Management solutions for an at-risk population of northern bottlenose whales (*Hyperoodon ampullatus)* in the international waters of the Sackville Spur

by

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Table of Contents

List of Tables

List of Figures

Abstract

Recent visual and acoustic evidence has indicated the presence of a previously undescribed population of northern bottlenose whales (*Hyperoodon ampullatus*) around the Sackville Spur, an undersea sediment drift bordering the Flemish Pass in the international waters east of Newfoundland. The area is subject to intense fishing pressure, ongoing hydrocarbon exploration activities and shipping traffic, which threaten this population of whales with acoustic disturbance, entanglement, vessel strike and exposure to contaminants and marine pollution. In light of these negative impacts and large knowledge gaps surrounding the population, protective measures are required. However, there are a lack of clear regulatory and governance mechanisms that exist to guide conservation of sensitive marine species in international waters. To address this complex situation, a risk analysis was conducted to identify which threats most required management intervention. Solutions for the most severe threats were evaluated based on their perceived feasibility and effectiveness, and formed the basis of a shortlist of management recommendations. In the absence of an existing international framework, proposed solutions include strengthening Canadian policy and legislation to address the effects of marine noise, incorporating whales into the ecosystem based approach used by regional fisheries management bodies, and implementing subsidy and incentive programs for marine industry. These protective measures would address the known threats and help ensure the long-term survival of this new population.

Keywords: northern bottlenose whale, species at risk, areas beyond national jurisdiction, risk analysis, threat management, international cetacean conservation

List of Acronyms

ABNJ – Area Beyond National Jurisdiction
ATBA – Area to be Avoided
APM – Associated Protective Measure
CBD – Convention on Biological Diversity
CCNAF – The Convention on the Cooperation in the Northwest Atlantic Fisheries
CEAA – Canadian Environmental Assessment Act
CMP – Conservation Management Plans
CMS – Convention on the Conservation of Migratory Species of Wild Animals
C-NLOPB – Canada-Newfoundland Offshore Petroleum Board
COSEWIC – Committee on the Status of Endangered Wildlife in Canada
CP – Contracting Party
CPRA – Canada Petroleum Resources Act
CSA – Canada Shipping Act
DFO – Fisheries and Oceans Canada
EA – Environmental Assessment
EBSA – Ecologically and Biologically Significant Area
EL – Exploration License
EEZ – Exclusive Economic Zone
EZ – Exclusion Zone
FC – Flemish Cap
FAO – Food and Agriculture Organization of the United Nations
GIC – Governor in Council
HSMPA – High Seas Marine Protected Area
ICCAT – International Commission for the Conservation of Atlantic Tunas
ICRW – International Convention for the Regulation of Whaling
IMO – International Maritime Organization
IUCN – International Union for the Conservation of Nature
IWC – International Whaling Commission
MARPOL – International Convention for the Prevention of Pollution from Ships
MMO – Marine Mammal Observer
MPA – Marine Protected Area
MV – Marine Vibroseis
NAFO – Northwest Atlantic Fisheries Organization
NBW – Northern bottlenose whale
NL – Newfoundland
NASCO – North Atlantic Salmon Conservation Organization
NGO – Non-governmental organization
NRA – NAFO Regulatory Area
OA – Oceans Act
PAM – Passive Acoustic Monitoring
PL – Production License
PD – Project Description
PSSA – Particularly Sensitive Sea Area
SARA – Species at Risk Act
SEA – Strategic Environmental Assessment
SDL – Significant Discovery License
SRKW – Southern Resident Killer Whale
TSS – Traffic Separation Scheme
UN – United Nations
UNCLOS – United Nations Convention on the Law of the Sea
UNGA – United Nations General Assembly
VME – Vulnerable Marine Ecosystem

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Chapter 1: Introduction

Northern bottlenose whales are a large species of beaked whale found only in the North Atlantic (Taylor et al., 2008). Two populations exist in Canada. The Scotian Shelf population lives almost exclusively in the Gully, a large submarine canyon about 200 nautical miles east of Halifax that was designated a marine protected area (MPA) in 2004 (DFO, 2016). The population is listed as Endangered under Canada's *Species at Risk Act* (*SARA*) and by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC). The Davis Strait-Baffin Bay population occupies a more northerly distribution, reaching as far as southern Baffin Bay, and is considered Special Concern by COSEWIC but is not listed under the *SARA* (COSEWIC, 2011). Based on recent acoustic and visual data collected by the Whitehead lab of Dalhousie University, a third, previously unknown population appears to exist in the waters of the Sackville Spur, a large underwater sediment deposit located east of Newfoundland, in international waters.

The United Nations Convention on the Law of the Sea (UNCLOS), broadly divides the global oceans into three administrative regions. The first is the territorial sea, which extends out to 12 nautical miles from the coast and over which the coastal State has complete sovereignty, including the air space, seabed, and subsoil (UNCLOS, 1982, Art. 2-3). Next is the Exclusive Economic Zone (EEZ), which extends from the 12-nautical mile limit of the territorial sea out to 200 nautical miles and within which States have freedom to explore and exploit living and non-living natural resources (UNCLOS, 1982, Art. 56-57). Finally, international waters, or the high seas, refer to all other parts of the ocean that are not part of the EEZ, the territorial sea or internal waters of a State (UNCLOS, 1982, Art. 86). Also known as Areas Beyond National Jurisdiction (ABNJ), these marine areas are outside the jurisdictional authority of any State. However, under UNCLOS, States still retain certain rights and responsibilities in the high seas. These include freedom to fish, navigate and conduct scientific activities (UNCLOS, 1982, Art. 87) and duties to conserve living resources and cooperate with other parties in doing so (UNCLOS, 1982, Art. 117-118) as well as a general obligation to protect the marine environment (UNCLOS, 1982, Art. 192). Despite these guidelines, laws in ABNJ are basic, difficult to enforce, and rely heavily on States and citizens to behave responsibly (Corrigan & Kershaw, 2008). There is also little in place for the protection of sensitive

marine species, including whales, and no global legal framework currently exists for the establishment of MPAs in ABNJ (Gjerde, 2008). Conservation measures that have so far been established in ABNJ, such as high seas marine protected areas (HSMPAs), have often been the result of lengthy and complex procedures initiated by a select few organizations or coastal States (O'Leary et al., 2012), and some have been deemed ineffective (e.g. Notarbartolo di Sciara, 2009). Management over high seas resources and activities is also quite sectorally and geographically fragmented. Organizations and management bodies have limited mandates to oversee only one or a few activities, making for uncoordinated management conducted on a mostly sectoral basis and where conservation actions are often not prioritized (Warner & Rayfuse, 2008).

As this new population of whales appears to exist entirely in international waters, it does not fall under the legal jurisdiction of any State. As a result, there is no established management plan or any legal measures in place to protect it. This of great concern because of the ongoing anthropogenic activities that are taking place in the Sackville Spur. Oil and gas exploration and fishing activity are heavy, and ship traffic regularly crosses the area. These activities are likely impacting the population through exposure to anthropogenic noise, entanglement in fishing gear, and vessel strikes, all of which have been identified as threats to northern bottlenose whales (DFO, 2016). Because so little is known about this population, the severity of the impacts is unclear, but based on what is known about northern bottlenose whales elsewhere and their status as an at-risk species, it is likely that these activities are threatening the survival of this population.

With no protective measures in place, but with anthropogenic activity placing this population at risk, management intervention is needed. However, due to existing governance gaps and jurisdictional uncertainties that exist on the high seas, it is not clear what can be done to protect this population of whales from continued disturbance, nor who should be held responsible for doing it. The research question that this paper attempts to answer is, in light of no overarching legal framework for protecting large pelagic species such as whales on the high seas, what can be done to protect this vulnerable population? To answer this question, the project provides a series of effective solutions for addressing the management problem at hand in the hopes of providing some guidance to relevant management bodies and responsible governments who have

authority over managing activities within the study area. The project begins by providing more detailed background information on the study area and the study species, the threats that the species faces, and an overview of existing management and governance of study the area. A review of relevant Canadian and international laws and policies as they pertain to marine biodiversity conservation and how they may apply to the management problem is also given. Solutions to the management problem are then identified and evaluated based on their perceived effectiveness and feasibility, with those that appear to be the best suited to addressing the problem providing the basis for the discussion and the final recommendations.

Chapter 2: Background

2.1 Physical and biological characteristics of the study area

The Flemish Cap (FC) is a large underwater plateau found about 120 nautical miles east of Newfoundland, in the international waters beyond Canada's national jurisdiction. It measures approximately 58,000 square kilometers and is surrounded to the west by a deep 1200-m deep channel known as the Flemish Pass, bordered by a shallower sediment drift called the Sackville Spur (Figure 1). The region is known to be highly productive. The southerly-flowing Labrador Current bifurcates over the FC bringing with it subarctic zooplankton and other nutrients from northern waters while the North Atlantic Current flows northward bringing warm, highly saline water to the southeast slope of the Flemish Cap (Maillet, Pepin, Craig, Fraser, & Lane, 2005).

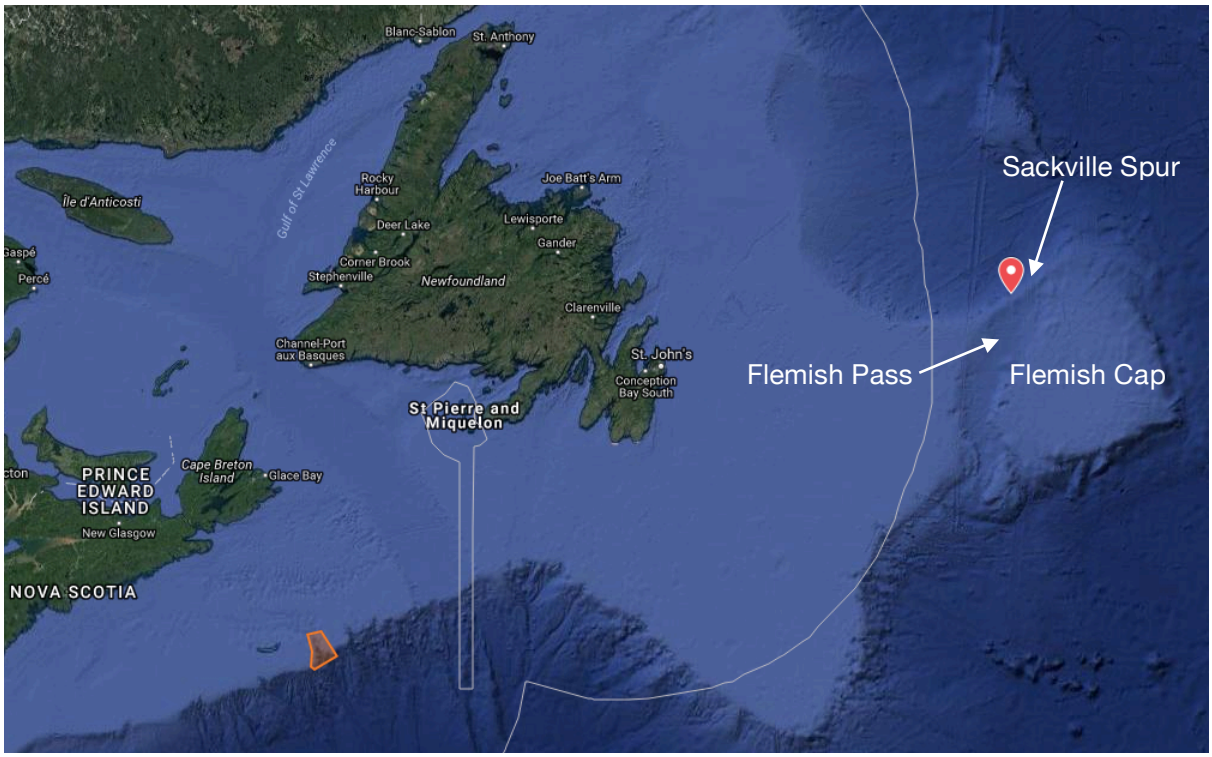

Figure 1: Map of the study area. Red icon indicates approximate location on the Sackville Spur where visual and acoustic detections of a new population of northern bottlenose whales were made. The Gully Marine Protected Area is indicated in orange. The limit of Canada's exclusive economic zone is delineated in white.

The high degree of productivity supports many slow-growing species of fishes, sponges, corals, echinoderms, and cnidarians (Beazley & Kenchington, 2015), making the

Sackville Spur an important biodiversity hotspot. Previous photographic transect surveys have revealed the presence of over 283 taxa present along the Sackville Spur, with echinoderms and sponges (porifera) among the phyla present in greatest abundance (Beazley & Kenchington, 2015). The ecosystem of the Sackville Spur also appears to support a number of marine mammal species including sperm whales (Karpouzli & Leaper, 2004) and northern bottlenose whales (DFO, 2016) which may depend on the area as a reliable source of prey species.

2.2 Historic and ongoing anthropogenic activities

2.2.1 Fishing

Because of the area's high productivity, the waters of and around the FC have long been subjected to intense fishing activity. As early as the 1400s, the Portuguese and Basque fished the Grand Banks, followed by other European fleets, and eventually countries such as the United States, Russia and local fleets from Newfoundland (DFO, 2012). The FC, while deeper than the Grand Banks, was fished heavily as well due to the high levels of cod and plaice that once lived there (DFO, 2012). Today fishing in the waters around the FC is governed by the Northwest Atlantic Fisheries Organization (NAFO), an intergovernmental body that aims to ensure long-term sustainability of fisheries within its Convention Area, a 6,551,289 km^2 area of the Northwest Atlantic and includes the 200-mile EEZ of nearby Coastal States (namely, the United States, Canada, St. Pierre et Miquelon, and Greenland) (Figure 2). However, NAFO is only responsible for managing fishing activity in waters beyond Coastal States' EEZs. This area is known as the NAFO Regulatory Area (NRA), which is divided into 31 divisions and totals 2,707,895 km^2.

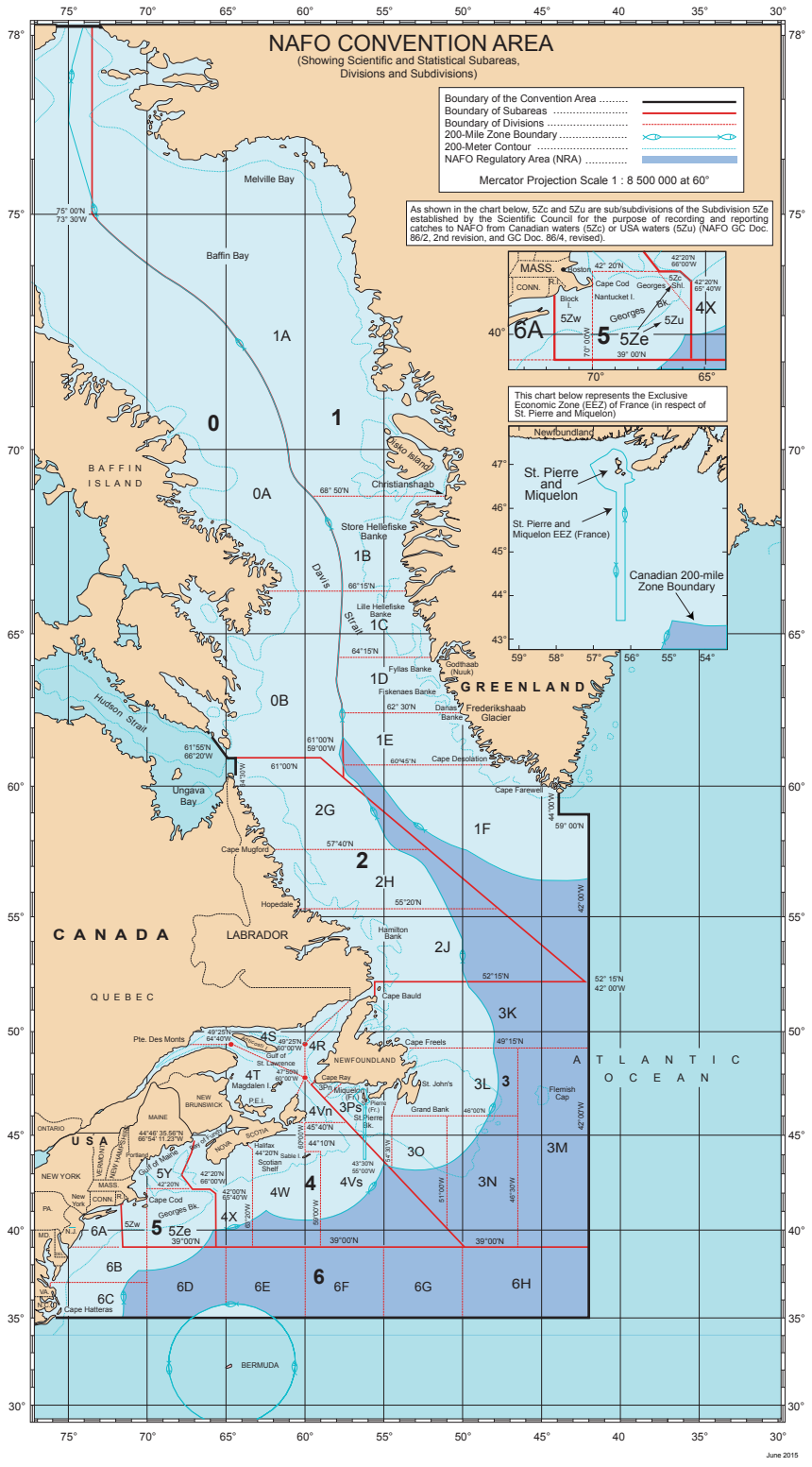

Figure 2: The Northwest Atlantic Fisheries Organization (NAFO) Convention Area. The NAFO Regulatory Area is indicated in dark blue. The Sackville Spur is located within the 3M Division. Source: NAFO (2017b).

The fisheries for which NAFO is responsible for managing are groundfish, shrimp and pelagic redfish. A moratorium is currently in place for the shrimp and pelagic redfish fisheries. Marine species which NAFO does not manage include non-mobile species (such as shellfish), salmon (managed by the North Atlantic Salmon Conservation Organization, NASCO), tunas and marlins (managed by the International Commission for the Conservation of Atlantic Tunas, ICCAT) and whales (managed by the International Whaling Commission, IWC) (NAFO, 2017a). In 2016, 47 fishing vessels spent 4,270 days in the NRA and harvested a total of 57,000 tons of fish (NAFO 2016a). This is a slight decrease from 2015, when there were 57 active fishing vessels in the NRA (NAFO 2016b). The majority of vessels (all those above 500 GTs) use trawls as their main gear type while smaller vessels (under 500 GTs) mainly use longlines (Table 1). Larger vessels (between 1000-2000 GTs and above) spend the longest time at sea, with trips lasting up to 107 days and over 2,000 days spent fishing. In the 3M Division, where the Sackville Spur is located, all fishing vessels appeared to be greater than 500 GTs and all used trawls as their main gear type. The total reported catch harvested in 2016 from the 3M Division was 22,782.2 tons, almost 40% of the total catch from within the entire NRA, indicating the relatively intense fishing effort in that area. This catch was composed mainly cod followed by redfish and Greenland halibut in addition to a number of other species (NAFO 2016a).

Table 1: Fishing effort in the NAFO regulatory area in 2016.

Vessel Class	# of fishing vessels	Main Gear	f = Total Fishing Days	Fishing Trip Range	Main Species	Main Divisions
Class 3-4 vessels (less than 500 GT)	5	Longline	175	1-20 days	YEL, HKW, HAL	3NO
Class 5 vessels (500-1000 GT)	20	Trawl	1506	10-84 days	GRO*	3LMNO
Class 6 vessels (1000-2000 GT)	19	Trawl	2147	3-107 days	GRO*	3LMNO
Class 7 vessels (> 2000 GT)	3	Trawl	442	29-109 days	GRO*	3LMNO
Total:	**47**		**4270**			

* Mixed of species constituting major species as directed fishery: COD, GHL, RED and SKA.

Source: NAFO (2016a).

Fishing effort around the Flemish Cap over the course of the entire 2015 year is illustrated in Figure 3; bottom-fishing closures are also shown. Around the Sackville Spur Closure, it is easy to see that while vessels appear to largely comply with avoiding it, fishing activity is heavy immediately outside it.

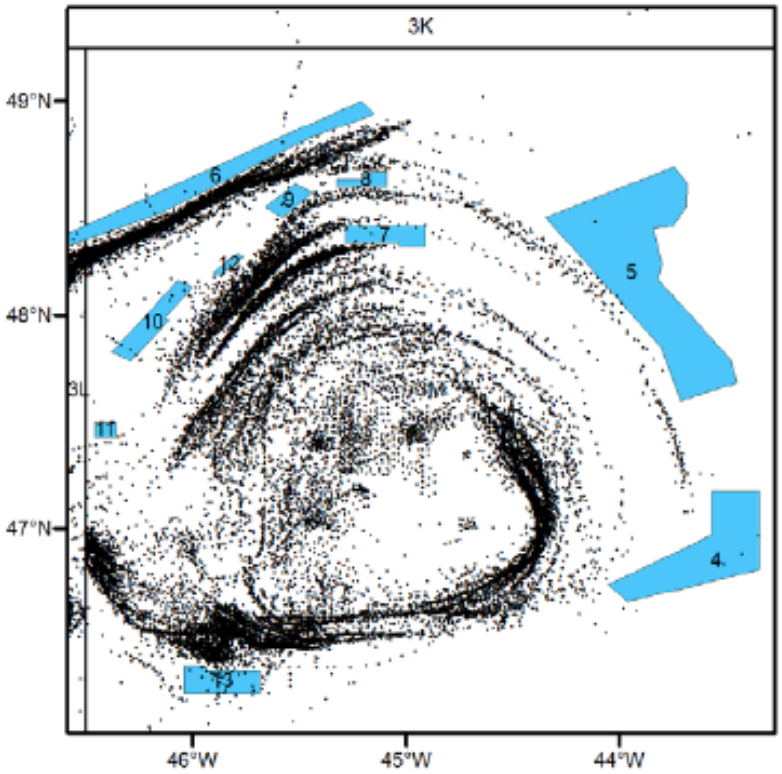

Figure 3: Vessel Monitoring System (VMS) plots of all vessels engaged in fishing activity around the Flemish Cap in the NAFO Regulatory Area in 2015 in relation to bottom fishing closures, shown in blue. The Sackville Spur closure is indicated as number 6. Source: NAFO (2016b).

2.2.2 Oil and gas exploration

In addition to fishing activity, the area surrounding the FC has been and continues to be subject to a great deal of oil and gas exploration. Activities in this region are overseen by the Canada-Newfoundland Offshore Petroleum Board (C-NLOPB). The Grand Banks host the three largest producing facilities offshore Newfoundland: Hibernia, Terra Nova, and White Rose, all located between 300-350 km east-southeast of St. John's. Activities in Newfoundland's offshore area are divided into 8 regions (Figure 4).

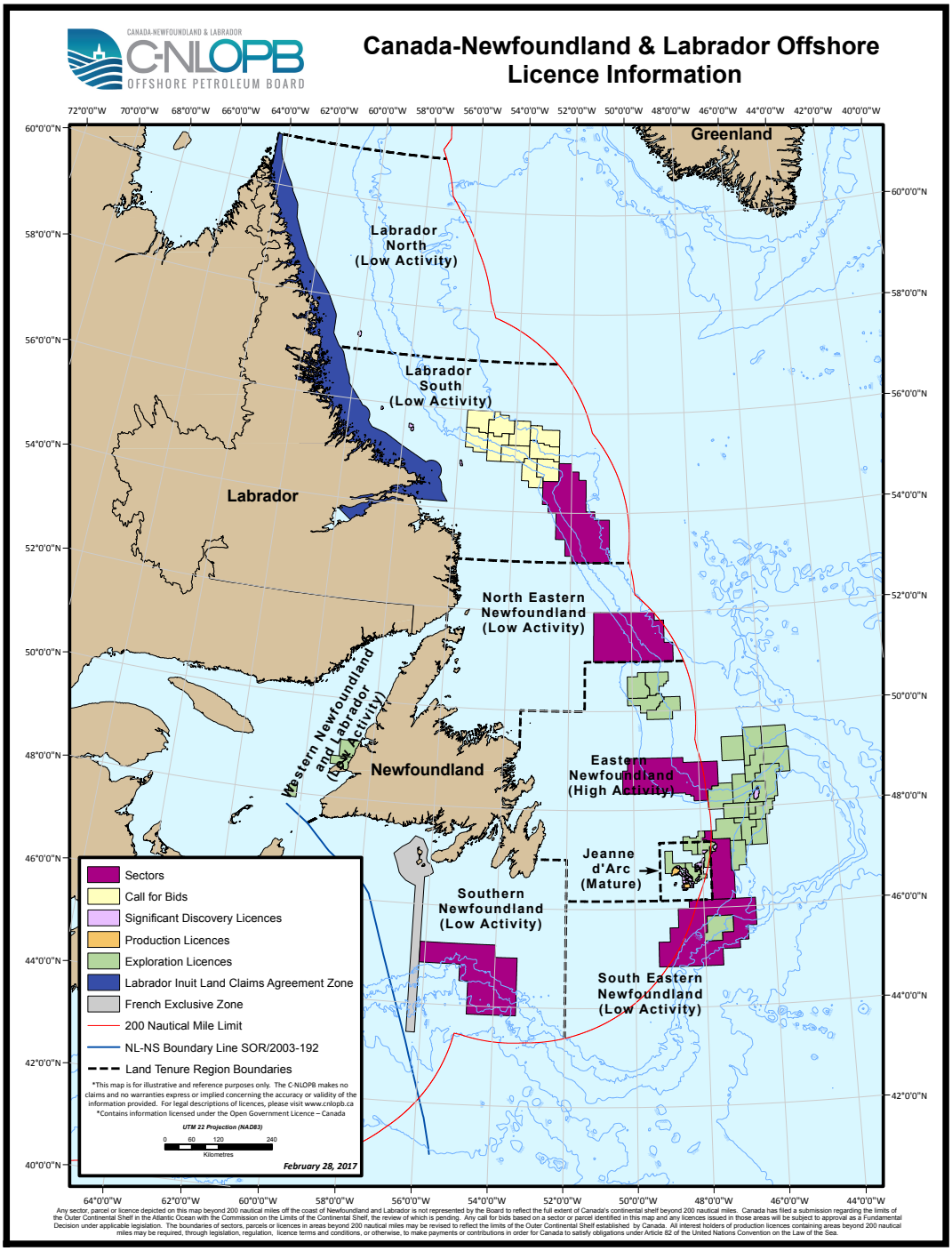

Figure 4: Offshore oil and gas license regions overseen by the Canada-Newfoundland Petroleum Board (C-NLOPB). Source: C-NLOPB (n.d.(a)).

In the Eastern Newfoundland region, where the Sackville Spur is located, exploration activities for oil and gas deposits are ongoing. Statoil is responsible for the majority of the

activity, as it currently holds 10 out of 16 Exploration Licenses (ELs) in the Flemish Pass Basin and two Significant Discovery Licenses (SDLs). Ownership of the remaining ELs in that area is divided up among BP, Chevron, ExxonMobil, Nexen and Husky (C-NLOPB, n.d.(a)). ELs allow these companies to carry out exploratory activities and drill for oil in order to determine the level of hydrocarbon deposit that may exist within that EL (C-NLOPB, n.d.(b)). In 2009, Statoil discovered hydrocarbons in the area and has continued targeted drilling in the Pass, making additional discoveries including the Bay du Nord prospect (Figure 5).

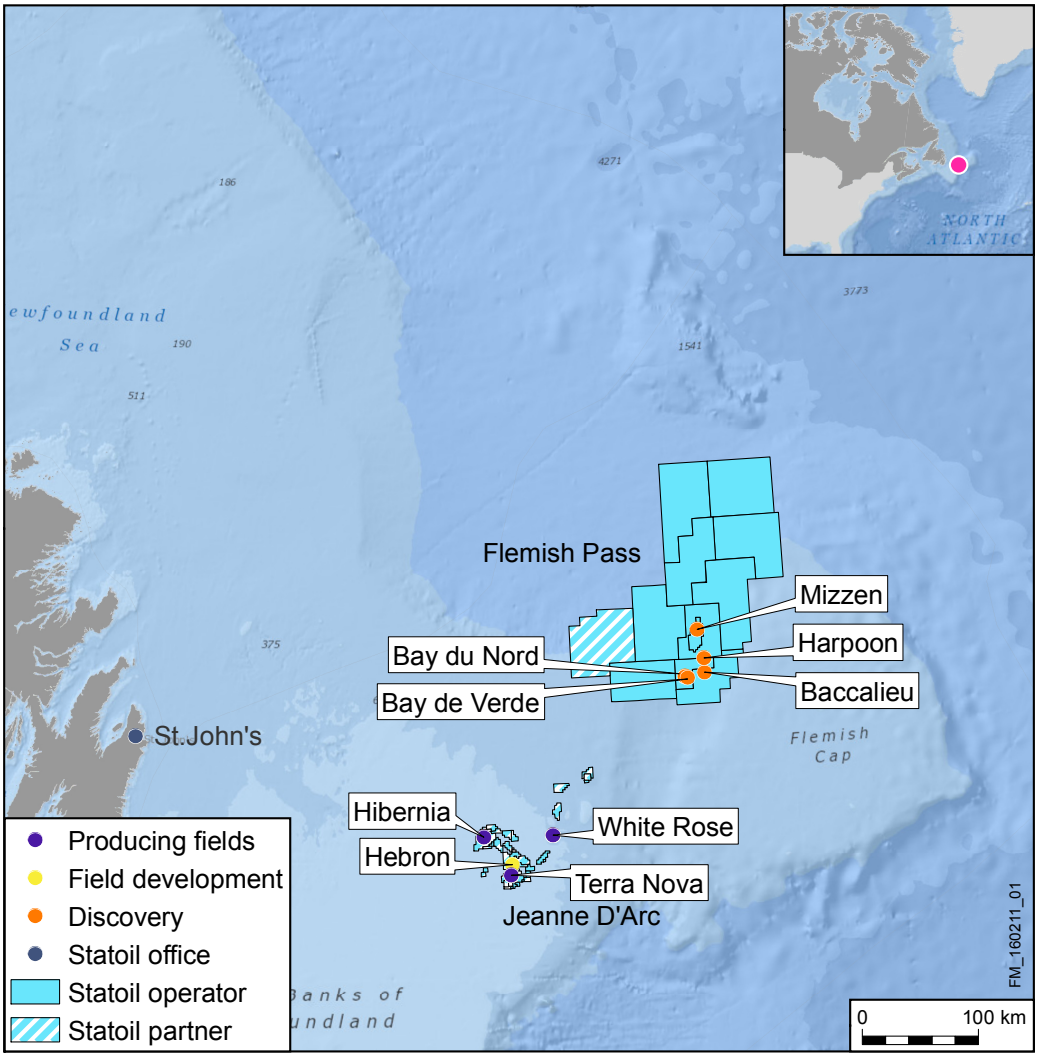

Figure 5: Exploratory licenses, significant discoveries and production areas owned by Statoil in the Eastern Newfoundland offshore region. Source: Statoil (2016a).

In 2017, Statoil completed drilling in two wells in the Flemish Pass Basin that did not result in hydrocarbon discovery but despite this, the company maintains that the Pass

“has potential to become a core producing area for Statoil post-2020” (Statoil, 2013). A 19-month drilling program was completed in 2016 that confirmed the previously estimated amounts of 300-600 million barrels of oil lying within the Bay du Nord prospect (Statoil, 2016a). In August of the same year, Statoil put forth a proposal for a 10-year drilling project that would take place within its licensed areas in the Flemish Pass Basin, set to begin in 2018 (Statoil, 2016b). The purpose will be to determine the presence, nature and quantities of potential hydrocarbon resources. The Canadian Environmental Assessment Agency (CEAA) is currently reviewing the proposal, and have provided guidelines for the Environmental Impact Assessment that will have to be carried out to Statoil. The location of the proposed project area is shown in Figure 6 where it is clear that the ELs slated for further exploration overlap directly with where the northern bottlenose whales are thought to occur. Also shown are NAFO bottom fishing closures and Ecologically and Biologically Significant Areas (EBSAs) established by Fisheries and Oceans Canada (DFO) which do not prohibit oil and gas exploration. In October of 2017, Chevron Canada Ltd. submitted to the C-NLOPB a proposal to conduct seismic surveys in EL 1138, commencing in 2018 with additional surveys planned for 2019-2021 (Chevron, 2017). The location of the proposed survey area is shown in Figure 7 where it also appears to overlap with suspected northern bottlenose whale habitat. The C-NLOPB has determined that the project requires an EA and input on the project is currently being sought from government and non-governmental organizations (NGOs).

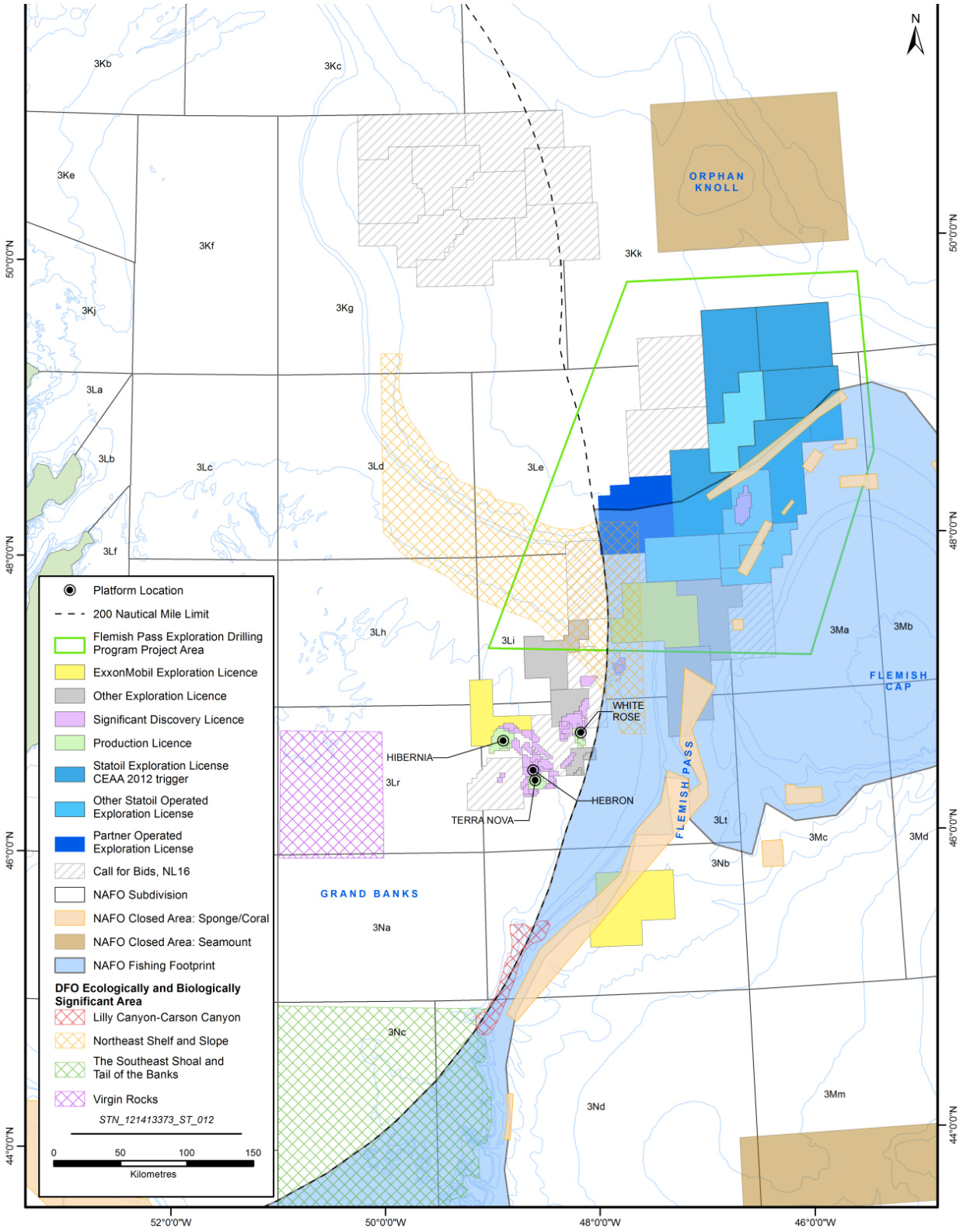

Figure 6: Map of the 10-year Flemish Pass proposed exploration drilling project area (outlined in green) along with various other spatially-defined components of the study area including NAFO fishing closures (tan). Source: Statoil (2016b).

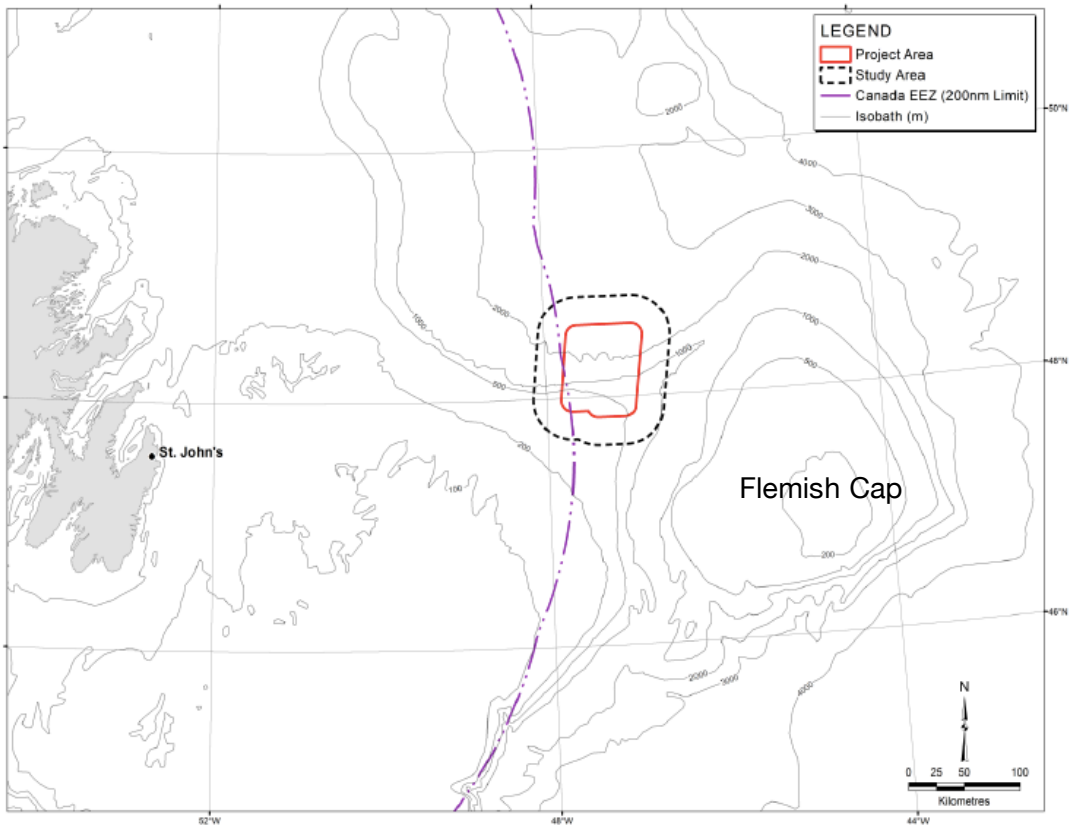

Figure 7: Petroleum exploration area recently proposed by Chevron Canada Ltd. Source: Chevron (2017).

2.2.3 Shipping

In addition to fishing vessels and those associated with oil and gas activity, the Sackville Spur is frequented by commercial and other ship traffic. The density of ship traffic representing just passenger vessels under 500 GTs in 2016 around the study area is shown in Figure 8, where a concentration of traffic along the Sackville Spur is observed. The map was obtained from Marine Traffic, an organization that uses the Automated Identification System of the global shipping fleet to track ship traffic. Since the data do not show vessels above 500 GTs, actual ship traffic within the Sackville Spur region is likely to be much higher.

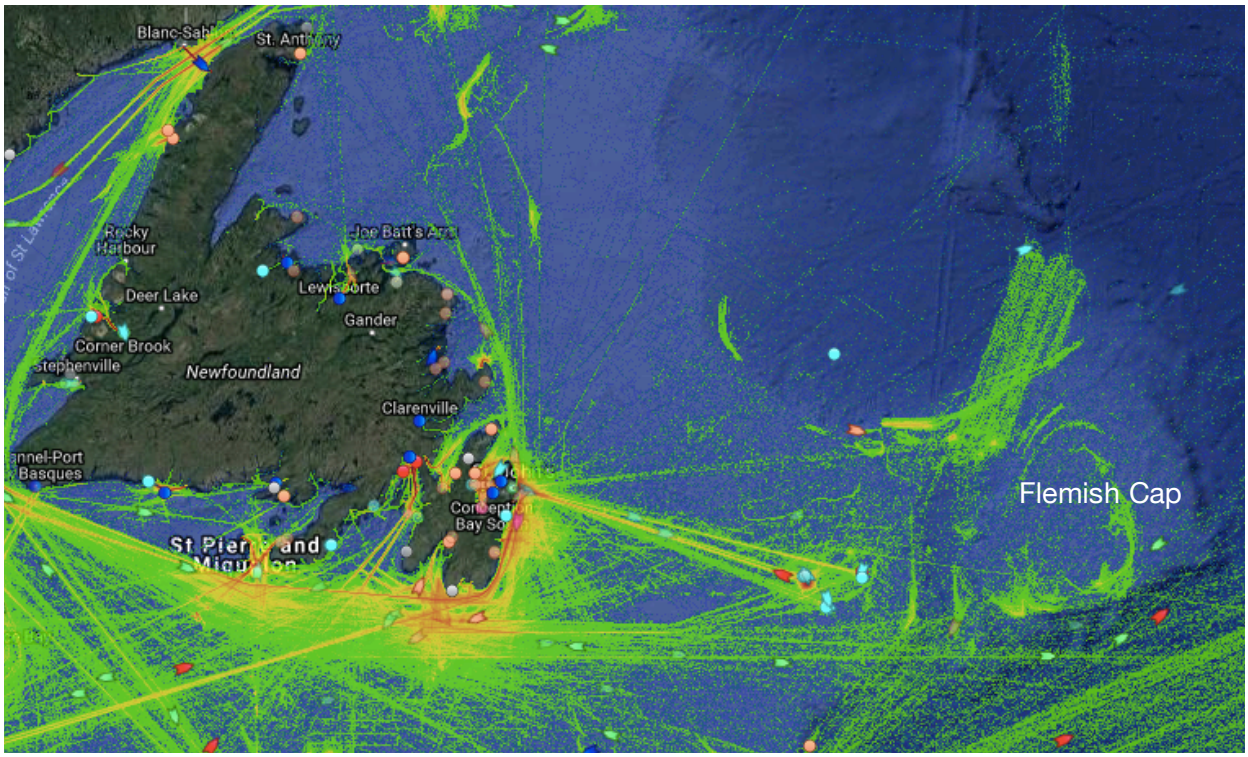

Figure 8: Density map showing 2016 global ship traffic density for passenger vessels less than 500 GTs in the study area. Source: Marine Traffic.

2.2.4 Summary of anthropogenic activities

It is clear that the Sackville Spur is subject to a great deal of pressure from different anthropogenic activities. The impact of these activities on the ecosystem of the Spur is unclear but is a cause for concern given the sensitive nature of many of the species that are found there. The distribution of the newly described population of northern bottlenose whales also overlaps directly with these activities, and virtually nothing is known about their current status. To provide some context of these threats for northern bottlenose whales, a discussion of their biology and status, and the threats they face is presented next. Special consideration is given to the population of the Sackville Spur.

2.3 Northern bottlenose whales

Northern bottlenose whales (*Hyperoodon ampullatus*) are a large species of beaked whale from the family Ziphiidae. They are found only in the North Atlantic, and their known range extends as far north as Baffin Island and southern Greenland down to the Cape Verde Islands (Taylor et al., 2008). Global population size has not been reliably

estimated but based on previous reports it appears there may have been around 100,000 whales before whaling reduced the population by at least two thirds (Whitehead & Hooker, 2012). The species has been classified as Data Deficient by the International Union for the Conservation of Nature (Taylor et al., 2008).

Individual whales range in size from about 6-9 meters and are characterized by their prominent beaks and melons. They are primarily found in pelagic waters deeper than 500 meters (DFO, 2016) and there is some evidence that they tend to associate with submarine canyons (Moors-Murphy, 2013). Their diet appears to be quite specialized as it is believed that they feed mainly on *Gonatus* spp. squid (Hooker, Iverson, Ostrom, & Smith, 2001), although they may sometimes also eat other organisms such as fish and invertebrates (Taylor et al., 2008). They are some of the deepest diving cetaceans, reaching depths of over 1000 m to forage for prey (Hooker & Baird, 1999). There are two recognized populations of northern bottlenose whales in Canada, the Scotian Shelf population and the Davis Strait-Baffin Bay population (Figure 9).

The whales of the Scotian Shelf display high site fidelity, residing year-long in the Gully, a large submarine canyon located 200 nautical miles east of Nova Scotia that was declared an MPA in 2004 (Hooker, Whitehead, & Gowans, 1999; Whitehead, Gowans, Faucher, & McCarrey, 1997) (see Figure 1). The Scotian Shelf population is believed to be composed of only about 140 individuals and that number appears to be stable (O'Brien & Whitehead, 2013). While the population resides primarily in the Gully, there is evidence that the whales also travel to the adjacent Haldimand and Shortland canyons, likely along the 500-1500 m isobath of the Scotian Slope (DFO, 2016).

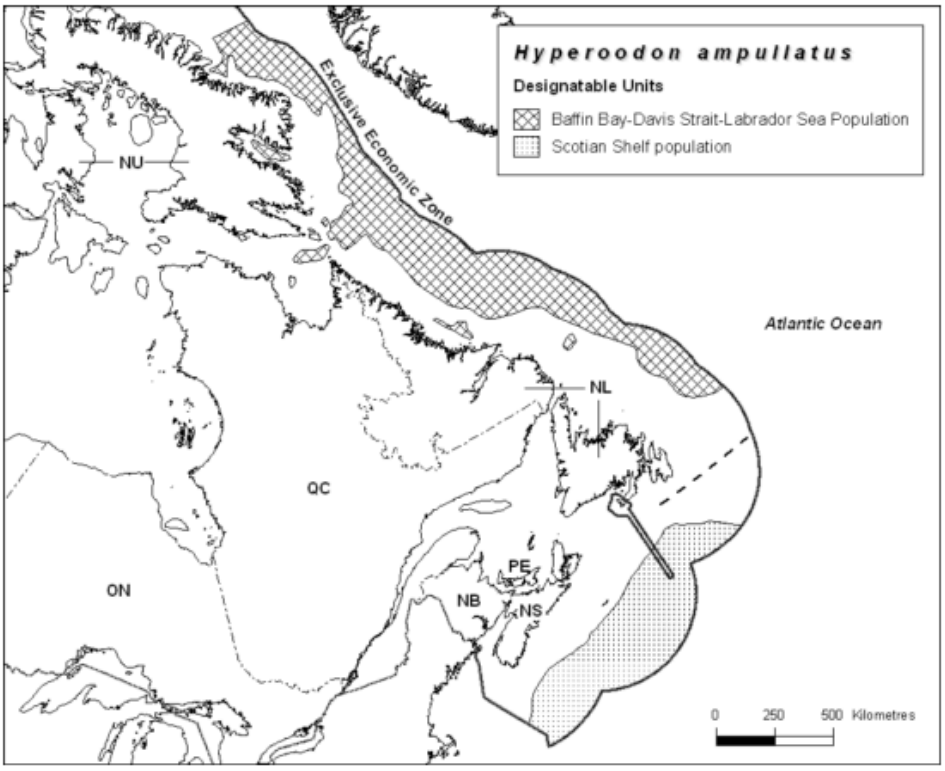

Figure 9: Ranges of the two recognized populations of northern bottlenose whales in Canada. Source: COSEWIC (2011).

Outside these areas, the whales are sighted with less frequency (Wimmer & Whitehead, 2004). Less is known about the Davis Strait population, which is believed to be larger and more widely dispersed (COSEWIC, 2011). They are thought to occupy the waters off eastern Newfoundland and Labrador, extending north through the Labrador Sea and Davis Strait up to Baffin Bay (COSEWIC, 2011). The two populations are considered distinct based on photographic and genetic analyses (Dalebout, Ruzzante, Whitehead, & Øien, 2006). The Scotian Shelf population has been listed as Endangered by COSEWIC and under the *SARA* while the Davis Strait population is considered Special Concern by COSEWIC but is not currently listed under the *SARA*

2.3.1 The Sackville Spur – a new population?

Based on acoustic and visual detections collected by researchers from the Whitehead Lab at Dalhousie University during the summers of 2015- 2017, there is evidence to suggest that a third, previously undescribed population of northern bottlenose whales exists around the Sackville Spur (Gillis, 2016) (see Figure 1). Clicks attributed to the species were first detected in the region during the 2015 season after surveys were

conducted around the perimeter of the Grand Banks. The following year, researchers returned to the same area and visually confirmed the presence of at least 50 individuals (L. Feyrer, pers comm, 2016). In 2017, visual encounters reconfirmed the presence of the species in the area and additional data collected is currently being analyzed. Prior to these encounters, anecdotal evidence suggested that northern bottlenose whales were present around the Flemish Cap (DFO, 2016), but the number of individual animals encountered in the region and the strong site fidelity of other populations suggest that these whales could represent a third distinct population. Due to the population's proximity to Newfoundland, it will be referred to as the Newfoundland (NL) population from this point forward.

2.4 Threats to northern bottlenose whales

2.4.1 Small population size

Historic whaling greatly reduced the number of northern bottlenose whales over the 20th century. It is believed that the entire population of the North Atlantic was at one point composed of up to 100,000 individuals (Whitehead & Hooker, 2012), but so far only rough estimates have been made. Over 80,000 whales were caught during the whaling period which lasted up until the 1970s (DFO 2016). The Scotian Shelf population remains small, and it is unknown what the pre-whaling population size was and whether this population has recovered or was ever previously much larger (DFO 2007). The population also appears to suffer from low mitochondrial diversity (Dalebout et al., 2006). Little is known about size of the Davis Strait population, but lack of sightings may indicate that it is smaller than initially thought (DFO, 2016). Compounding the effect of small population sizes, the small geographic ranges and specialized diet of northern bottlenose whales indicate that they occupy a narrow niche and may be tied to a very specific habitat (Whitehead et al. 2003), making them especially susceptible to disturbances. If the NL population is also small in size and geographically restricted, it too is particularly susceptible to impacts from human activity.

2.4.2 Anthropogenic noise

It has been widely accepted that anthropogenic sound causes negative impacts on marine mammals (Clark et al., 2009; Nowacek, Thorne, Johnston, & Tyack, 2007; Tyack

et al., 2011; Weilgart, 2007). Whales rely heavily on sound for nearly every part of their life history; to communicate with conspecifics, maintain group cohesion, find prey, and navigate (Hildebrand, 2005). Northern bottlenose whales produce clicks in the range of 20-55 kHz at a source level (i.e., loudness) of 175-202 decibels (dB) (Wahlberg, Beedholm, Heerfordt, & Møhl, 2011), and are considered to occupy a mid-frequency hearing range (Southall et al., 2007). Figure 10 shows the frequency range occupied by various biological and anthropogenic sounds, including northern bottlenose whale clicks and the hearing range of mid-frequency cetaceans which includes northern bottlenose whales. Table 2 outlines the source level of different anthropogenic sounds as they compare to northern bottlenose whale clicks.

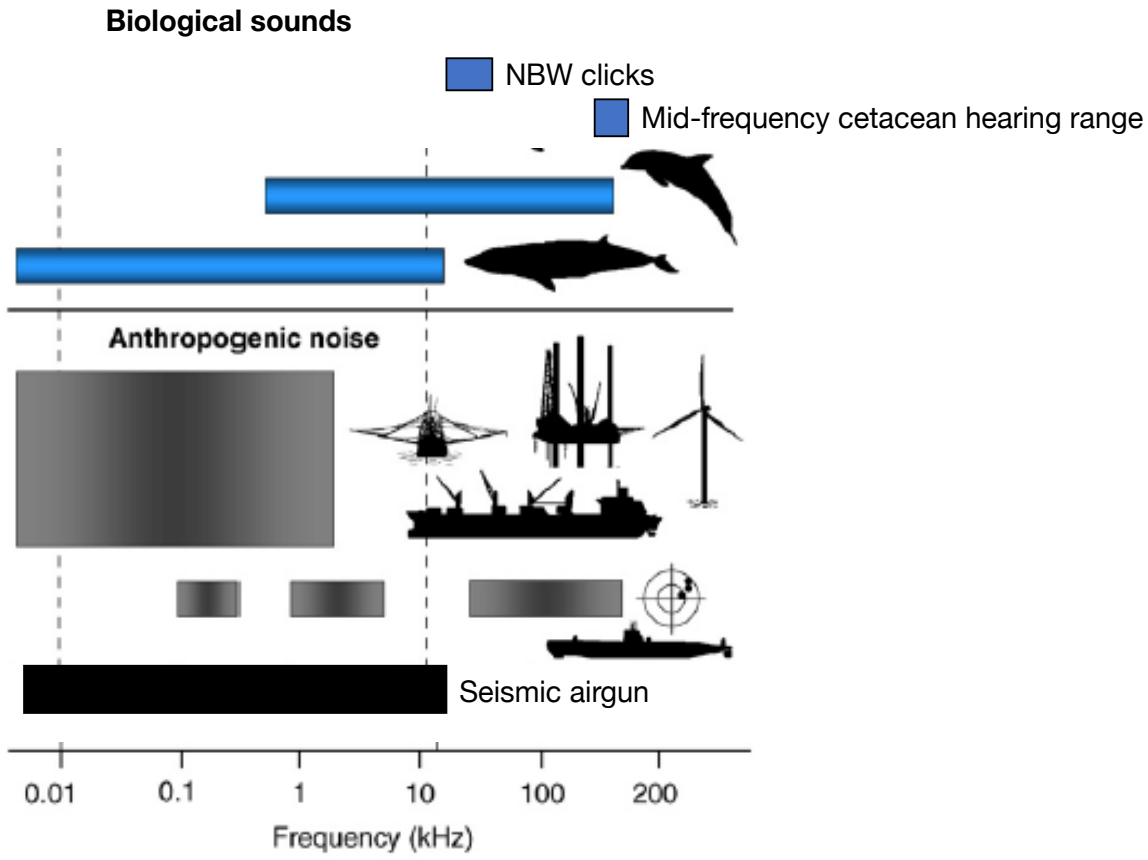

Figure 10: Frequency ranges of different biological and anthropogenic sound sources. Adapted from Slabbekoorn et al. (2010).

Table 2: Source level of northern bottlenose whale clicks and three different anthropogenic sound sources.

Sound type	Source level (dB)
Northern bottlenose whale clicks	175-202
Seismic survey	260 (Hildebrand, 2009)
Cargo vessel	192 (Hildebrand, 2009)
Small outboard engine (20 knots)	160 (Hildebrand, 2009)

With increased ambient noise, important biological functions become impaired, often resulting in serious negative impacts. These can generally be grouped into one of three types: behavioural changes, auditory impacts, and physiological impacts.

2.4.2.1 Behavioural changes

Behavioural changes manifest themselves in a manner of ways, from subtle changes in breathing or surfacing behaviour to direct avoidance of a sound source (Hildebrand, 2005). Avoidance can be temporary or longer-term. Temporary avoidance can result in certain negative impacts such as reduced foraging efficiency (Aguilar Soto et al., 2006). More serious consequences may arise from longer-term or repeated temporary avoidance. Northern bottlenose whales appear to be highly dependent on specific habitat sites, which likely offer reliable food sources and provide other elements that are essential their life history. If appropriate habitat does not exist elsewhere, animals may be forced to endure “costs” associated with continued exposure to sound (Weilgart, 2007). Cetaceans may also alter their dive patterns in response to noise exposure. The longest and deepest dive ever recorded for a northern bottlenose whale was linked to an avoidance manoeuvre due to the exposure to high-frequency naval sonar (Miller et al., 2015). Because beaked whales perform such deep dives in order to find food, abruptly altering their dive patterns in response to disturbance can have other associated consequences, such as interrupting foraging activity (DeRuiter et al., 2013) or, even inducing an effect similar to decompression sickness (Hooker et al., 2012) which can lead to more serious physical injury or even death.

Cetaceans have also been known to change their vocalization patterns in response to anthropogenic noise. Humpback whales were found to decrease their singing activity in the presence of seismic survey pulses (Cerchio, Strindberg, Collins, Bennett, & Rosenbaum, 2014) and a Cuvier's beaked whale stopped echolocating when exposed to mid-frequency sonar (DeRuiter et al., 2013). Alternatively, other species have been known to increase their rate of calling in response to increased noise levels. Blue whales were found to call more on days when seismic exploration activity was happening (Di Iorio & Clark, 2010) and killer whales increased call amplitude in response to vessel noise (Holt et al., 2009). If animals are altering their communications during times of increased noise levels, social functions such as group cooperation or mating may be negatively affected, and associated costs such as increased energy expenditure of compensatory behaviours can increase (Holt et al., 2015). Thus, the accumulation of chronic negative impacts for individuals can have serious implications for small populations and endangered species.

2.4.2.2 Auditory Impacts

Auditory impacts from sound exposure generally refer to effects that sound can have on hearing ability and function. One of the most commonly identified effects is called masking, wherein sound transmission and receipt is impeded by increased ambient noise (Clark et al., 2009). This can have obvious consequences for things like communication and foraging effectiveness, as individuals are less capable of picking up sound from conspecifics or target prey species, and so mating and feeding opportunities may be reduced (Clark et al., 2009). More serious auditory impacts can occur when hearing ability is negatively altered due to exposure to high intensity sounds. If normal hearing ability is recovered, the effect is known as a temporary threshold shift (TTS), but if the effect is permanent, then a permanent threshold shift (PTS) occurs (Southall et al., 2007). Due its permanency, a PTS is considered auditory "injury" (Southall et al. 2007). Both of these effects, PTS in particular, may cause serious negative impacts if individuals are no longer able to effectively receive biological sound signals important in carrying out daily functions.

2.4.2.3 Physiological impacts

Physiological impacts occur when sound exposure causes changes to an animal's physiology. For example, North Atlantic right whales experience increased stress levels in the presence of ship traffic noise (Rolland et al., 2012). More severely, exposure to intense sounds has also been linked with physical injury and death. Acute, high-intensity sounds produced from industrial sources such as seismic airguns used in exploration surveys or navy sonar have been linked to cetacean stranding events, and some of the animals examined post-mortem have shown signs of auditory trauma (Jepson et al., 2003). In the Canary Islands, fourteen beaked whales stranded following navy sonar activities that were conducted nearby. Post-mortem examination showed the presence of gas bubble lesions and fat embolisms, thought to be linked with exposure to the high-intensity mid-frequency sonar. Whales that were severely injured either died or stranded and then died due to cardiovascular collapse (Fernández et al., 2005). It is thought that in the presence of high-intensity acute sounds, cetaceans can become disoriented when attempting to flee the area and end up stranding on nearby beaches and shorelines (Parsons et al., 2008). If they have not already sustained lethal injury, the animals are then at risk of dying due to the complications of stranding. Interestingly, after a ban on military was enacted in the Canary Islands in 2004, no cetacean strandings had been recorded according to an update published by Férnandez, Arbelo, & Martin, in 2013.

Due to ongoing seismic exploration and drilling and heavy ship and fishing vessel traffic in and around the SS region, it is reasonable to assume that the area is experiencing increased levels of ambient noise, likely negatively impacting cetacean species that occur there, including northern bottlenose whales.

2.4.3 Entanglement in fishing gear

Entanglement in fishing gear has been identified as a threat to northern bottlenose whales (COSEWIC, 2011; DFO, 2016). The species has been known to interact with fishing vessels, as there are reports of interactions with the offshore Greenland halibut fishery in northern Labrador and the western Davis Strait (COSEWIC, 2011). Since the early 1980s, there have been 8 reported northern bottlenose whale entanglements in Atlantic Canada from the At-Sea Observer Program. These entanglements were due to longlines and benthic and pelagic otter trawls set for swordfish, silver hake, Greenland

halibut and squid, although silver hake and squid are no longer fished in the area. A number of the entangled animals were cut free, but it is unclear if they survived, while others endured lethal effects (COSEWIC, 2011). A gillnet from the Greenland halibut fishery was observed around the caudal peduncle of one of the dead individuals (COSEWIC, 2011). Another whale was seen entangled in longline gear in the Gully by researchers at Dalhousie University in 1999 (Gowans, Whitehead, Arch, & Hooker, 2000). In the 3M NAFO Division, groundfish (i.e., benthic) trawls are mainly used to fish target species (cod, redfish and Greenland halibut).

It is important to note that incidence of entanglements is likely higher than described by the literature due to interactions that go unseen and/or unreported in offshore areas. While the rate of reported entanglements is relatively low, for the Scotian Shelf population even one death per year caused by entanglement would exceed the 0.3 maximum potential biological removal (i.e., the maximum number of removed individuals that the population could sustain without suffering negative effects) (COSEWIC, 2011). Without knowing the population size of the NL population, it is possible that entanglements present a serious threat if they are responsible for the death of even a very small number of individuals.

2.4.4 Contamination & plastic debris

A study conducted in 2008 on the presence of contaminants present in northern bottlenose whales from the Gully and Davis Strait populations showed that DDT, PCBs, chlordanes, HCHs and dieldrin were all present in all collected blubber biopsy samples. Concentrations were higher in the Gully population than the Davis Strait population and there was a significant difference in the concentration of certain contaminants between samples taken before and after oil and gas development began near the Gully MPA (Hooker et al., 2008). Despite this, the levels appeared to be below the level that is suspected to cause health problems for other, more contaminated odontocete species. Contaminant levels are not known for the SS population, but nearby oil and gas exploration may pose the risk of remobilizing contaminants in sediments or introducing new contaminants into the area. However, there is no information on the effects of contaminants on northern bottlenose whales and thus it is difficult to discern whether this presents a serious threat to the species (COSEWIC, 2011).

Another concern is plastic waste present in the marine environment, as plastic persists in the ocean almost indefinitely. Rather than naturally biodegrading, large pieces of plastic degrade into increasingly smaller pieces until reaching microplastic size (<5 mm) (Andrady, 2011). Macro and microplastics have been found ingested by cetaceans, including beaked whales. Both types were found in the digestive tracks of three stranded True's beaked whales in Ireland (Lusher et al., 2015) and in Brazil, the stomach of a stranded Blainville's beaked whale was found to contain a large bundle of plastic threads (Secchi & Zarzur, 1999). In a more recent study, plastic was found to make up the vast majority (92.3%) of the debris found within the digestive tracks of a number of different cetacean species that were examined for marine debris ingestion in Irish waters (Lusher et al., 2017). For deep-diving species including beaked whales, the most common plastic item found were plastic bags. Microplastics were also identified in all the individuals examined for this type of debris, including two beaked whales. Some of the debris may have come from land, while some appeared to originate from fishing activities (Lusher et al., 2017). Presence of both micro and macroplastics can have negative effects on marine mammals. Large objects such as macroplastic debris can cause blockages causing the animal to eat less and eventually starve (Jacobsen, Massey, & Gulland, 2010). Because microparticles attract pollutants, it is possible that microplastics also cause bioaccumulation of pollutants in the tissues of some animals, resulting in sub-lethal effects (Lusher et al., 2017) . While coastal and pelagic species may be expected to be exposed to greater amounts of marine debris, Lusher et al. (2017) found that deep divers actually contained more plastic items than pelagic species, notably plastic bags. Although it is not possible to confirm the reason for ingestion, prey confusion where plastic bags are mistaken for cephalopods, was speculated. The presence of microplastic particles in marine mammals is likely due to trophic transfer from their prey.

During surveys conducted in 2017 around the Flemish Cap by researchers from the Whitehead Lab at Dalhousie University, a number of marine debris types were observed. Items such as miscellaneous food packaging, organic food waste, plastic and glass bottles and garbage bags were all observed. Debris were often sighted in the wake of a large mid-water trawl vessel that was fishing in the area and were attributed to that

source. As the NL population of northern bottlenose whales are encountering plastic marine debris, they are also at risk from associated negative impacts.

2.4.5 Prey reduction

While the diet composition of northern bottlenose whales has not been quantified, they appear to rely heavily on *Gonatus* spp. squid (Hooker et al., 2001). It has been suggested that the resident whales of the Gully remain in such a localized area due to a consistent supply of prey (Hooker, Whitehead, & Gowans, 2002). If there are few alternative habitats with a sufficient abundance of food and whales are displaced from their habitat, there could be serious impacts on the population (DFO, 2016). If the diet of the NL population is similarly specialized, and prey habitat is limited outside this area, food limitation may occur. While squid is not fished in the region, they are caught as bycatch by other fisheries. Furthermore, there is evidence that noise generated from certain anthropogenic activities such as seismic airguns can also disturb marine invertebrates such as squid (André et al., 2011). However, without more information on the whales' range and diet in this area, the full impacts of this threat on this population are unclear.

2.4.6 Vessel strikes

No confirmed cases of a vessel collision with a northern bottlenose whale exist, although a few individuals have been observed with markings that may have been caused by collisions (Gowans, 1999). There also exists a documented case of a Sowerby's beaked whale found on Sable Island, which appeared to suffer injuries indicative of a ship strike (Lucas & Hooker 2000). The offshore distribution of northern bottlenose whales makes it difficult to document interactions with vessels, so collisions remain a possibility. Based on ship traffic, the SS population may be at risk of vessel strike. However, due to their speed and relatively short surface intervals, versus time spent at depth, it is likely that this species is able to avoid most collisions (DFO, 2016). These factors, combined with the low incidence of known collisions, makes the severity of this threat difficult to quantify at this time.

2.5 Existing management and governance in the study area

Limited international conservation measures exist to protect or manage a poorly understood population of whales in ABNJ, making the number of anthropogenic pressures that the SS population currently face extremely worrying. However, that is not to say that no management or governance exists for the high seas. The oil and gas exploration, fishing, and shipping activities that take place on and around the Sackville Spur are all subject to a degree of oversight through a selection of management bodies and conventions. An examination of these regimes as they pertain to the study area follows.

2.5.1 Provisions under the United Nations Convention on the Law of the Sea

The United Nations Convention on the Law of the Sea (UNCLOS) is the most comprehensive Convention guiding activities in the world's oceans and lays out the legal basis for activities carried out on the high seas. Definitions set out in UNCLOS are largely what determine Canada's right to exploit the seabed beyond its EEZ. According to Article 77, "The coastal State exercises over the continental shelf sovereign rights for the purpose of exploring it and exploiting its natural resources", natural resources being defined as "the mineral and other non-living resources of the seabed and subsoil…" (UNCLOS, 1982). Article 76 defines the continental shelf as comprising "the seabed and subsoil of the submarine areas that extend beyond its territorial sea throughout the natural prolongation of its land territory to the outer edge of the continental margin, or to a distance of 200 nautical miles from the baselines from which the breadth of the territorial sea is measured where the outer edge of the continental margin does not extend up to that distance" (UNCLOS, 1982). It also defines the continental margin as "the submerged prolongation of the land mass of the coastal State, and consists of the seabed and subsoil of the shelf, the slope and the rise" (UNCLOS, 1982). A coastal State is able to "establish the outer edge of the continental margin wherever the margin extends beyond 200 nautical miles from the baselines from which the breadth of the territorial sea is measured" based on various definitions laid out in the Convention (UNCLOS, 1982, Art. 76). Thus, based on the bathymetric characteristics of Canada's continental shelf, it is able to freely exploit the natural resources (including hydrocarbon deposits) of the seabed beyond the legal 200 nm EEZ limit.

2.5.2 Canada-Newfoundland and Labrador Offshore Petroleum Board

The C-NLOPB is the main body responsible for managing oil and gas activities in offshore Newfoundland. The Eastern Newfoundland region, which encompasses the Flemish Pass Basin and the Sackville Spur, is an area of "High Activity". It is currently part of an active Call for Nominations, which is when industry puts forth nominations for areas which it wishes to explore further (known as areas of interest, AOIs) (C-NLOPB n.d.(b)). Upon consideration of these nominations, the C-NLOPB will design a sector, which is the area within which a Call for Bids will be made. Once a Call for Bids is open, members of industry can bid on the individual parcels that have been put forth. ELs are then awarded to those companies that submitted the highest bids (in terms of exploration expenditure over a 6-year period) for each parcel. An EL allows a company the exclusive rights to explore and drill for petroleum in their parcel, develop that portion of the offshore to produce oil and/or gas, and to obtain a production license for that parcel. If the exploratory drilling results in a significant discovery then an SDL is issued. If a commercial discovery is made and declared, a by a production license (PL) is then issued, which offers the same rights as an EL in addition to the exclusive rights to produce petroleum within that parcel and the title to that petroleum (C-NLOPB n.d.(b)). PLs are valid for 25 years.

When a proponent is interested in beginning a project, the C-NLOPB has a process for ensuring that an Environmental Assessment (EA) is conducted. The C-NLOPB also conducts Strategic Environmental Assessments (SEAs), which are broader-scale EAs that consider a larger ecological area rather than a specific site. An SEA of the Eastern Newfoundland Region was completed in 2014 (C-NLOPB, 2014).

2.5.3 Northwest Atlantic Fisheries Organization

As mentioned, NAFO is the responsible body for managing fishing in the international waters of its NRA. According to its Convention, NAFO's objective is to "ensure the long-term conservation and sustainable use of the fishery resources in the Convention Area and, in so doing, to safeguard the marine ecosystems in which these resources are found." (NAFO, 2017b, Introduction). The Convention sets out a series of manners by

which NAFO may manage the fisheries within its NRA, such as carrying certain conservation and management measures, setting total allowable catches (NAFO, 2017, Art. 8(a-c)), and reviewing the status of fish stocks and identify any actions that might be needed or their conservation (NAFO, 2017, Art. 6(a)). There are currently 12 NAFO Contracting Parties (CPs): Canada, Cuba, Denmark (Faroe Islands and Greenland), the European Union, France (via St. Pierre et Miquelon), Iceland, Japan, Norway, Republic of Korea, Russian Federation, Ukraine and the United States of America. By signing on as CPs, states are involved in decision-making and have a say in what kind of measures NAFO takes with respect to managing the fishery.

Through its Conservation and Enforcement Measures, NAFO has also taken steps to preserve marine ecosystems in the region. Within its regulatory area, NAFO has also identified 21 Vulnerable Marine Ecosystems (VMEs) which are closed to bottom fishing (Figure 10). In the context of NAFO, VMEs are defined using the characteristics outlined in the *FAO (Food and Agriculture Association) International Guidelines for the Management of Deep-Sea Fisheries in the High Seas*. These guidelines outline a series of characteristics used to help identify VMEs, and they include: i) Uniqueness or rarity; ii) Functional significance of the habitat; iii) Fragility; iv) Life-history traits of component species that make recovery difficult; v) Structural complexity (FAO, 2009). Based on these criteria, structures that are most commonly designated as VMEs are organisms such as corals, sponges, dense faunal aggregations, and invertebrate and microbial species endemic to certain areas. In addition, VMEs may also include the underwater geological features that support these kinds of species aggregations such as edges and slopes, canyons, hydrothermal vents, and cold seeps (FAO, 2009). These 21 VMEs are composed of 6 seamount closures, one large coral area closure, and 14 sponge and coral closures, including the Sackville Spur High Sponge and Coral Closure (Figure 11). All but one of these areas are protected from bottom-fishing until December 2020, after which time they will be reassessed. The Eastern Flemish Cap coral and sponge closure is closed until December 2018 (NAFO, 2017c, Art. 17(3)(b)). While VMEs protect sensitive benthic organisms from bottom fishing, they do not prohibit midwater trawling or oil and gas exploration.

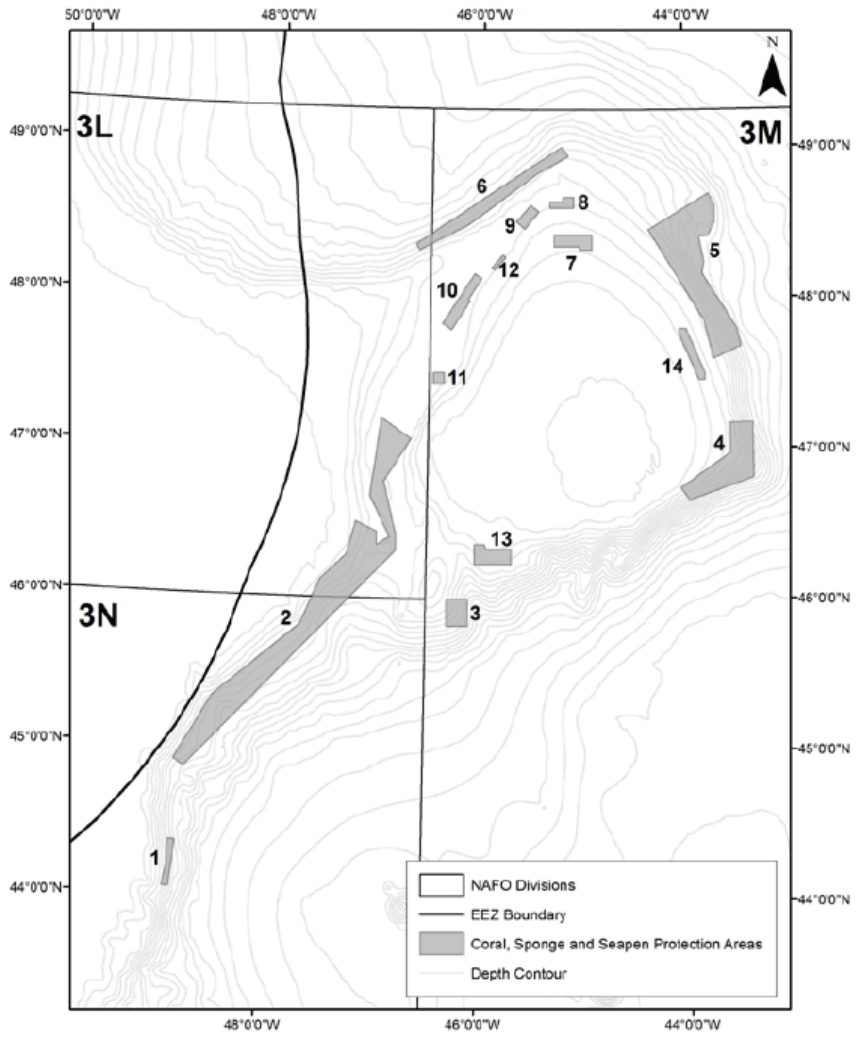

Figure 11: Location of sponge and coral concentrations closed to bottom fishing and recognized as Vulnerable Marine Ecosystems, managed by the Northwest Atlantic Fisheries Organization. The Sackville Spur closure is indicated as number 6. Source: NAFO (2017c).

NAFO has also adopted a fishery observer program, whereby "…every fishing vessel shall at all times in the Regulatory Area carry at least one independent and impartial observer." (NAFO, 2017c, Art. 30(1)). According to Article 30(2), observers are required to (a) monitor compliance and verify logbook entries including catch species, (b) maintain detailed records, and (c) record the catch composition for each haul, among other duties (NAFO, 2017c).

2.5.4 International Maritime Organization

A specialized agency of the United Nations, the International Maritime Organization (IMO) is the global authority for shipping interests and safety at sea. It was developed as a response to the understanding that shipping is an international industry and requires an international basis for regulations and standards to be effectively implemented (IMO, 2013). Its main priorities are safety, security and environmental performance, and it works to keep existing legislation updated and properly implemented by the countries that have accepted them (IMO, 2013). As the main international body responsible for international shipping, the IMO occupies a central role regarding managing threats to at-risk marine species that may stem from either collisions or shipping noise. Depending on the State with which the ships that traverse the waters of the Sackville Spur are registered, they may or may not be subject to various IMO Conventions and regulations that address these issues.

Chapter 3: Setting the legal and political context

Although largely a high seas management issue, Canadian law and policy for biodiversity protection is relevant for a number of reasons. Chiefly this is because Canada exerts authority over oil and gas licensing in the area, any environmental protection measures will be carried out in line with Canadian guidelines. In addition, Canada has put forth a request to legally extend its claim over the seabed in the Atlantic region through the United Nations (UN) Extended Continental Shelf Program. Pending approval of Canada's claim, Canadian sovereignty over the seabed would expand eastward to include the Flemish Cap (DFO, 2017a), and the whales' habitat. As a result, any activities or permits affecting the seabed that might overlap with the whales' habitat would be fully under Canadian jurisdiction. Canada is also the closest coastal state to this new population of whales, and with two at-risk populations within its waters, it may be reasonable to expect Canada to take on a leadership role in helping to protect this population. Furthermore, if this population does indeed interact or is in some way connected with existing Canadian populations, then management of the NL population may directly support the management of the at-risk populations within Canadian waters. The following section will review both Canadian and international policies on biodiversity conservation in the marine environment that are considered relevant to the management problem at hand, and evaluate their perceived effectiveness. It is not meant to be a comprehensive list but rather a selected review of the legal tools available to protect sensitive marine species.

3.1 Relevant Canadian Policy

Statement of Canadian Practice with Respect to the Mitigation of Seismic Sound in the Marine Environment

The Statement of Canadian Practice (SOCP) represents the minimum standard mitigation measures that companies should take when conducting seismic surveys in non-ice covered Canadian waters. The SOCP outlines a number of measures that are recommended for reducing the impact of sound generated by seismic surveys on marine mammals. These include, but are not limited to: (1) planning surveys to avoid marine mammal aggregations, (2) the establishment of a 500-meter exclusion zone (EZ) that must be monitored by a trained marine mammal observer (MMO) at all times during

daylight hours, (3) a 30-minute pre-watch period before the array is started, (4) a ramp-up procedure whereby the airguns are stared up incrementally, (5) delaying array ramp-up or, depending on the animal's status under the *SARA*, shutting the array shut-down if a marine mammal is sighted within the EZ, (6) the use of alternative technologies such as passive acoustic monitoring (PAM) when the full safety zone is not visible (SOCP, 2007a).

While these measures have been formulated to guide activities during seismic surveys, they are still just recommendations for industry and are not binding. It should be noted that the SOCP allows for regional specificities in oceanographic, biological and other characteristics to dictate modifications in the way the mitigative measures outlined above are applied (SOCP, 2007b). Concerns have also been raised over the effectiveness of these guidelines (Compton et al. 2008), especially for protecting beaked whales. Beaked whales are notoriously difficult to spot based on their elusive nature and long dive times, and some argue that the likelihood of visually observing them during seismic surveys is too low to ensure that proper mitigation is actually carried out (Barlow & Gisiner, 2006). Furthermore, because of their deep dives, beaked whales can remain below the surface for upwards of an hour (Hooker & Baird, 1999) and so a 30-minute watch prior to starting the array is insufficient to guarantee that whales will surface before the airgun begins to fire. Finally, because beaked whales may be particularly susceptible to the effects of sound, a 500-meter EZ may not represent sufficient distance to ensure that these animals are not experiencing effects. In fact, the size of the EZ was developed largely arbitrarily (Compton et al., 2008) and there is little understanding of what kind of noise thresholds are tolerable for different cetacean species, nor what kind of distance is required to maintain this threshold, especially when sound attenuation varies based on oceanographic characteristics and technical properties of the sound source (Southall et al. 2007). Overall, the SOCP represents what some have argued is a weak attempt at protecting at-risk species from the impact of seismic survey noise, and this is likely especially true for beaked whales.

Oceans Strategy

Canada's *Oceans Strategy* is the Government of Canada's policy on managing estuarine, coastal and marine areas. Within it, there are three main policy objectives:

understanding and protecting the marine environment, supporting sustainable economic opportunities and international leadership. The strategy also embraces a number of principles including an ecosystem approach to conservation and the application of the precautionary approach to the "conservation, management and exploitation of marine resources in order to protect these resources and preserve the marine environment" (Oceans Strategy, 2002). Application of the precautionary approach is further emphasized through commitments to taking an ecosystem-based approach to management, applying conservation measures "necessary to maintain biological diversity and productivity of the marine environment, including the establishment of marine protected areas", and giving priority to "maintaining ecosystem health and integrity, especially in the case of uncertainty" (Oceans Strategy, 2002). Under the first broad policy objective of understanding and protecting the marine environment, the Oceans Strategy acknowledges unique, sensitive and ecologically significant areas that must receive special protection and states that recovery of endangered or threatened species is urgent and actions are needed to keep healthy populations from becoming at risk (Oceans Strategy, 2002). Under the second objective of international leadership, the Strategy acknowledges the need for international ocean management and asserts that by using its influence on international priorities and decisions, Canada can ensure, among other things, sustainable ocean resources (Oceans Strategy, 2002). This commitment suggests it may be a reasonable expectation for Canada to take on a leadership role in promoting the protection of a sensitive, at-risk species and championing proactive efforts in international waters. This will be discussed further in Chapter 7.

3.2 Relevant Canadian legislation

Canada Shipping Act, 2001

The *Canada Shipping Act* (CSA) applies to all Canadian vessels that are operating anywhere in the world and foreign vessels operating in Canadian waters. While it does incorporate some measures from the IMO's International Convention for the Prevention of Pollution from Ships (MARPOL) which is aimed at reducing pollution from ships, it does not address noise as pollutant. Section 187 states that "No person or vessel shall discharge a prescribed pollutant…" and defines a pollutant as "a substance that, if added

to any waters, would degrade or alter or form part of a process of degradation or alteration of the quality of the waters to an extent that is detrimental to their use by humans or by an animal or a plant that is useful to humans" (CSA, 2001). While it could be argued that noise indeed degrades the quality of the waters in a way that is detrimental to marine animals, particularly marine mammals, noise is technically not part of the definition of a pollutant so at this time the CSA offers no protection from the impacts of ship noise on marine life.

Oceans Act, 1996

The *Oceans Act* (OA) is Canada's most broadly reaching piece of legislation regarding ocean management and is designed to complement and provide authority to the aforementioned *Oceans Strategy*. As per section 30, it is based on the principles of sustainable development, integrated management, and, most notably, application of the precautionary approach, "that is, erring on the side of caution" (Oceans Act, 1996). Although there are no specific measures directed towards minimizing threats to at-risk marine species, the *Act* does provide the responsible Minister with the authority to designate marine protected areas within Canada's internal waters, the territorial sea and the EEZ. Section 35 of the *Act* specifies reasons for MPA designation including for the "(a) conservation and protection of commercial and non-commercial fishery resources, including marine mammals, and their habitats; (b) the conservation and protection of endangered or threatened marine species, and their habitats; (c) the conservation and protection of unique habitats; (d) the conservation and protection of marine areas of high biodiversity or biological productivity" (Oceans Act, 1996). Section 35 was used to designate the Gully as an MPA in 2004, largely due to its importance for a resident population of northern bottlenose whales (Hooker et al., 2002).

Fisheries Act, 1985

Marine mammals are included in the definition of "fish" under the *Fisheries Act.* While there are prohibitions against any activity that "results in serious harm to fish", this applies only to species that are part of a commercial, recreational or Aboriginal fishery (Fisheries Act, 1985, s. 35). There are also provisions prohibiting the introduction of a deleterious substance in waters frequented by fish, a deleterious substance being defined as "any substance that, if added to any water, would degrade or alter or form

part of a process of degradation or alteration of the quality of that water so that it is rendered or is likely to be rendered deleterious to fish or fish habitat or to the use by man or fish that frequent that water." (Fisheries Act, 1985, s. 34). While it could potentially be argued that noise could be considered a deleterious substance under this definition, it remains exceedingly difficult to demonstrate degradation of an environment as a result from sound. Pursuant to section 43 of the *Fisheries Act*, legislation directed more specifically towards marine mammals was developed through the creation of the *Marine Mammal Regulations.* While these regulations are heavily geared towards hunting and harvesting activities, they do include a prohibition against disturbing or harassing marine mammals except when fishing for them (*Marine Mammal Regulations*, s. 7). However, no definition of "disturbance" is given, leaving this measure vague and open to interpretation.

Canadian Environmental Assessment Act, 2012

The *Canadian Environmental Assessment Act* (CEAA) was enacted with the purpose of to protecting "the components of the environment that are within the legislative authority of Parliament from significant adverse environmental effects caused by a designated project" and to ensure "that projects, […] that are to be carried out on federal lands, **or those that are outside Canada** and that are to be carried out or financially supported by a federal authority, are considered in a careful and precautionary manner **to avoid significant adverse environmental effects**" (CEAA, 2012, s. 4(1)(g), emphasis added). Per section 5(1), "…the environmental effects that are to be taken into account in relation to an act or thing, a physical activity, a designated project or a project are (a) a change that may be caused to the following components of the environment that are within the legislative authority of Parliament: (i) fish and fish habitat as defined in subsection 2(1) of the *Fisheries Act*, (ii) aquatic species as defined in subsection 2(1) of the *Species at Risk Act,* […], (iv) any other component of the environment that is set out in Schedule 2" (CEAA, 2012).

According to section 15, the responsible authority for projects that are subject to an environmental assessment (EA) is, among others, "…the federal authority that performs regulatory functions" (CEAA, 2012). In the case of oil and gas activities in Newfoundland's offshore, the federal authority is the C-NLOPB. It is thus up to the C-

NLOPB to ensure that the proponent conducts an EA, that a report is prepared with respect to that EA, that the report is open for public comment, and then revised and submitted to the Minister (CEAA, 2012).

According to the *Act,* "The responsible authority with respect to a designated project may delegate to any person, body or jurisdiction referred to in paragraphs (a) to (f) of the definition *jurisdiction* … the carrying out of any part of the environmental assessment of the designated project and the preparation of the report with respect to the environmental assessment of the designated project, but must not delegate the duty to make decisions under subsection 27(1)" (CEAA, 2012, s. 26(1)). Based on this section, the C-NLOPB delegates to the proponent the duty to perform an EA when a proponent expresses interest in exploring an area for oil and gas. Once that has been completed, "The responsible authority … after taking into account the report with respect to the environmental assessment of the designated project, must make decisions under subsection 52(1)." (CEAA, 2012, s. 27(1)). Subsection 52 states that "…the decision maker … must decide if, taking into account the implementation of any mitigation measures that the decision maker considers appropriate, the designated project (a) is likely to cause significant adverse environmental effects referred to in subsection 5(1); and (b) is likely to cause significant adverse environmental effects referred to in subsection 5(2)" (CEAA, 2012). Thus, it is up to the C-NLOPB to decide whether or not a proponent's actions will cause significant adverse environmental effects, based on the proponent's proposed mitigation strategy. If the C-NLOPB decides that a project will cause significant adverse environmental effects, they must refer to the Governor in Council (GIC) to determine where effects are justified (CEAA, 2012, s. 52(2)). In that instance, the GIC makes the final call regarding whether or not effects are justified (CEAA, 2012, s. 31(1)). This gives a lot of decision-making power to the C-NLOPB in terms of evaluating what constitutes significant environmental effects and whether or not mitigation measures are adequate, especially given that the definition of what constitutes "significant" adverse environmental effects and what can be considered fair justification for these effects is not specified. As many proponents use the SOCP as their proposed mitigation scheme, it is likely that considerations made by the C-NLOPB are not rigorous enough for beaked whales and that proposed mitigation measures are not being

adequately evaluated. Furthermore, since socio-economic concerns are part of this decision-making process, these may take precedence over environmental protection.

Species at Risk Act, 2002

The *SARA* protects Threatened and Endangered species and their habitats. Section 32(1) states that "No person shall kill, harm, harass, capture or take an individual of a wildlife species that is listed as an extirpated species, an endangered species or a threatened species." Regarding protection of habitat, section 33 states "No person shall damage or destroy the residence of one or more individuals of a wildlife species that is listed as an endangered species or a threatened species…" and, regarding critical habitat, "…no person shall destroy any part of the critical habitat of any listed endangered species or of any listed threatened species […] if (a) the critical habitat is on federal land, in the exclusive economic zone of Canada or on the continental shelf of Canada" (among other things) (SARA, 2002, s.58(1)). The *SARA* also takes into account the application of the precautionary approach, stating that "…if there are threats of serious or irreversible damage to a wildlife species, cost-effective measures to prevent the reduction or loss of the species should not be postponed for a lack of full scientific certainty" (SARA, 2002, s. 38). While the *SARA* represents the most robust piece of legislation for protecting at-risk species in Canada, its measures really only extend over those species or designated populations that have been officially listed as either Endangered or Threatened. The NL population of whales, being newly discovered and residing outside Canada's legal boundaries, currently holds no recognized status under any legislation.

3.3 Relevant international laws and conventions

The following is an overview of select international conventions and organizations that address in some form or another the preservation of marine biodiversity and the marine environment. They are presented in no particular order.

UNCLOS, 1982

UNCLOS contains some provisions for preserving marine biodiversity. Article 192 gives a general obligation for States to "protect and preserve the marine environment" while according to Article 194(5), States are to take all necessary measures "to protect and preserve rare or fragile ecosystems as well as the habitat of depleted, threatened or endangered species and other forms of marine life." (UNCLOS, 1982). There are few articles that mention marine mammals directly, although they are referenced in Article 65 which reads that "…States shall cooperate with a view to the conservation of marine mammals and in the case of cetaceans shall in particular work through the appropriate international organizations for their conservation, management and study" (UNCLOS, 1982). Within the section dealing specifically with the high seas, Article 120 states that the same provision made under Article 65 also applies to marine mammals in the high seas (UNCLOS, 1982).

The Convention on Biological Diversity, 1993

The Convention on Biological Diversity (CBD) came about in response to the United Nations' recognition that in the face of human activity, global biodiversity needed to be preserved for future generations. Notably, in Article 4, the CBD makes express mention of areas beyond national jurisdiction: "…the provisions of this Convention apply, in relation to each Contracting Party: (a) in the case of components of biological diversity, in areas within the limits of its national jurisdiction; and (b) In the case of processes and activities, regardless of where their effects occur, carried out under its jurisdiction or control, within the area of its national jurisdiction or beyond the limits of national jurisdiction." (CBD, 1993). Protection of biodiversity is limited to areas within national jurisdiction. The "processes and activities" referred to in Article 4(b) include marine scientific research and bioprospecting carried out in areas beyond national jurisdiction, neither of which appear to pose threats to northern bottlenose whales in the SS at this time. Commitments to directly protecting biodiversity are made under Article 8, which states that "Each Contracting Party shall, as far as possible and appropriate: (a) Establish a system of protected areas or areas where special measures need to be taken to conserve biological diversity; … (d) Promote the protection of ecosystems, natural habitats and the maintenance of viable populations of species in natural surroundings; … (f) Rehabilitate and restore degraded ecosystems and promote the

recovery of threatened species, *inter alia*, through the development and implementation of plans or other management strategies…" (CBD, 1993, Art. 8). Regarding activities that may induce negative impacts, Article 14(1)(a) calls for "…appropriate procedures requiring environmental impact assessment of its proposed projects that are likely to have significant adverse effects on biological diversity with a view to avoiding or minimizing such effects and, where appropriate, allow for public participation in such procedures…" (CBD, 1993).

Convention on the Conservation of Migratory Species of Wild Animals (CMS)

The CMS is a treaty under the United Nations Environment Programme that strives to protect migratory animals and their habitats on a global scale. It is the only global convention aimed specifically at migratory species. The Convention defines migratory species as "...the entire population or any geographically separate part of the population of any species or lower taxon of wild animals, a significant proportion of whose members cyclically and predictably cross one or more national jurisdictional boundaries" (CMS, 2017a, Art. I). Through this Convention, CPs are expected to individually or cooperatively take action to conserve these types of species and their habitat and to take action to avoid any such species becoming endangered (CMS, 2017a, Art. II). The northern bottlenose whale is listed under Schedule II of the CMS, which means they have been deemed to have an "unfavourable conservation status" and require international agreements for their conservation which may range in formality from legally binding treaties to Memoranda of Understanding (CMS, 2017b). Despite this listing, Canada is not currently a Party to the CMS, and therefore protection of northern bottlenose whales through action under the CMS will not be discussed further.

The Convention on the Cooperation in the Northwest Atlantic Fisheries

The Convention on the Cooperation in the Northwest Atlantic Fisheries (CCNAF) guides and governs the action of NAFO and is legally binding on its CPs. The Convention was amended in May of 2017 with the intent of modernizing it by incorporating, among other things, an ecosystem approach to fisheries management that includes a commitment to minimizing the adverse effects of fishing activities and considering the relationship between all the components of the ecosystem. Each CP has the duty to "(a) implement this Convention and any conservation and management

measures or other obligations binding on it and regularly submit to the Commission a description of the steps it has taken to implement and comply with such measures…" and to "(c) take all necessary actions to ensure the effectiveness of and to enforce the conservation and management measures adopted by the Commission" (NAFO, 2017b Art. X).

Under Article III, the Convention has affirms commitments to "…(c) apply the precautionary approach; (d) take due account the impact of fishing activities on other species and marine ecosystems and in doing so, adopt measures to minimize harmful impact on living resources and marine ecosystems; (e) take due account of the need to preserve marine biological diversity; … (i) take due account of the need to minimize pollution and waste originating from fishing vessels as well as minimize … catch of species not subject to a directed fishery and impacts on associated or dependent species, in particular endangered species." (NAFO, 2017b).

As per Article VI(13), CPs are permitted to pursue "non-discriminatory trade-related measures against any flag State or fishing entity whose fishing vessels engage in fishing activities that undermine the effectiveness of the conservation and management measures adopted by the Commission." (NAFO, 2017b). This is of note as it may allow for Canada to adopt a leadership role in encouraging other NAFO CPs to observe the new amendments in the interest of protecting this new population of whales.

Guidelines and actions under the International Maritime Organization

In 2014, the IMO released its *Guidelines for the Reduction of Underwater Noise from Commercial Shipping to Address Adverse Impacts on Marine Life*. While these are non-mandatory guidelines and there is no actual requirement for member States to adopt them, they nonetheless represent an acknowledgement of the negative impacts on marine life generated by ship noise and the need for appropriate solutions. The guidelines are mainly focused on the design of new ships, particularly propellers designed to reduce cavitation, the major source of ship-generated noise caused when bubbles of water vapour burst as water moves over a propeller blade (IMO, 2014). Homogeneous hull design, selection of onboard machinery, proper location of equipment in the hull, and a number of other measures are considered. For existing ships, propeller

cleaning and the application of effective hull coatings can help reduce noise as can reducing ship speed and rerouting to avoid sensitive marine areas (IMO, 2014).

The IMO has also developed spatial strategies for the protection of marine organisms and ecosystems. Particularly Sensitive Sea Areas (PSSAs) are areas that are recognized as requiring special protection from the impacts of shipping due to ecological socio-economic or scientific importance and must accompanied by an associated protective measure (APM) that can be legally controlled by the IMO, such as area avoidance (IMO, 2006). To have an area considered for PSSA designation, any IMO Member State can submit an application to the IMO's Marine Environmental Protection Committee for review. Among the ecological criteria for PSSA designation are areas that contain rare or fragile ecosystems, have been identified as critical habitat for a rare or endangered marine species, and/or are highly productive (IMO, 2006). Other IMO-sanctioned measures include Areas to be Avoided (ATBAs), which are areas that should be avoided by all or some classes of ships for various reasons including damage to the environment, and Traffic Separation Schemes (TSS), which alter or establish specific ship traffic lanes (Altman, n.d.). These strategies have previously been used to protect cetaceans. In 2007, the IMO approved a request to have Roseway Basin, identified as critical habitat for endangered North Atlantic right whales, be designated a voluntary Area To Be Avoided (ATBA), the first ATBA that was ever implemented specifically for an endangered species (Vanderlaan & Taggart, 2009). A vessel speed reduction measure to protect cetaceans has also been established under the auspices of the IMO in the Strait of Gibraltar, the first speed recommendation established under a TSS for cetacean conservation (Silber et al., 2012).

The International Convention for the Regulation of Whaling

The International Convention for the Regulation of Whaling (ICRW) was signed in 1946 for the purpose of conserving whale stocks and regulating the whaling industry, and also established the International Whaling Commission (IWC). While the ICRW is written such that it focuses mainly on regulating commercial whaling activities, it does allow the Commission to take protective measures to conserve whales such as establishing sanctuary areas (ICRW, 1946, Art. V). However, the basis for these kinds of measures and the extent of this authority are not clearly defined. Furthermore, the language of the

ICRW is often contradictory, at once providing for consideration that whales have been over-exploited and require protection, while also stating that increasing whale stocks will allow for increased whale captures (ICRW, 1946, Preamble). This contradiction is more widely illustrated in practice through the ongoing tension between States with an interest in whaling and other CPs who either have no interest or who oppose it (Simmonds & Hutchison, 1996). As a result, the interests of the IWC are strongly divided between its CPs. Still, it remains the only body with the authority to establish whale sanctuaries in ABNJ. The aim of these sanctuaries is to prohibit commercial whaling, and currently only two are in existence with a third not yet having achieved three-quarters majority required for designation (IWC, 2017a). While the IWC has historically mainly focused on managing large whales, small cetaceans, which include northern bottlenose whales, have more recently begun to receive greater attention. According to the IWC, the Commission "recognizes the need for international co-operation to conserve and rebuild depleted populations of small cetaceans. It encourages countries to seek scientific advice from the IWC on small cetaceans, and has invited IWC member nations to provide technical or financial assistance to countries with threatened small cetacean populations" (IWC, 2017b). In 1979, the IWC established the Scientific Committee's Small Cetaceans Sub-Committee established to study and advise on small cetacean conservation issues. One of the main ways the IWC is advancing small cetacean conservation is through Conservation Management Plans (CMPs) which aim to protect and rebuild at-risk cetacean populations. The first CMP for a small cetacean species, the Franciscana dolphin, was developed in 2016. However, according to the CMP Work Plan, it takes a minimum of three years from when a CMP is nominated to when it becomes endorsed by the Commission (IWC, 2016). Furthermore, it is the proponent of a CMP who must be the main source of funding to support the effort. The IWC has also set up a Small Cetacean Conservation Research Fund that supports high-priority research to improve conservation outcomes for small cetaceans through contributions from governments and NGOs (IWC, 2017b). The lengthy wait time for consideration, the lack of guarantee that a proposal will even be accepted by the IWC, and the overall low degree on action for small cetacean protection shown by the IWC thus far makes this a less than ideal solution for the pressing matter at hand.

United Nations General Assembly Resolution 69/292

Perhaps the most promising resolution holding most potential to address biodiversity conservation in the high seas is the recent United Nations General Assembly's (UNGA) resolution 69/292 calling for the "development of an international legally-binding instrument under UNCLOS on the conservation and sustainable use of marine biological diversity of areas beyond national jurisdiction" (UNGA, 2015, Preamble). This resolution is the product of the 2012 UN Sustainable Development Conference in Rio where commitments were initially made to address issues relating to high seas conservation. Resolution 69/292 was officially adopted in June of 2015. Since that time, a Preparatory Committee (Prep Com), open to all UN Member States, was established so that parties can begin making recommendations to the General Assembly on elements for inclusion in a draft text of this new legally binding instrument. According to the Prep Com report, "[t]he General Assembly has decided that negotiations shall address … conservation and sustainable use of marine biological diversity of areas beyond national jurisdiction, in particular, …, measures such as area-based management tools, including marine protected areas, environmental impact assessments and capacity-building and the transfer of marine technology" (UN Prep Com, 2017, Introduction). To help identify areas for which protection may be required, the report lists "special importance for life history of species" and "importance for threatened, endangered or declining species and/or habitats", among others (UN Prep Com, 2017, s. 4.3.1). The report also lists the ecosystem approach, the precautionary approach, science-based approach, and adaptive management as some of its guiding principles. The fourth and final Prep Com meeting was held in July of 2017 and the Committee is supposed to report back to the UNGA by the end of the year. However, negotiations are likely to be ongoing for some time. Nevertheless, this initiative represents a significant step forward in high seas conservation and will have interesting implications for all nations going forward.

3.4 Summary of Management Context

Despite recent advancements, it is clear from this chapter that high seas protection remains largely fragmented and sectorally-based. Most management bodies have limited mandates to control only one or a few activities on the high seas, and many measures are not legally binding on member States. Spatial and regulatory gaps remain for managing many important species and habitats. Many marine species are transboundary in nature, crossing international borders or even living their entire lives outside the

management authority of any country. Yet they are still subjected to anthropogenic pressures because while conservation efforts on the high seas have largely been overlooked, human activity is rampant, externalizing costs to the environment. Without a standard, global instrument for protection of biodiversity in ABNJ, sensitive species such as the NL northern bottlenose whales are at great risk. The following sections outline the methods used to explore management solutions that could help protect this at-risk population in the absence of an existing comprehensive conservation framework.

Chapter 4: Methods

Analyzing potential solutions to address the management problem was informed by observations made in the field and a literature review, a risk analysis of threat severity, and a feasibility analysis to assess which solutions appear to address the issue most effectively.

4.1 Fieldwork

From July 12th to August 2nd 2017, fieldwork was conducted around the Flemish Cap to obtain genetic and photographic data on the northern bottlenose whale population that is believed to live there. Research was conducted from aboard the Valiant 40 class ocean-going sailboat *Balaena.* A significant portion of time was spent surveying the SS, but the vessel also circumnavigated the Flemish Cap surveying for whales. Photographs and biopsy samples were retrieved and continuous acoustic recordings were also made to pick up northern bottlenose whale vocalizations. All other cetacean encounters were also recorded in addition to observations of anthropogenic activity. The data retrieved is currently being analyzed as part of a larger study on the metapopulation dynamics of northern bottlenose whales in the Northwest Atlantic. Observations made during fieldwork allowed for a better understanding of both cetacean presence in the area as well as the types and level of anthropogenic activities that are taking place and the sort of pressures those might be exerting on the whales that live there. This better informed the risk analysis by allowing for a more accurate evaluation of the severity and likelihood of each threat, as well as the suitability of each solution.

4.2 Literature review

In order to understand of what kind of impacts this population of whales may be experiencing, a literature review was conducted. This review focused mainly on reports published by governments and NGOs on the status of northern bottlenose whales both worldwide and in Canada. Since so little is currently known about this new population of whales, and as Canada is the closest coastal State, current threats were informed by those identified in the most recent Canadian northern bottlenose whale recovery strategy, assessment and status report (COSEWIC, 2011; DFO, 2016) as well as observations made in the field. Solutions to the problem were also gathered from a

literature review of a number of different sources including primary peer-reviewed journal articles, books, technical reports and reports authored by NGOs.

4.3 Risk analysis

In order to identify which of the identified threats pose the most serious risk to the population, a risk analysis was carried out. The risk analysis was based on the "Oceans Management Risk Module" developed by DFO (2017b). This framework was chosen to guide the present project because it was formulated specifically to inform decision-making for oceans management. The steps and their associated required actions defined in the framework are outlined in Table 3.

Table 3: Steps in the "Oceans Management Risk Module" developed by Fisheries and Oceans Canada that were followed for the present analysis. Source: DFO (2017b).

Steps	Requirements
1. Establish the Context	Define objectives, scope and other key contextual aspects
2. Identify risk	Characterize ecological components, identify sources of risk
3. Analyze risk	Assess impact and likelihood of each risk, determine risk level
4. Evaluate risk	Determine which risks require treatment
5. Treat risk	Identify management options

Step 1 of the module was to establish the context. This was completed through a literature review (which informed chapters 2-3), fieldwork and discussions with other cetacean researchers and policy experts. Step 2 was to identify risk. Potential risks identified through the literature review, were compiled and refined based on observations made during the field season and expert opinion. Step 3 was to analyze risk using an impact and likelihood approach. Here each threat identified in Step 2 was analyzed and ranked based on the potential impact if the threat did occur, and the likelihood that such a threat may actually occur. The rationale behind the rankings for both factors was derived from the literature review, personal observations made during fieldwork, and opinions from experts in the field of cetacean conservation and research.

Once the level of impact and likelihood was determined for each threat, Step 4 was to evaluate risk. The module offers two levels of risk tolerance that can be used. The normal tolerance matrix is generic and widely used within the government, business and other institutions. The low risk tolerance matrix reflects a precautionary approach, used for decisions relating to MPAs, depleted species, *SARA*-listed species and other sensitive components of the marine environment. As this project is concerned with an at-risk species, where the precautionary approach should be followed, the low tolerance matrix was selected as most appropriate. Each threat was plotted on the low tolerance risk matrix to determine their overall risk level: high, moderately high, moderate, or low.

Step 5 was to treat risk. Corresponding to each level of risk there are tolerance levels that dictate what type of treatments might be appropriate. In order to keep the scope of the analysis at an appropriate level for this project, only those threats that were found to have an overall high level of risk were considered for treatment (Table 4). Treatments range from avoiding the risk, mitigating the risk, retaining the risk, and transferring the risk. In the Oceans Program context upon which this risk analysis is based, only the first three options are applicable (DFO, 2017). Additionally, as the present analysis was focused solely on top three highest risks that require immediate treatment, only solutions that either avoided or mitigated the risks were considered.

Table 4: Risk level, tolerance and overall treatment recommendation used to guide risk analysis. Source: DFO (2017b).

Risk level	Tolerance	Treatment recommendation
High	Unacceptable	Treatment is recommended to contribute towards adequate protection of ecosystem component
Moderately high	Tolerable	Treatment may or may not be recommended based on further consideration of the nature of the risk
Moderate		
Low	Broadly acceptable	No treatment is required

Solutions were identified based on information gained during the literature review, and associated legislative, policy, and incentive-based tools available for their implementation were also identified. However, this represented a far greater number than could reasonably be implemented, so a feasibility analysis was conducted to determine the best options.

4.4 Feasibility analysis

To carry out the feasibility analysis, an analytical framework was developed. Based on information from the literature review, each identified solution was given a score out of 5 for perceived feasibility and potential effectiveness in treating the problem, with 1 indicating a low level of feasibility and effectiveness, 2 indicating low to moderate, 3 indicating moderate, 4 indicating moderate to high and 5 indicating high, for a highest possible total score of 10 (Table 5). The two scores were added, and those solutions that scored a total of 7 or greater were considered to have the greatest potential in effectively addressing the management problem at hand and formed the basis of the discussion. A total score of 7 was selected because a score 6 or below was viewed as reflecting solutions that would be too weak in their overall effectiveness and feasibility, and their inclusion in the final recommendations would reduce the robust standard of protection outlined by this analysis. A minimum score of 8 or more was viewed as too exclusionary and risked omitting too great a number of potentially effective solutions.

Table 5: Scores used in the feasibility analysis and their corresponding level of feasibility or effectiveness

Score	**Corresponding level of feasibility or effectiveness**
1	Low
2	Low-moderate
3	Moderate
4	Moderate-high
5	High

Chapter 5: Results

5.1 Literature review

Based on information gathered from the literature review, threats facing the NL northern bottlenose whales were identified as: (1) exposure to chronic and acute noise, entanglement and/or bycatch, (2) contaminants and pollution (particularly plastic pollution), (3) vessel strikes, and (4) ecosystem changes brought about by factors such as climate change and prey reduction.

5.2 Risk analysis

After evaluating each threat listed above, risk analysis determined that the top most severe threats were, in no particular order: entanglement in fishing gear, exposure to chronic noise, and exposure to acute noise (Figure 12). The rationale behind this evaluation is presented in Table 6. It should be noted that acute and chronic noise were treated as separate threats. This is because different activities produce different sounds at different intensities and frequency ranges, and will therefore induce varying responses from affected organisms. Acute sounds, defined as relatively high frequency, high decibel noise from activities like oil and gas exploration or navy sonar are more likely to cause impacts such as changes in auditory ability or injury (Ellison et al. 2012). Chronic noise, defined as moderate frequency, moderate decibel and often repetitive sounds such as those produced as a by-product of shipping activity, are generally thought to be responsible for other effects including masking (Clark et al., 2009).

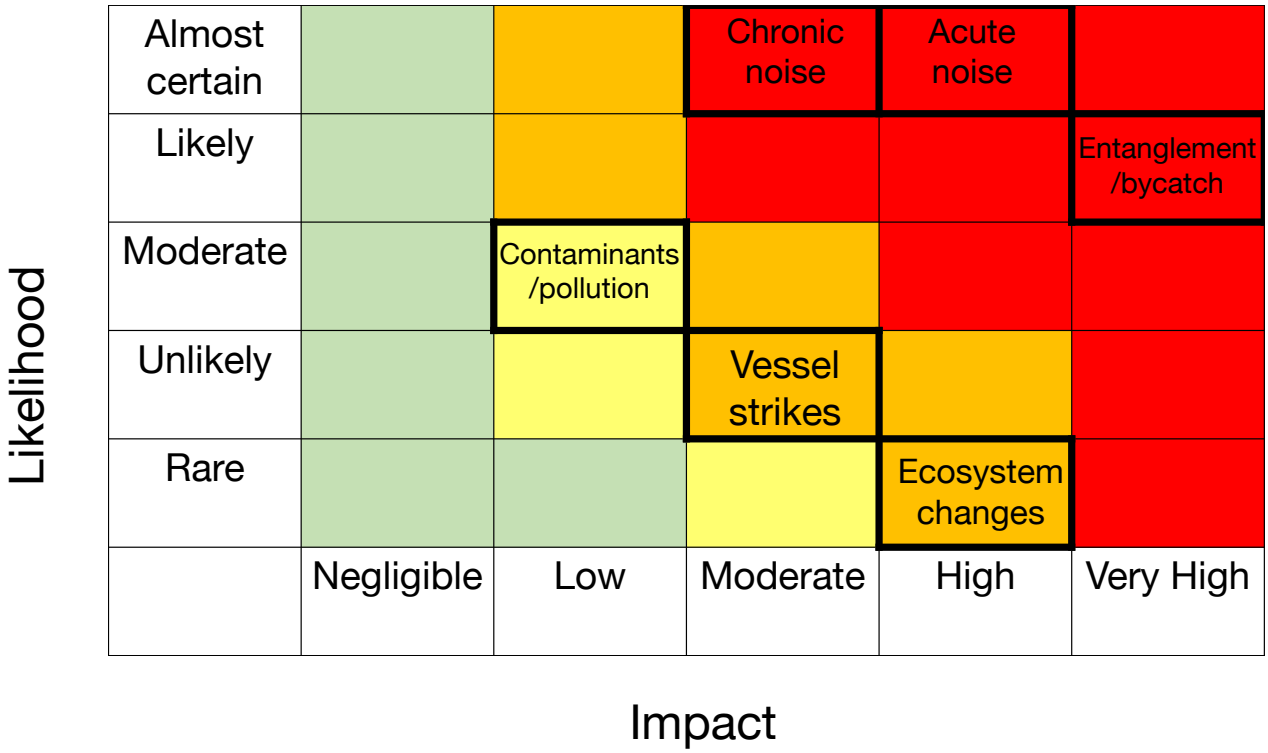

Figure 12: Risk matrix displaying risk level for each identified threat facing the Sackville Spur population of northern bottlenose whales.

Table 6: The impact and likelihood level for each identified threat facing the NL population of northern bottlenose whales and the associated rationale behind each

Threat	Impact and rationale	Likelihood and rationale
Acute noise	**Impact level:** High **Rationale:** - Acute noise generated by seismic surveys have been shown to negatively impact cetaceans (Stone & Tasker, 2006) - Beaked whales may be particularly sensitive to noise (Miller et al., 2015) - Noise from seismic surveys may cause them to interrupt foraging or move away from preferred habitat (Whitehead & Hooker, 2012) - A northern bottlenose whale (NBW), along with other beaked whale species, was part of a mass stranding event linked to military sonar activity (Simmonds & Lopez-Jurado, 1991) - In addition, sublethal or longer-term effects could be occurring and not detected (DFO 2004)	**Likelihood:** Almost certain **Rationale:** - Seismic activity is ongoing in the immediate vicinity of the Sackville Spur where the whales have been observed - Seismic noise was picked regularly on the hydrophone during fieldwork - There are plans to continue and expand seismic exploration activity in the Flemish Pass for at least 10 more years (Statoil, 2016b)
Chronic noise	**Impact level:** Moderate **Rationale:** - Ship traffic causes low-frequency sounds that can mask important biological signals (Aguilar Soto et al., 2006) - However, beaked whales vocalize at a higher frequency (Hooker & Whitehead, 2002), and so the degree of masking and other effects may not be as severe for NBW compared to other species	**Likelihood:** Almost certain **Rationale:** - Large fishing vessels seen almost constantly in the area during fieldwork - Fishing effort appears to be high around the Sackville Spur (see Figure 3) - Ship traffic regularly transits the area
Entangle-ment/ bycatch	**Impact level:** Very high **Rationale:** - NBW entanglement events have been known to result in injury or mortality (COSEWIC, 2011) - Even if an entanglement event does not result in mortality, animals that get entangled can continue to drag gear around causing injury, energy depletion and other deleterious effects	**Likelihood:** High **Rationale:** - Fishing trawls can be a significant cause of mortality for cetaceans (Fertl & Leatherwood, 1997) - While relatively few incidents have been reported, NBW have been documented associating with trawl fisheries and entangled in fishing gear

	(Moore & van der Hoop, 2012) - If the NL population is still recovering from the impacts of whaling, the death of even one individual could have negative effects on the survival of the population	in Atlantic Canadian waters while others have been observed with scars similar to entanglement marks (COSEWIC, 2011) - The Sackville Spur is subject to fishing pressure - A large mid-water trawler was observed with regular frequency in the area during fieldwork and NBW were observed swimming directly behind, likely engaging in depredation behaviour - Scars and marks reported by COSEWIC (2011) indicates that interactions may be more common than observed and that the low number may simply reflect low levels of observer coverage, meaning incidence is likely higher than known
Vessel strikes	**Impact level:** Moderate **Rationale:** - If an event were to occur, it could potentially result in serious injury or death	**Likelihood:** Low **Rationale:** - Evidence of NBW with scarring that might be indicative of ship strike (Gowans, 1999) and NBW have a tendency to associate with vessels - However, no confirmed ship strikes involving NBW and it is likely they are able to avoid strikes due to their speed and small size (DFO, 2016)
Contaminants/ pollution	**Impact level:** Low **Rationale:** - Persistent contaminants have been measured in NBW populations in Canada, but at levels below those suspected to cause health problems (Hooker et al., 2008) - Presence of contaminants in the NL population is unknown at this time - There are demonstrated incidences of beaked whales elsewhere having ingested plastic debris (Lusher et al., 2017)	**Likelihood:** Moderate **Rationale:** - Oil and gas activity could introduce deleterious substances into the habitat of the NL population through drilling, ship source oil pollution and bilge dumping - Garbage thrown overboard from fishing vessels, including plastic debris, was directly observed in the Sackville Spur during fieldwork

Ecosystem changes	**Impact level:** High **Rationale:** - If the NL population are dietary specialists like other NBW populations, prey reduction would have serious impacts such as forcing them from preferred habitat (DFO, 2016) - Climate change impacts are unknown at this time but could result in changes in the whales' prey and prey habitat as well (DFO, 2016)	**Likelihood:** Rare **Rationale:** - No directed squid fishery in the area and bycatch by existing fisheries is likely low - Impacts caused by climate change are not well understood at this time

5.3 Feasibility analysis

A total of nine different solutions were identified that either partially or completely treated at least one of the top three most severe risk factors. These are summarized in Table 7 along with their corresponding tools for implementation. It should be noted that this is not an exhaustive list, but rather a summary of the solutions that were found to be most commonly suggested throughout the literature. Also, some solutions are listed more than once in the table to reflect their ability to address more than one risk factor.

Table 7: Possible solutions and their corresponding tools for implementation identified for treating the three most severe threats facing the Newfoundland population of northern bottlenose whales. Note that some solutions are listed more than once to reflect their ability to address more than one risk factor.

Risk factor	Solutions	Tools for implementation
Chronic noise (shipping)	Establish a high seas marine protected area (HSMPA)	• Regional governance bodies • UNGA Resolution
	Vessel avoidance/speed reduction recommendation	• IMO
	Establish an incentive and/or subsidy program to encourage the use of ship quieting technology and maintenance	For Canadian ships: • OA • CSA • Eco-certification program • Economic instruments Internationally: • CBD • UNCLOS • IMO

	Develop stronger legislation to protect sensitive marine species from the impacts of vessel noise	For Canadian ships: • CSA Internationally: • IMO • CBD • New resolutions/agreements
Acute noise (oil and gas activities)	Establish a high seas marine protected area (HSMPA)	• Regional governance bodies • UNGA Resolution
	Close area to oil and gas activity	• CEAA
	Adopt enhanced seismic survey mitigation measures specifically addressing beaked whales	• SOCP • CEAA
	Develop stronger legislation to protect sensitive marine species from the impacts of oil and gas noise	• SARA • CEAA
	Establish an incentive and/or subsidy programs to encourage the use of alternative technologies (e.g.: marine vibrioseis)	• CEAA • CEPA • Eco-certification program • Economic instruments • Place-based restrictions (i.e., make certain places off-limits to traditional seismic methods)
Entanglement in fishing gear	Establish a high seas marine protected area (HSMPA)	• Regional governance bodies • UNGA Resolution
	Implement seasonal/temporary fishing closures	• NAFO Convention
	Implement fishing gear/type restrictions	
	Improve NAFO's ecosystem based management approach and monitor bycatch	

While each solution proposed provides varying degrees of effectiveness in addressing the management problem at hand, serious consideration and an in-depth discussion of

each was beyond the scope of this paper. By conducting a feasibility analysis, the solutions were narrowed to a few that could be discussed further and more seriously considered for implementaton. The results of the feasibility analysis are summarized in Table 8, followed by the rationale behind each of the scoring outcomes.

Table 8: Overall feasibility and effectiveness scores of each potential solution to address the most severe threats. Scores are denoted as follows: 1-low, 2-low/moderate, 3-moderate, 4-moderate/high, 5-high. Only those scoring a total of 7 or higher (indicated in green) were explored further.

Threat addressed	Solution	Feasibility	Effective-ness	Total
Chronic noise Acute noise Entanglement	High seas marine protected area (HSMPA)	1	4	5
	Vessel avoidance/speed reduction recommendation	3	4	7
	Incentive program/subsidies for quieter technologies (seismic and shipping)	4	3	7
	Stronger legislation to address impacts of anthropogenic noise (seismic and shipping)	4	4	8
	Oil and gas exploration area-based closure	2	4	6
	Enhanced seismic survey mitigation procedures	5	3	8
	Fishing closure	1	5	6
	Gear restrictions	1	5	6
	Improve NAFO's ecosystem based management approach and monitor bycatch	5	3	8

1. *Establishment of a high seas marine protected area (HSMPA)*

Feasibility: 1 (low)

Feasibility was assessed as low at this time because the establishment of MPAs in the high seas remains a difficult process logistically and politically. No country has power to unilaterally establish MPAs in the high seas, and any country that attempts to impose

restrictions on the activities of other States goes against the freedom of the high seas established under UNCLOS. There are a great number of stakeholders with interests in pursuing activities in the high seas and in a productive area like the Sackville Spur where fishing activity is relatively high, the conflicts that would arise are likely to be exceedingly difficult to resolve without any kind of establishment framework or governance structure in place. Finally, HSMPAs require significant political will and cooperation among coastal States and it is unclear at this time how much political will Canada would have for this initiative, especially considering the current paucity of information about the whales and the existing efforts already being made to fulfill the Aichi Biodiversity target of protecting 10% of national waters by 2020 (CBD, 2010).

Effectiveness: 4 (moderately high)

Ideally, an HSMPA established around the Sackville Spur would be closed to all activities that are known to cause negative impacts on whales, but it is difficult to know what kind management plan would be established for this hypothetical MPA and what kind of activities would or wouldn't be allowed or, equally as important, what kind of enforcement measures would be in place. There is also some debate over the effectiveness of MPAs for cetaceans. For example, the Pelagos Sanctuary in the Mediterranean, located in international waters, has been deemed as poorly managed and ineffective (Notarbartolo di Sciara, 2009). Further, noise travels great distances underwater and if activities such as seismic exploration and shipping were to still be conducted immediately outside the MPA boundaries, it is possible that some level of disturbance might still exist. Still, if an HSMPA established for the SS were to be closed to fishing and seismic activity, the associated impacts of two of the top most severe threats would likely be significantly reduced. Sightings of whales in the Gully increased after the area became MPA, indicating that the protective effects of an MPA may still effective for some species (Whitehead, 2013). Thus, a score of moderately high was given to the potential effectiveness of an HSMPA in the Sackville Spur.

Total score: 5

2. *Implementing an IMO-based vessel speed reduction/avoidance recommendation*

Feasibility: 3 (moderate)

As described in section 3.2, there are a number of tools under the IMO that can be implemented to reduce the threat of ship strike and the impact of vessel noise on cetaceans. While the Sackville Spur appears to satisfy the requirements for a PSSA, these often take years to gain approval (MPA News, 2002). A PSSA has also not yet been established in the high seas, and in order to implement one IMO member states would have to work together to negotiate a cooperation agreement which would likely take a great deal of time. Furthermore, because of difficulties in cooperation and enforcement, an APM under a PSSA in the high seas would probably be more recommendatory than anything at this stage (Kachel, 2008). Because of these reasons, a PSSA is not likely to be feasible at this time although it may represent a viable solution pending further scientific study of the area. However, other measures under the IMO may indeed be more realistic, such as a vessel speed recommendation, modification of shipping routes through a TSS, or an ATBA. Whatever measure is deemed most appropriate, the precedents that exist for protecting whales through these IMO-based actions lend support to the notion of the Sackville Spur also being a candidate for these types of interventions. Still, proposals to the IMO for conservation measures require strong needs statements and associated documentation. Without much information on the measurable effects of ship noise or the incidence of ship strike on this population of northern bottlenose whales, it may be difficult at this time to gain approval by the IMO for a mandated conservation measure. Feasibility is therefore assessed as moderate.

Effectiveness: 4 (moderately high to address collision and ship noise)

Vessel speed reduction programs have been implemented elsewhere to reduce the impact of vessel noise on odontocete whales. The Vancouver Port Authority's ECHO program focuses specifically killer whales in the Haro Strait of British Columbia. According to that program, slowing to 11 knots down from 18+ for container ships and 13+ for bulk carriers would theoretically reduce sound intensity by 75% for container ships and 40% for bulk carriers (Robertson, 2017). A slow down would also reduce the likelihood of ship strike as well and these benefits would also extend to other cetacean species such as sperm whales, which were observed in the vicinity of the SS with frequency during the field season. In addition, due to its international authority, conservation measures mandated by the IMO appear to result in high levels of compliance, even compared to domestic legislation (Geijer & Jones, 2015). The IMO

also has the competency to deal with issues in the realm of high seas, and an IMO measure would be implemented more quickly and be more adaptable than an MPA should biological information on the population indicate that changes (such as spatial configurations) are needed.

Total score: 7

3. *Establishing an incentive program/subsidies for quieter technologies (seismic and shipping)*

Feasibility: 4 (moderately high)

Canada became the first country in the world to implement a marine noise reduction incentive. On January 1, 2017, the Vancouver Port Authority
added quiet-vessel ship classifications and three propeller technologies to its EcoAction program that qualify ships for discounted harbour due rates (Banse, 2017). The incentive is part of the port authority's ECHO program which was initiated to better quantify and ultimately reduce the impact of commercial vessel activity on the Southern Resident Killer Whale (SRKW) population off the southern coast of British Columbia. An eco-certification program is also already in place for the North American marine industry. Aimed at ship owners, ports, terminals and shipyards, Green Marine is a voluntary initiative that addresses ship-based environmental issues through a series of 12 performance indicators against which participants evaluate their own performance, have their results verified, and then published. It is managed by Green Marine Management Corporation, a non-profit organization led by a board of directors with offices in both Canada and the United States. Underwater noise has newly been identified as a performance indicator for ports and ship owners. Both these initiatives show that such programs are indeed feasible, and something similar could be implemented on the east coast for ports where ships that have traversed through the Sackville Spur could enjoy reduced port fees if they have implemented measures to reduce their noise output. This would likely require the generation of a great deal of public support and political will, especially given the whales' remote offshore location, unlike the coastal SRKWs that are highly visible and well known to the Vancouver public. There are numerous ways to make ships quieter, such as reducing cavitation (Malakoff, 2010), and alternative seismic survey methods such as marine vibroseis (MV), which spreads the sound energy over a longer period and reduces the peak acoustic power (Weilgart, 2010). MV may be ready

for commercial use in the next few years (Simmonds et al., 2014). At this stage, getting the Canadian government to implement policies that support the development and use of these technologies and to invest more heavily in them can be justified considering commitments to protect the ocean that is pervasive throughout legislation and recent investments in ocean conservation efforts through the new Oceans Protection Plan.

Effectiveness: 3 (moderate)

The use of quieter technologies has the potential to greatly reduce the impacts of shipping and seismic survey noise. Some alternative technologies to airguns such as vibrator pulses are 100 times quieter and other controlled sources can reduce sound amplitude by 30 dB (Weilgart, 2012). State-of-the-art ship propellers can also significantly reduce cavitation noise (IMO, 2014).

Total score: 7

4. *Develop stronger legislation to address marine noise*

Feasibility: 4 (moderately high at the national level)

On the international level, the IMO's *Guidelines for the reduction of underwater noise from commercial shipping* represent a great step forward in officially recognizing ship noise as a pollutant and providing mitigative measures to reduce it. Some international organizations like the CBD and the CMS already classify noise as a pollutant (CBD, 2012; CMS, 2011). However, many measures such as the IMO guidelines are non-binding, and so stronger legal instruments are required. Developing these at the international level will take an enormous degree of cooperation and compliance, and an in-depth examination of the implications and requirements for developing a new international noise mitigation agreement is beyond the scope of this assessment. However, an examination of Canadian legislation is appropriate. Perhaps of greatest significance is the outcome of a court case between the David Suzuki Foundation and the Government of Canada where it was found that due to high levels of noise, the Federal Government failed to adequately protect critical habitat of SRKWs, setting a legal precedent in the recognition of noise as a source of habitat degradation and the quality of the acoustic environment as a component of critical habitat (David Suzuki Foundation v. Canada, 2010). However, legislation and policy does not currently reflect this kind of thorough approach to managing sound. The SOCP remains non-binding, and

some national legislation, such as the *CEAA*, lack enough strength to effectively protect marine mammals. The *CEAA* relies heavily on external "responsible authorities", such as the C–NLOPB, to evaluate EAs submitted by proponents and make decisions regarding projects based on their interpretation of what constitutes "significant adverse environmental effects". Furthermore, many pieces of legislation, such as the *SARA* or the *CSA*, simply do not directly address the impact of noise on the marine environment and their specific impacts on marine mammals. Creating stronger legislative tools by either amending existing policy and legislation or developing altogether new binding regulations requires political will, but considering the increasing recognition of noise as a serious source of harm and the commitments to protect marine biodiversity throughout various Canadian statutory tools, amending relevant legislation to reflect a precautionary approach to managing the impacts of noise generated from oil and gas activities and commercial shipping is deemed to be a moderately high, feasible option.

Effectiveness: 4 (moderately high at the national level)

If Canadian legislation is successfully updated to reflect more rigorous approach to reducing the impacts of sound generated by oil and gas activities and these new, binding measures are adopted by operators, then the reduction in negative impacts has the potential to be significant.

Total score: 8

5. *Oil and gas exploration area-based closure*

Feasibility: 2 (moderately low)

Feasibility for this measure was assessed as low mainly due to the likely intense objection that would be made by petroleum companies operating in the region against closing the area to further exploration, especially in light of the major discoveries that have been made in the Flemish Pass. Also, since socio-economic concerns are part of the decision-making process under the *CEAA*, and due to the high revenue generated from leasing the area to oil and gas companies, the current and potential economic gains are likely too great for Canada and the province of Newfoundland to relinquish. Additionally, the justification of time-area closures generally rely on detailed spatial and temporal information on species distribution patterns (Simmonds et al., 2014) which is unknown for this population at this time. However, oil and gas exploration has been

prohibited elsewhere, such as off the coast of British Columbia, and can be accomplished if sufficient political will and public support can be garnered. It may be possible that if enough attention is brought to the issue and a great deal of public concern and support is generated, closing the area to seismic exploration may be feasible. Overall feasibility was therefore assessed as moderately low at this time.

Effectiveness: 4 (moderately high)

Ensuring that a closed area is effective in protecting the whales from the negative impacts of sounds generated by oil and gas activity depends heavily on knowing where the whales occur and whether they persist there seasonally, which is not known at this time. Furthermore, because of the intensity of noise from seismic exploration, the sound generated can travel great distances. It is that likely sound generated by activities outside the closed area could still be heard inside the closed area, albeit at a lesser intensity and volume. Nevertheless, prohibiting oil and gas from occurring within the whales' critical habitat would likely go reasonably far in reducing the overall negative impact of high intensity seismic sound on the population.

Total score: 6

6. *Enhanced Canadian seismic survey mitigation procedures with special considerations for beaked whales*

Feasibility: 5 (high)

As described earlier, the CSOP is considered a weak tool for protecting marine mammals, particularly beaked whales, from the impacts of seismic surveys. More robust seismic survey mitigation protocols have already been called for (Compton et al., 2008; Williams et al., 2014) and tangible recommendations on how governments can improve these protocols have already been put forward (Compton et al., 2008; Weilgart, 2007). In addition, many of the recommended changes would come at relatively little extra cost to seismic companies. There exists sufficient evidence that beaked whales are particularly sensitive to noise (Aguilar Soto et al., 2006; DeRuiter et al., 2013; Miller et al., 2015; Tyack et al., 2011) so amending current Canadian guidelines on seismic mitigation to reflect this would be justified. Furthermore, such changes would also act to fulfill the precautionary principle that is already so pervasive in much Canadian legislation and policy such as the *OA* and the *SARA*.

Effectiveness: 3 (moderate)

Despite potentially limiting the severity of impact, whales will still be exposed to seismic noise. Additionally, even with these measures, visual detection remains an overall poor measure to monitor the presence of whales, especially beaked whales which are notoriously elusive (Barlow & Gisiner, 2006). The use of PAM during periods of low visibility also has limited effectiveness in detecting beaked whales (Barlow & Gisiner, 2006).

Total score: 8

7. *NAFO fishing closure*

Feasibility: 1 (low)

The feasibility in closing the area where the whales are thought to occur was assessed as low for a few reasons. First and foremost, NAFO just this year (2017) amended their Convention and so it is unlikely that they would agree to implement further changes, especially one as drastic as a complete area-based closure. This is especially true given the paucity of information regarding the population and no known evidence of these whales having been entangled by NAFO vessels. Secondly, because of the intense fishing interests held by certain NAFO member states, there is likely to be lots of opposition against an initiative such as this and justification may be difficult to provide given the current lack of information.

Effectiveness: 5 (high)

Restricting fishing activity altogether would significantly reduce the likelihood of entanglement and bycatch on this population. While it is still possible that ghost gear could drift into the closure and risk entangling a whale, the reduction in overall risk level would likely still be significant. As the northern bottlenose whales in the Sackville Spur were observed in close proximity to fishing vessels that were actively hauling, should fishing activity be restricted here, this risk-prone behaviour would be mitigated. However, it is recognized that if whales were to travel outside the fishery closure they would once again be at risk of entanglement.

Total score: 6

8. *NAFO fishing gear restrictions/modifications*

Feasibility: 2 (moderately low)

Once again, due to many of the same reasons discussed above, NAFO is unlikely to introduce new gear requirements at this time. Furthermore, the majority of gear types currently used in the 3M fishing area are trawls, so restricting this gear type would likely reduce allowable fishing to almost negligible levels. Still, fishing gear requirements are outlined in NAFO's Conservation and Enforcement Measures (NAFO, 2017c), so it may be possible to introduce some measure of gear-based modification provided that bycatch incidences for northern bottlenose whales can eventually be demonstrated.

Effectiveness: 3 (moderate)

Gear changes have been implemented in the past to reduce cetacean bycatch, most notably in the case of bottlenose dolphin bycatch reduction in tuna fisheries (Hall, Alverson, & Metuzals, 2000). It is possible that measures taken up among NAFO fisheries would be effective in also reducing northern bottlenose entanglement and/or bycatch risk. However, NAFO appears to be struggling to fulfill its existing mandates as evidenced by the fact that fisheries overseen by Regional Fisheries Management Organizations across the globe, including NAFO, are in decline (Cullis-Suzuki & Pauly, 2010). If NAFO is already grappling with meeting its existing objectives, demanding that NAFO also take on the responsibility of enacting cetacean conservation measures within the NRA may only overburden an already struggling organization and not yield any measureable benefit.

Total score: 5

9. *Improve NAFO's ecosystem based management approach and monitor bycatch*

Feasibility: 4 (moderately high)

Based on recent changes to NAFO's Convention that embrace the precautionary principle, an ecosystem approach to management, and a commitment to taking account of catch of non-target species and minimizing fishery impacts on these species (NAFO 2017, Art. III(i)), it could be argued that NAFO is currently not doing enough to manage other species that are at risk of negative impacts due to NAFO-controlled fisheries. As a

member state of NAFO and the closest coastal State to where these whales occur, Canada could take a leadership role in supporting conservation actions on behalf of NAFO to address this issue. As a starting point, implementing a bycatch monitoring program would provide the evidence needed to conduct ecosystem based management. NAFO fishing boats are already required to have fisheries observers onboard, and if bycatch can be quantified, it would be difficult for NAFO to refuse to take action if records of bycatch included northern bottlenose whales, as this would contravene its current Convention. Feasibility is assessed as moderately high.

Effectiveness: 3 (moderate)

While monitoring programs themselves do not reduce bycatch, establishing the rate of northern bottlenose whale bycatch would provide ample justification for increased mitigation actions to be taken by NAFO fisheries. As a result, initiating a bycatch monitoring program has the potential to go far in protecting northern bottlenose whales, and on-board observers have been recommended by other studies as necessary to address the problem of cetacean bycatch (Fertl & Leatherwood, 1997). However, the effectiveness of reducing the impact of entanglement hinges on NAFO being able to respond and implement appropriate mitigation measures. Considering how NAFO is struggling to meet its existing management objectives, it is possible that the effectiveness of additional bycatch reduction measures is limited.

Total score: 7

Only solutions that scored 7 or greater in the feasibility analysis, were considered for further exploration and discussion. Solutions scoring greater than 7 included: 1) enhance current Canadian seismic mitigation protocols to include a special consideration for beaked whales 2) develop stronger legislation to address the impacts of anthropogenic noise on marine species 3) improve NAFO's ecosystem-based management approach 4) establish a vessel speed reduction/avoidance measure through the IMO 5) implement incentive programs and subsidies to encourage the adoption of quieter marine technologies.

Chapter 6: Discussion

In examining the top solutions deemed most feasible and effective based on the analysis it become apparent that the problem cannot be addressed with one single action. The complex nature of the issue means that effectively protecting the NL northern bottlenose whales will require a whole host of measures implemented at different scales using legislative, political and economic tools. Because addressing the problem requires such a diversified approach, the different solutions identified vary in the speed with which they

can realistically be implemented and in the specificity with which they address the management problem. It is important to therefore point out that some solutions can be implemented within a relative short-term timeline (1-5 years) specifically address the problem at hand, and may occur on an intermediate timeline, while others are longer-term undertakings (5-10 years) that address concerns associated with acoustic disturbance and entanglement on cetaceans in general. Table 9 groups solutions by implementation timeline and they are discussed in order from shorter-term to longer-term solutions.

Table 9: Estimated timeframe for implementation of each proposed management solution

Solution	Estimated implementation time	Type of solution
Enhance seismic mitigation procedures	1 year	Short term
Develop stronger legislation for noise mitigation	3-5 years	Short term
Improve NAFO's ecosystem approach and implement bycatch monitoring	1 year	Short term
Implement an incentive and/or subsidy program for quieter ship and seismic technologies	5-10 years	Long term
Implement an IMO-based vessel avoidance/speed reduction recommendation	Variable depending on chosen option	Variable but likely long term

6.1 Short-term solutions

1. Enhance Canadian seismic mitigation procedures with special considerations for beaked whales

Perhaps the most immediate action that can be taken is for the Canadian government to update the SOCP. Within their EAs, many oil and gas proponents list the use of the SOCP as part of their environmental mitigation plan, yet these guidelines remain problematic for mitigating impacts to beaked whales. Because of their cryptic nature and ability to remain submerged for long periods of time, visual detection rates for beaked whales during seismic surveys are likely very low. Barlow & Gisiner (2006) estimated that fewer than 2% of beaked whales are detected if the animals are immediately in front the ship. Furthermore, there is doubt whether ramp-up procedures and other mitigation

measures outlined in the SOCP are even effective at protecting species from the sounds produced by seismic surveys (Weir & Dolman, 2007). Finally, as mentioned, regulators often tailor their requirements to local conditions, which creates a non-uniform level of protection (Williams et al., 2014). If oil and gas operators are going to continue to employ the techniques outlined in the SOCP, then it is imperative that they be amended to reflect the best available knowledge and a more stringent approach to mitigation, especially for projects operating near known or suspected beaked whale habitat. A number of measures that would help increase the effectiveness of the SOCP with respect to better protecting beaked whales are hereby proposed. First and foremost, operators, the C-NLOPB and the Canadian government should increase efforts to avoid habitat of sensitive and at-risk cetacean species. MMOs should be trained and experienced in identifying beaked whales. At least two MMOs should be on watch at all times to increase the chances of spotting a beaked whale, and PAM should be mandatory for all surveys during nighttime house and during periods of reduced visibility. The size of the EZ should be based on scientific understanding rather than be arbitrarily designated, and should be evaluated on a project-specific basis. In areas where especially sensitive species like beaked whales are known or believed to occur, the EZ should be based on a precautionary sound level. Beaked whale behavioural disturbance has been observed at a received sound level of 107dB re 1 *u*PA (rms) (Miller et al., 2015) (see Table 2 for reference), so in beaked whale habitat the EZ should be calculated to ensure that sound levels outside of the EZ are no greater than that. The pre-watch period and ramp-up delay should be increased to at least one hour. Due to uncertainties with species identification in the field, a shut-down of the airgun array should be triggered for all beaked whale species, not just those species listed as Endangered or Threatened under the *SARA*. Finally, the Canadian government should make the SOCP the **mandatory** minimum that regulators must employ during surveys.

2. Develop stronger legislation and policy for mitigating the impacts of anthropogenic sound

Northern bottlenose whales in Canada are by definition at risk, and any other nearby populations in ABNJ should therefore be treated as priority species of conservation concern. Regardless of our level of knowledge regarding the status of this population, any additional impacts could prevent species recovery elsewhere and put the NL

population in serious peril. The discovery of this population thus presents an opportunity for Canada to review its practices respecting the conservation and protection of endangered species from negative impacts, to ensure they are upholding their commitment to a precautionary management approach as stated in numerous policies and legislation such as the Oceans Strategy, the *OA* and the *SARA.*

Adopt an "assume threatened" status

Because so little is known about the NL population and because it exists in an ANBJ, it is does not have any official status. Yet, it is these "data deficient" species that are often the most likely to be endangered due to their low abundance, restricted distribution and other factors (Parsons, 2016). As suggested by Parsons (2016), an alternative status such as "assume threatened" should be employed to ensure that proper protection and study can be carried out before a population is permanently impacted or depleted. The NL whales are an excellent example where the data deficient status is failing a presumably at-risk population in light of impacts from ongoing anthropogenic activities. Canada should amend the *SARA* to include a special "assume threatened" clause for data deficient species that provides interim protection until more information can be gathered to establish the population's status. Current status quo suggests that the NL whales will continue to be exposed to negative impacts from oil and gas activities for at least the next 10 years under current exploration plans. Under this timeline, serious and potentially irreversible effects may take place before the population can even be adequately described. Special consideration for this population using an "assume threatened" status might help bring about protection more quickly and reduce the extent of negative impacts. A policy outcome from this course of action could be to enhance the requirements for seismic surveys, such as described above, so that when a northern bottlenose whale is detected (visually or acoustically), a shut-down of the airgun array is triggered. Rather than relying on formal status assessments or assuming that a lack thereof somehow precludes beaked whales from adequate protection, a policy that assumes all beaked whales are threatened unless otherwise determined is needed so that action is taken and negative impacts are reduced in a timely manner.

Strengthen the *CEAA*

The *CEAA* needs to be strengthened to reflect a more precautionary approach. Currently too much is open to interpretation by responsible authorities over what constitutes a "significant adverse environmental impact" and adequate mitigation against those impacts when evaluating EAs. The *Act* should be more transparent in determining what is considered "significant" in terms of impacts well as "adequate" in terms of mitigation and careful evaluation of these should be rigorously applied. A precautionary approach would postpone approval of new projects in the area until more is known about the status of the SS whales, so decisions regarding their management can be informed. Alternatively, new projects should be postponed until it can be demonstrated that proposed activities do not pose a serious threat to the population or can be mitigated adequately. Without such a measure, the *CEAA* cannot adequately protect poorly understood marine populations or species with no official status such as the SS northern bottlenose whales.

Amend the *CSA*

Canada should move forward with implementing the IMO's noise-reduction guidelines to moderate the impact of chronic noise on northern bottlenose whales and cetacean species operating within its waters and beyond. The *CSA* already contains some provisions from MARPOL but should be amended to include the more recent guidelines. The most effective measure would be to add noise to the *CSA*'s definition of pollution and subsequently take increased measures to reduce ship noise produced by its own shipping fleet.

Expand the *Oceans Act*

As the most comprehensive piece of legislation Canada has in terms of governing and protecting its oceans, the *OA* should be amended to include noise mitigation strategies. As suggested by Williams et al. (2014), it could be used to set specific criteria for acute and chronic noise exposure that should not be exceeded both within specific important habitats and within MPAs.

3. Improve NAFO's ecosystem based management approach and monitor bycatch

While it is understood that NAFO's mandate and capacity is limited, it is also the only authority in the area with the ability to manage the fishing activities that are posing a risk to northern bottlenose whales. Ecosystem-based management for fisheries (to which NAFO has fully committed) requires consideration of impacts from commercial fishing on all parts of the marine ecosystem (Brown, Reid, & Rogan, 2015). As such it is reasonable that they take a more proactive role in reducing the risk of entanglement on cetaceans, including bottlenose whales. A reasonable starting point would be for NAFO to implement a bycatch monitoring program to obtain data on the incidence of northern bottlenose whale entanglement. Canada should put forward a request to NAFO to require observers to record incidences of interactions between northern bottlenose whales and include them in the Electronic Observer Reports that are submitted to the Executive Secretary, per their reporting protocol (NAFO, 2017c). This would help to quantify bycatch incidence with fisheries and help determine whether further action on behalf of NAFO is necessary.

6.2 Long-term solutions

Solutions that will take a significantly longer time (5-10 years) to implement do not offer protection as immediately as is desirable. Nevertheless, they are worth considering as they still have the potential to significantly reduce the severity of impacts for the NL whales.

1. *Implement an incentive and/or subsidy program to support quieter seismic and vessel technologies*

Setting up an incentive program for oil and gas operators and shipping companies to employ quieter technologies could help to reduce the impact from these noise-generating activities. Cleaning ship propellers and the use of certain coatings on ship hulls are known to reduce noise. Companies that regularly conduct this kind of maintenance could be rewarded through some kind of incentive program set up by the Canadian government, such as reduced port fees. The Government of Canada should also be actively encouraging investment in quieter technologies such as MV to increase their use by industry. The government could also incentivize the use of MV by restricting certain areas that are of interest to oil and gas companies to only those that use it. Participation in eco-certification programs like the Green Marine program discussed earlier should be

more widely promoted and encouraged. Ports on the east coast that are visited by large ships that have passed through the Sackville Spur area could implement their own reward or incentive programs, such as reduced port fees similar to what has been implemented on the west coast for killer whales. These should be investigated further to determine the best manner of implementation.

2. Designate the area under an IMO-sanctioned spatial avoidance measure

The IMO is the only authority that can control vessel traffic on the high seas and so an IMO-based measure likely represents the only legal means by which chronic vessel noise can be effectively minimized in the Sackville Spur. Based on the guidelines set out by the IMO, the Sackville Spur may fulfill the requirements of a PSSA. Although one has not yet been established in the high seas and it would likely be only a recommendation, it still might offer an effective solution in reducing the impacts of ship traffic on northern bottlenose whales as well as other cetacean species that frequent the Sackville Spur. Other measures such as an ATBA or a TSS could represent equally effective solutions, and both these measures take less time than a PSSA designation. Regardless of the measure taken, approval is likely to take some time and depend on upon more detailed biological data on the population. Therefore, these measures represent solutions that could only be considered over the longer-term.

The Sackville Spur as an HSMPA?

At this time, conservation and management on the high seas remains highly sectoral with no overarching standards or protocols for protecting specific areas or species. Those HSMPAs that have been established thus far were done through regional initiatives that required several review processes which cost a great deal of time, effort and resources and a high burden of proof. Data limitations remain a difficulty in providing evidence for protection in the poorly understood realm of the high seas. (Freestone et al., 2014). In the absence of a global instrument, it is likely that biodiversity protection in ABNJ will continue to be carried out at a regional scale. At least for the time being the role of regional management bodies will remain important (Freestone et al., 2014). Encouragingly, actions are being taken to develop a procedure for establishing MPAs in ABNJ through the UNGA resolution 69/292. However, many challenges and unknowns remain, including how sites would be identified, designated, managed and enforced,

what kind of governance structure would be employed, and where funding allocation would come from (Corrigan & Kershaw, 2008). Although it will likely be a while before a solid framework to guide those issues is developed, a UN resolution is a promising development for biodiversity conservation in the high seas. Like many previous conservation initiatives in ABNJ, State “champions” have been effective in moving things forward (Ardron et al., 2014). If, through this new resolution, States are given the opportunity to propose new high seas areas deserving of legal protection, the highly productive and sensitive Sackville Spur ecosystem, now also home to an at-risk population of northern bottlenose whales, may well provide a leading example for Canada. Canada has also submitted an application to the UN to legally extend the limits of its claim over the seabed. If successful, Canada will have jurisdiction over an area of the seabed that includes the Sackville Spur. While this will not include sovereignty over the water column, the claim nonetheless reasonably increases the responsibility and the authority that Canada will have in protecting at-risk species that occur there.

Chapter 7: Final recommendations and conclusion

Solely due to the fact that the NL population of northern bottlenose whales are found beyond the jurisdiction of any State, they are highly susceptible to ongoing negative impacts from intense industrial activities without the protection of any management intervention. Northern bottlenose whale populations globally are still recovering from the impacts of historical whaling. They are a small cetacean, highly dependent on specific species of prey and unique habitat features, and are particularly sensitive to human activity. It is is reasonable and even precautionary to assume then that the NL population of northern bottlenose whales are at risk from industrial activities in the area.

There is a clear need for increased action to protect the NL northern bottlenose whales from human activity. The population is almost certainly being negatively impacted from oil and gas exploration and ship traffic, and the risk of entanglement is high. Without knowledge on their status, any reduction in population size or overall fitness could potentially have grave consequences for other populations in Canada and the species as a whole. This lack of knowledge should not preclude relevant management organizations from taking steps to mitigate impacts. In fact, it should spur greater action on behalf of these bodies and the Canadian government. Thus, a precautionary, flexible, risk-based approach to conservation is called for. Actions should be prioritized to address the most pressing threats, namely exposure to chronic and acute noise and entanglement. First and foremost, the presence of this population and their degree of vulnerability need to be seriously considered by the C-NLOPB and the Canadian government before additional oil and gas activities are permitted in the Sackville Spur. If Canada is going to assert jurisdiction over the seabed of its extended continental shelf and exercise its right to exploit resources therein, then it should follow that Canada be responsible for taking every measure possible to account for and reduce the impact of its actions on the environment. As more seismic activity is planned for the region that directly overlaps with where the whales are believed to occur, the urgency for action on this front cannot be stressed enough. It would be most precautionary to halt these activities until more is known about the population and the current degree of disturbance they are undergoing so that more targeted management measures can be applied. At the same time, appropriate legislation including the *CEAA, OA* and *SARA* must be amended to reflect a

more precautionary approach and more stringent seismic survey mitigation standards need to be developed. As an IMO member State, Canada should also update its *CSA* to include the noise-reduction strategies put forth by the IMO. NAFO should begin to take concrete steps to fulfill its commitment to the ecosystem approach, starting with a bycatch monitoring program to quantify the incidence of entanglement for these endangered whales. Based on that assessment, any necessary steps to prevent entanglement should be swiftly implemented. Longer term, developing incentive programs to encourage the uptake of noise-reduction measures by the shipping and oil and gas sectors and investing more heavily into alternative technologies should be a priority for Canada. Of course, key to making these measures work will be effective coordination between and among different sectors and conservation regimes (Ardron et al., 2014).

The objective of this analysis was to provide guidance and options for those with the authority to do so to take necessary action to ensure that this vulnerable species is adequately protected. As the closest coastal State with strong commitments to ocean protection, Canada should lead by example and fulfill its own obligations by championing the conservation of the Sackville Spur and its cetacean inhabitants now and for the future.

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