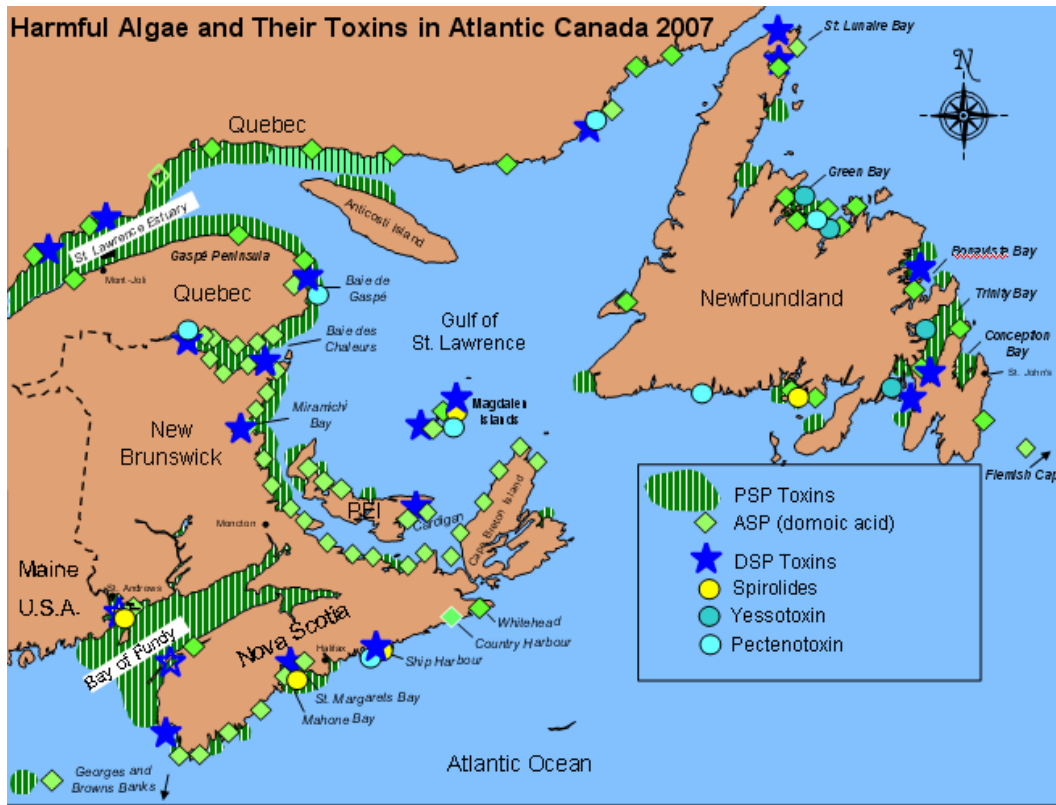


Figure 2. Risk areas of harmful algal bloom events, based on historical monitoring records (Bates SS, Forbes JR, 2009).

- Based on this information we have estimated areal extent in the moderate range.

Score 5

Contact:

- Phytoplankton forms the basis of the marine foodchain, and algal blooms occur wherever adequate nutrients and sunlight (upper photic zone) are available. HAB toxins can accumulate in the foodchain leading to mortality of marine organisms at all trophic levels including zooplankton, fish, seabirds and marine mammals (Agriculture and Consumer Affairs, 2004) (Sindermann, C. J., 2003), but species at the top of the foodchain are generally considered most at risk. It has recently been discovered that more than half of all marine mammal mortalities in US water can be attributed to marine biotoxins (UNESCO-IOC, 2009), but little data is available on incidents in seabirds.
- Since most components of the CP feed at a relatively high trophic level, contact is considered high for seabird feeding. However, this CP also refers to seabird aggregation, nesting and refuge, which are would have a much lower score for ‘contact’ with HABs.
- Therefore a moderate score was selected, which is an average of all the activities within the CP. A higher score would be been assigned if the CP referred only to ‘feeding’.

Score 5

Duration:

- Seabirds are present in the EBSA throughout the year, although dominant species may vary with the season.
- HABs are considered a chronic stressor which may potentially occur every year, and so is given a moderate score. Algal blooms are of short duration, although cysts of some species can remain dormant indefinitely in sediments and re-suspension of sediments (and cysts) into the photic zone can lead to further outbreaks.
- Based on this information we have selected a score in the moderate range.

Score 5

Intensity:

- Incidents of harmful algal blooms are increasing world-wide, and incidents within Placentia Bay have also increased as shown in Figure 3.

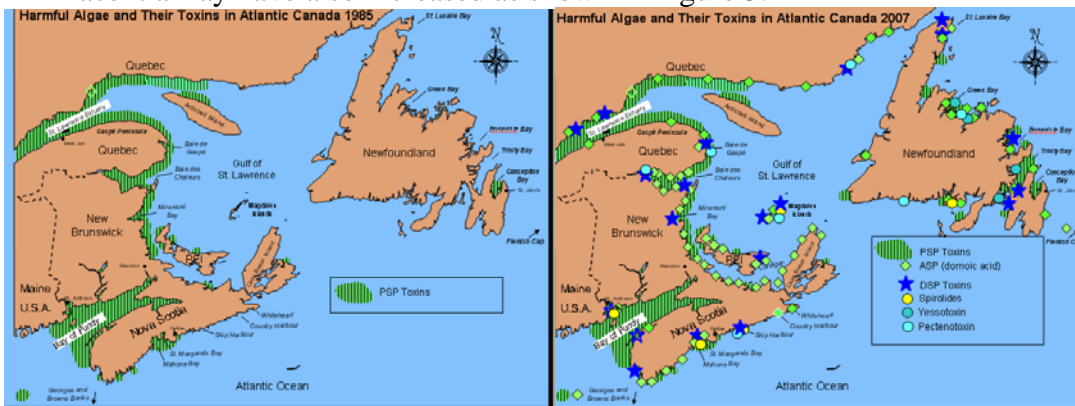


Figure 3. Increase in harmful algal bloom risks in Atlantic Canada from 1985 to 2007 (Bates SS, Forbes JR, 2009).

- Since incidents in Placentia Bay appear to be moderate relative to global levels, we have selected a score in the medium range

Score 6

Magnitude of Interaction: $(5 \times 5 \times 5 \times 6)/1000 = 0.8$

Sensitivity

Sensitivity of the CP to acute impacts:

- Of the thousands of phytoplankton species, less than one hundred or so are considered harmful. Those that produce toxins (poisons) are of particular concern to seals. PSP (Paralytic Shellfish Poisoning) is among the most toxic HABs, with small quantities leading to rapid paralysis and death. HABs can accumulate in the foodchain leading to mortality of marine organisms at all trophic levels (Agriculture and Consumer Affairs, 2004; Sindermann, C. J., 2003).
- Species such as piscivorous seabirds which feed at the top of the food-chain are generally considered to be most at risk from HABs. A recent discovery that more than half of all marine mammal mortalities in US waters are now attributed to marine biotoxins

- Since there is no evidence of significant mortality of seabirds as a result of HABs we have selected a score low range.

Score 2

Sensitivity of the CP to chronic impacts:

- The population sizes of all seabird species in Newfoundland remained stable or increased in recent years, with the exception of gulls which declined. These changes related largely to changes in the fishery (Chardine, J. W., Diamond, A. W., Elliot, R. D., & Lock, A. R., 1999).
- Since there is no evidence of mass mortality of seabirds associated with HABs in Placentia Bay, and the population appears to be stable, chronic impacts are thought to be low.

Score 2

Sensitivity of ecosystem to harmful impacts to the CP:

- Seabirds are an important component of the marine ecosystem, playing a role as high level predators and also in nutrient cycling. The rich, diverse, feeding and breeding grounds of Placentia Bay attract a wide variety of marine birds to the area. The number of cliffs, sea stacks and islands throughout the bay provide appropriate nesting habitat and the cold Labrador Current that influences the bay supports a rich assortment of prey including plankton, capelin, and other small fish and invertebrates. Observations of seabird species in Placentia Bay have included 27 species (ORCA Inc., 2005), and numerous nesting colonies (Community Resource Services Ltd & Jacques Whitford Environment Ltd, 2001). Large stocks of capelin that breed in the inshore zone in summer are the principal prey of the large breeding populations gannets, auks, murres, Atlantic puffins, dovekies, and guillemots and kittiwakes (Locke et al; Carscadden, J. E., Montevecchi, W. A., Davoren, G. K., & Nakashima, B. S., 2002). If prey is scarce near the colonies, it will have a direct effect on feeding chicks and, ultimately, on their survival- these birds cannot simply pick up and move (Rose, G. A., 2007).
- The most significant colony is located at the Cape St. Mary's Bird Sanctuary. The reserve is a nesting area for approximately 24,000 Northern gannets, 20,000 black-legged kittiwakes, 20,000 common murres, 2,000 thick-billed murres, 100 pairs of razor-bills, 60 pairs of black guillemots and some double crested and great cormorants and northern fulmars. Its gannet colony is the biggest in Atlantic Canada and the third biggest in North America (Lock, A. R., Brown, R. G. B., & Gerriets, S. H., 1994). Other breeding colonies with varying numbers of breeding pairs exist throughout the bay (Lock, A. R., Brown, R. G. B., & Gerriets, S. H., 1994).
- Seabirds, by virtue of their position in the food chain, can be used as an indicator of the health of marine ecosystems. Studies of seabirds can provide indications of significant changes in prey availability and ecosystem changes. Information about oceanographic and food web shifts can be gathered from surface-feeding predators like kittiwakes that

- The social and economic value of seabirds is also significant – bird watching is one of the world’s most popular hobbies, and bird watching contributes significantly to ecotourism in the EBSA. The Cape St. Mary’s Ecological Reserve hosts thousands of visitors during the peak of the season. Seabird hunting is also an important cultural activity.

Score 8

Sensitivity: $(2+2+8)/3 = 4$

Risk of Harm: $0.8 \times 4 = 3.2$

Certainty Checklist

Answer yes or no to all of the following questions. Record the number of NO's 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?
- Y 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 years or more) from multiple surveys (5 years 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:

Because they are long-lived, abundant top predators, and relatively easy to locate at regular nesting sites, seabirds are an excellent indicator of marine ecosystem health in local areas such as Placentia Bay or for the LOMA as a whole and should be used in regular monitoring programs. Improved techniques and increased sampling of animal tissues for HABs may allow improved detection of HAB-related mortality or morbidity.

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Summary Table: Seabird Aggregation, Feeding, Nesting, and Refuge in Placentia Bay Extension

Key Activity/Stressor	a	c	d	i	MoI $\frac{(a \times c \times d \times i)}{1000}$	as	cs	es	S $\frac{(as+cs+es)}{3}$	Risk of Harm	Certainty
Gillnet (bottom)	6.5	3.5	8.3	6	1.1	9	7.5	8	8.2	9.0	Low
Seabird hunt	10	8	2.8	10	2.2	8	6	8	7.3	16.1	Med
Oil Pollution	9	10	7.5	9	6.1	10	8	8	8.7	53	Med
POPs	6	8	7	8	2.7	1	3	8	4	10.8	Low
Litter	8	9	7	9	4.5	3.5	5	8	5.5	24.8	Med
HABs	5	5	5	6	0.8	2	2	8	4	3.2	Low
Cumulative CP Score										116.9	