4.3.1.5 Recreational and Food Fisheries

Recreational fishing takes place in both coastal and inland waters around the island of Newfoundland and the coastal areas of Labrador, distant from the EA Study Area. A marine food fishery for groundfish has also been allowed in recent years for restricted periods during the summer and fall. Although such fishing is permitted in the Study Area, it is not likely to occur considering the non-commercial status of most participants and the great distances from shore. Both residents and non-residents are permitted to participate without licences or tags. Open times vary, as do other aspects of the fishery, which is announced each year. Table 4.47 shows key management requirements and restrictions for 2017. Commercial fishing and sale of catch from the recreational fishery are not permitted, and commercial vessels may not take commercial catches on a recreational/food fishing trip (DFO 2017d).

Table 4.47 Recreational/Food Groundfish Fishery (2017)

Species	Season(s)	Restrictions	Individual Retention Limit	Boat Limits
Groundfish (with some fish prohibited)	Summer and Fall (see below)	Some locations prohibited; Only angling gear and handlines with a maximum of three hooks permitted. For safety, fishing is only permitted from 1 hour before sunrise until 1	5 groundfish (including cod) per fisher per day	15 groundfish when 3 or more persons are fishing in one boat. For 2017, tour boat operators can apply for a licence for an increased trip limit, with specific reporting requirements.
Source: DFO (2017d)				

The 2017 open dates (a total of 46 days) are:

Summer Season:

Saturday July 01, 2017 to Monday July 03, 2017
Saturday July 8, 2017 to Sunday July 09, 2017
Saturday, July 15, 2017 to Sunday, August 06, 2017,
Saturday, August 12, 2017 to Sunday, August 13, 2017
Saturday, August 19, 2017 to Sunday, August 20, 2017
Saturday, August 26, 2017 to Sunday, August 27, 2017

Fall Season:

Saturday, September 23, 2017 to Sunday, October 01, 2017

4.3.1.6 Potential Future Domestic Fisheries

Recent consultations related to Newfoundland and Labrador fisheries have noted that continuing changes within the marine environment are affecting the availability of several species. A recent example of these changes is the closure of the northern shrimp fishery in Divisions 3L and 3M, and the increasingly fragile status of this species to the north. As the marine environment continues to warm, fishers expect that they will be able to fish more for groundfish, as in pre-moratorium times, and many have kept their groundfish licences in anticipation of this trend in the future (Amec 2014). Similarly, extended warm water periods in the Study Area may increase the prevalence of high-value large pelagic species (swordfish and tunas). Fishers have therefore stated that it is important to consider not only what the fishery looks like now, but how it may be in the future, such as if a directed fishery for cod were to resume, there might be an increased use of mobile gear (Amec 2014).

In terms of fish species that are currently considered to be underutilized and possible future fisheries in the Study Area, identifying and evaluating this potential requires consideration of a wide range of factors, including biological (species presence, abundance, status) and socioeconomic (market demand and price, skills and equipment costs) considerations, as well as resource management and regulatory decisions. If, however, a new fishery, or a currently closed fishery, should become active within the Study Area during the ten-year temporal scope of this Project and its EA, it will be identified in the fishery information and analysis required in the annual EA Updates that the proponent will file in any Project year.

4.3.1.7 Aboriginal Fisheries

Several Newfoundland and Labrador region aboriginal groups hold commercial fishing licences for NAFO Divisions that overlap with the Project Area. This includes licences that permit access to a variety of species and locations within NAFO Divisions 3KLMN (see preceding figures). This includes the following (D Ball, Fisheries and Oceans Canada, pers. comm. 2017):

a) *Labrador Inuit (Nunatsiavut Government):* Inshore groundfish enterprises licensed to operate in 3KL, and seal licences in Seal Fishing Areas 4-33 (Atlantic-wide).

b) *Labrador Innu (Innu Nation):* Mid-shore enterprise (65 to 100 feet) with a groundfish licence permitting access to a variety of areas (Atlantic-wide) including 3KLMN and an Area 6 (3K) shrimp licence; an inshore enterprise with a mobile gear and fixed gear groundfish licence for 3KL.

c) *NunatuKavut Community Council*: Multiple inshore enterprises with access to 3KL groundfish; Area 6 (3K) shrimp licences; seal licences allowing access in Seal Fishing Areas 4-33 (Atlantic-wide), and a swordfish licence that includes 3KLMNO.

d) *Miawpukek First Nation*: Multiple enterprises and licences that give access to 3KL; tuna licences in 3LN; a seal licence for Seal Fishing Areas 4-33.

e) *Qalipu Mi'kmaq First Nation Band*: An inshore enterprise with a groundfish licence for 3K; a shrimp licence for Area 6 (3K); pelagic fishery access (herring, mackerel, and capelin) which occurs close to shore in 3KL. Also holds a snow crab licence for Area 4 (NAFO 3K).

f) *Mi'kmaq Alsumk Mowimsikik Koqoey Association* (formed by Miawpukek First Nation and Qalipu Mi'kmaq First Nation Band): an enterprise with a groundfish licence in 3KL.

In addition to Newfoundland and Labrador aboriginal fisheries, several groups in the DFO Maritimes and Gulf Regions hold communal licences which permit access to NAFO Subarea 3 fisheries.

During Nexen's engagement (see Section 3.2) none of these groups indicated that they hold, claim or otherwise assert Aboriginal or Treaty rights within or near the proposed Project Area, pursuant to Section 35 of the *Canadian Constitution Act, 1982*. Rather, Nexen understands that these organizations undertake fishing activity off eastern Newfoundland through commercial licences issued by the federal government under the *Fisheries Act* and its associated *Aboriginal Communal Fisheries Licencing Regulation,* as well as other government policies and strategies that are designed to involve Aboriginal people and communities in commercial fisheries in Canada.

There is no documented food, social, or ceremonial fishing within or near the Project Area. The closest Aboriginal Reserve to the Project is that of the Miawpukek First Nation (Conne River), located on the south coast of Newfoundland several hundred kilometers west of the Project Area.

4.3.1.8 Commercial Fishing by Foreign Countries

As described in Section 4.3.1.2, the DFO datasets record primarily domestic fish harvests and harvesting locations for species that are landed in Canada. However, the waters off Newfoundland and Labrador have also long been the focus of commercial fishing activity by the fleets of many foreign countries (Amec 2014), particularly in the areas beyond the 200 nautical mile EEZ and within the NAFO Regulatory Area.

As noted in Section 4.3.1.1, NAFO manages most fisheries in the NRA (the part of the overall Convention Area outside any nation's EEZ), but it also has management responsibilities for several species within the Canadian EEZ. These are primarily "straddling stocks", which typically span domestic and international waters. DFO (2017f) reports, that:

> *NAFO management covers most fishery resources in the Northwest Atlantic except salmon, tunas/marlins, whales, and sedentary species (e.g. snow crab, lobster and various clams). NAFO covers the following straddling stocks: cod in NAFO division(s) 3NO, redfish in 3LN and 3O, American plaice in 3LNO, yellowtail flounder in 3LNO, witch flounder in 3L and 3NO, white hake in 3NO, capelin in 3NO, skates in 3NO, Greenland halibut in 3LMNO, squid in sub-areas 3 & 4, and shrimp in 3L.*

The following provides an overview of these NAFO fisheries and reports catch quantities at the NAFO Division level, as identified in Section 4.3.1.1. Note that these data include the same Canada-landed catches for relevant species included in the DFO data presented in Section 4.3.1.4 for the description of the domestic commercial fisheries.

Figure 4.121 shows quantities of harvests in the two key NAFO Divisions that overlap the Study Area, by year, for the ten-year period 2007 to 2016, which is the latest data currently available from NAFO. It includes Canadian catches, and all foreign catches aggregated. Table 4.48 provides catch statistics by nation for 2007–2016 (averages) and for 2016. Table 4.49 shows the composition of the recorded catches, by species for foreign (non-Canadian) nations only, for the same time periods.

The maps that follow show views of overall fishing activity in the NRA. Figures 4.122 shows the area within which fishing usually occurs outside the EEZ (NAFO 2017b) – the NRA harvesting "footprint". Figure 4.123 is based on ship-based VMS transponder records for the period 2008-2012, as provided by NAFO, which indicate relative levels of fishing intensity within the footprint area (WGEAFM 2012; NAFO 2014, cited in Amec 2014).

Figure 4.121 Canadian and Foreign NAFO Divisions 3L and 3M Quantity of Harvest by Year, 2007 - 2016

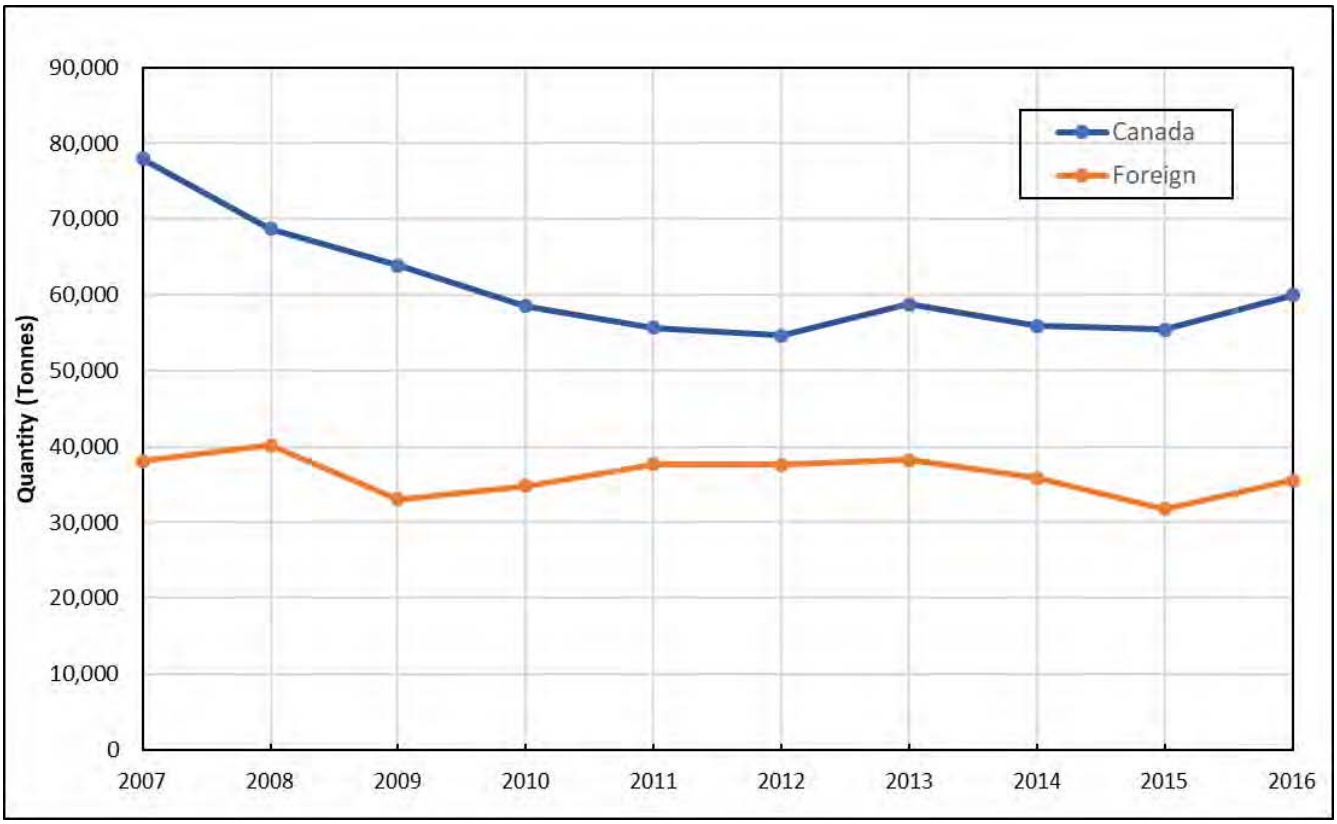


Table 4.48 Quantity of Harvest by Canadian Region and Foreign Nation, NAFO Divisions 3L and 3M 2007–2016 Average and 2016

Nation/Region	Average Quantity (t) 2007-2016	Quantity (t) 2016	% of 2007-2016 Quantities	% of 2016 Quantities
Canada Newfoundland	60,242	60,004	61.9%	62.8%
Canada Maritimes	709	-	0.7%	0.0%
Canada Scotia - Fundy	43	-	0.0%	0.0%
Portugal	9,667	13,696	9.9%	14.3%
Spain	9,369	8,460	9.6%	8.9%
Estonia	4,403	1,430	4.5%	1.5%
Russia	4,330	5,165	4.5%	5.4%
Faroe Islands	4,008	3,413	4.1%	3.6%
Norway	1,175	1,330	1.2%	1.4%

Nation/Region	Average Quantity (t) 2007-2016	Quantity (t) 2016	% of 2007-2016 Quantities	% of 2016 Quantities
Latvia	694	-	0.7%	0.0%
Lithuania	565	-	0.6%	0.0%
United Kingdom	526	1,209	0.5%	1.3%
Japan	471	792	0.5%	0.8%
France St. Pierre et Miquelon	432	-	0.4%	0.0%
Cuba	282	-	0.3%	0.0%
Denmark Greenland	200	-	0.2%	0.0%
Poland	41	-	0.0%	0.0%
Iceland	40	-	0.0%	0.0%
United States of America	36	-	0.0%	0.0%
Federal Republic of Germany	30	-	0.0%	0.0%
Totals	97,262	95,499	100.0%	100.0%

Table 4.49 Foreign (non-Canadian) Quantity of Harvest by Species, NAFO Divisions 3L and 3M 2007–2016 Average and 2016

Species	Average Quantity (t) 2007- 2016	Quantity (t) 2016	% of 2007- 2016 Quantities	% of 2016 Quantities
Atlantic Redfishes	8,975	10,618	24.7%	29.9%
Atlantic Cod	8,121	13,966	22.4%	39.3%
Turbot/Greenland Halibut	8,083	7,552	22.3%	21.3%
Northern Prawn	7,097	0	19.6%	0.0%
Sharks	1,676	1,985	4.6%	5.6%
Roughhead Grenadier	494	115	1.4%	0.3%
Roundnose Grenadier	304	55	0.8%	0.2%
Skates and Rays	245	108	0.7%	0.3%
American Plaice	240	289	0.7%	0.8%
Witch Flounder	233	222	0.6%	0.6%
Swordfish	191	211	0.5%	0.6%
Wolffishes (catfish)	111	31	0.3%	0.1%
Atlantic Halibut	81	156	0.2%	0.4%
Red Hake	73	3	0.2%	0.0%
Other Finfishes (ns)	72	0	0.2%	0.0%
Dogfishes	68	22	0.2%	0.1%
Haddock	55	121	0.2%	0.3%
Greenland Cod	42	0	0.1%	0.0%
White Hake	36	18	0.1%	0.1%
Tunas	22	17	0.1%	0.0%
All Other	53	6	0.1%	0.0%
Totals	36,269	35,495	100.0%	100.0%

*ns=not specified

Figure 4.122 NAFO NRA Fisheries "Footprint"

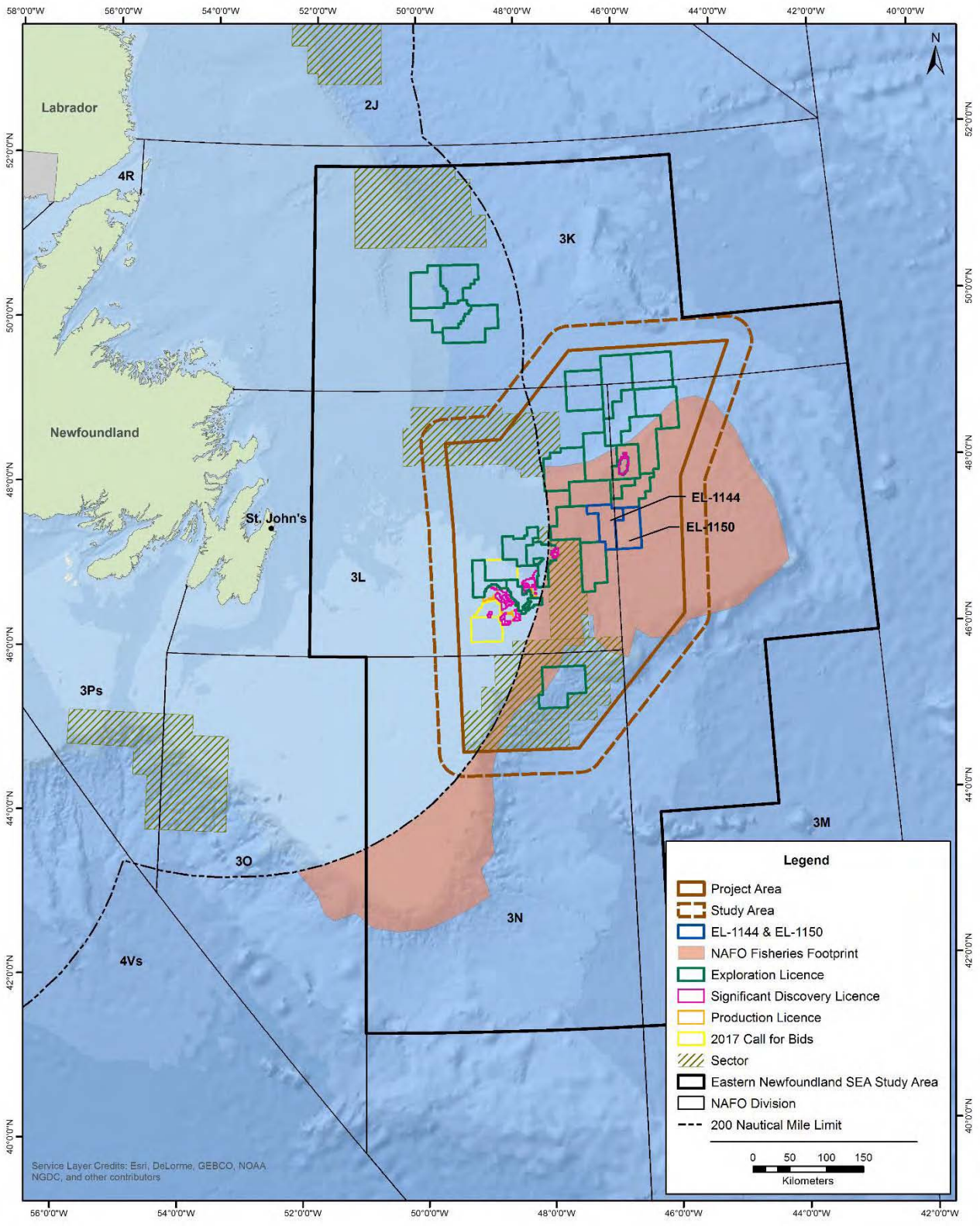
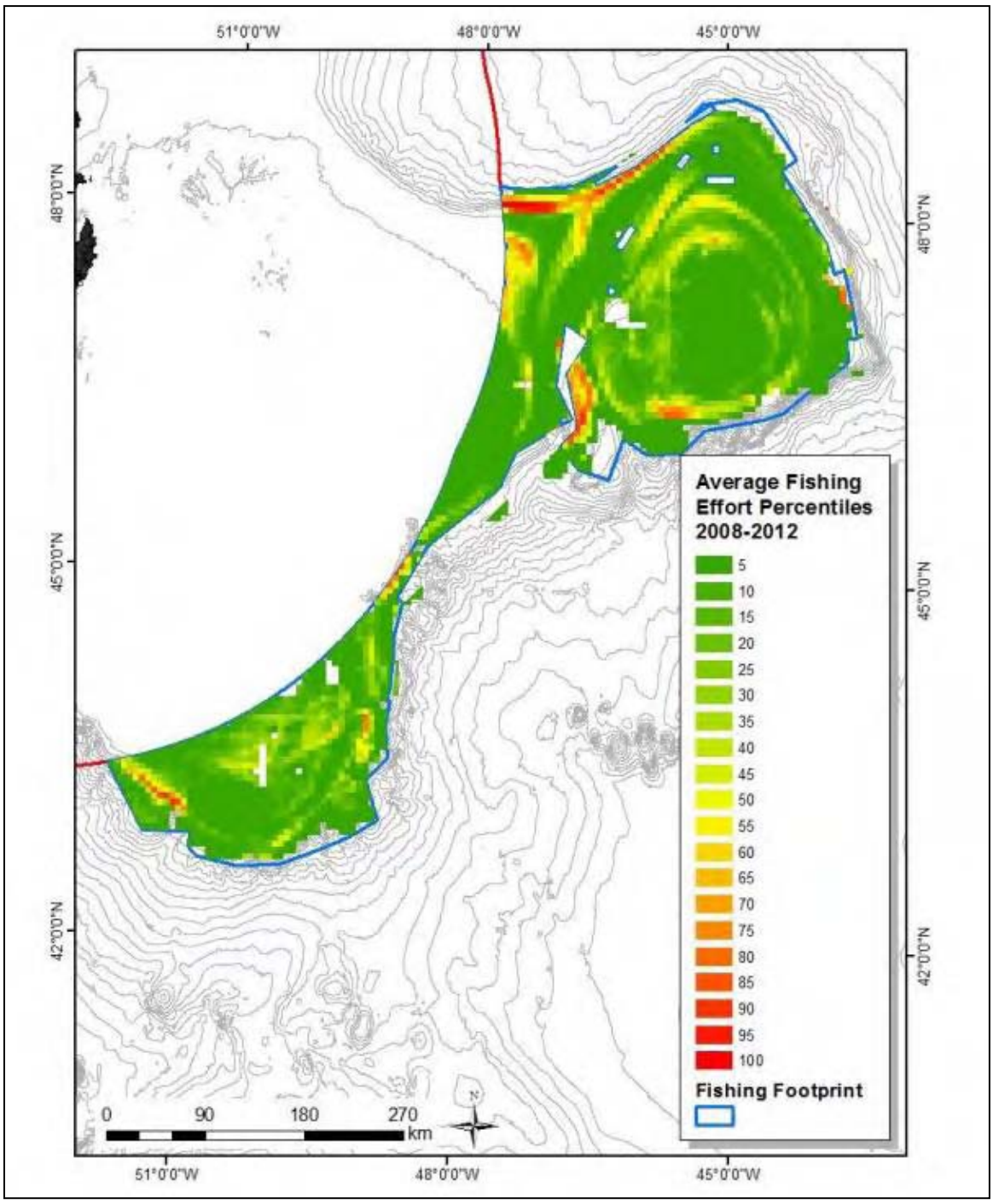


Figure 4.123 Average Fishing Effort in 5th Percentile Categories using Gridded VMS Data (2008-2012)



4.3.1.9 Industry and DFO Research Surveys

Several fisheries science programs are expected to occur within the Study Area during the temporal scope of this Project. These surveys are conducted by both government (DFO) and/or industry groups, and are important to the fishing industry and to DFO managers because the survey results provide biomass indices and may be used to modify quotas and other aspects of a fishery's management regime.

DFO Multispecies Research Vessel (RV) Trawl Surveys

As in other regions of Canada's oceans, DFO conducts annual standardized bottom-trawl surveys to collect information for managing and monitoring fish resources in the Newfoundland and Labrador Region. Spring surveys have been conducted in NAFO Divisions 3LNOPs since 1975, while fall surveys began in NAFO Divisions 2HJ3KLMNO in 1977. The spring and fall surveys take place in different but overlapping areas. While the survey design has remained somewhat consistent, there may be some annual variation in exact location and timing.

Since 1995, these surveys have been conducted by Canadian Coast Guard research vessels using a Campelen 1800 shrimp trawl. The tentative 2017 schedule for DFO RV surveys in the Study Area Divisions is provided in Table 4.50; more finalized information can be accessed in consultation with DFO managers closer to the expected survey dates.

Table 4.50 DFO Research Vessel Surveys within Study Area NAFO Divisions, by Vessel, 2017 (Tentative)

Vessel	Activity	NAFO Division	Tentative Start Date	Tentative End Date
CCGS Needler	NL Spring Survey	3O+3N	May 9	May 23
		3L+3N	May 24	June 10
	NL Fall Survey	3O+3N	September 26	October 10
		3N+3L	October 11	October 24
		3L	October 24	November 7
		3K+3L	November 8	November 21
			November 21	December 2
CCGS Teleost	NL Spring AZMP[1]	3L	April 4	April 25
	Capelin Survey	3KL	May 2	May 23
	NL Summer AZMP[1]		July 8	July 29
	NL Fall Survey	2J+3K	October 24	November 7
		3K	November 8	November 21
		3K+3L Deep	November 21	December 5
			December 6	December 20

[1] Atlantic Zone Monitoring Program
Source: D. Power, Fisheries and Ocean Canada, pers. comm (2017)

Industry - DFO Collaborative Post-Season Snow Crab Trap Survey

Since 2003, an annual Industry - DFO Collaborative Post-season Trap Survey for snow crab has been conducted in many inshore and offshore areas within Newfoundland and Labrador Region waters as a research partnership between the FFAW-Unifor and DFO. It is conducted using commercial and

modified snow crab traps at established trap stations starting in late August or early September after the commercial snow crab season has ended. The survey continues until all the stations selected for the year are finished, sometimes into late November. The station locations are determined by DFO, selected from a set of pre-established locations and up to 1,500 are surveyed annually. Each survey station is fixed and follows a general grid pattern with maximum station spacing of 5' X 5' (Stansbury et al, 2013, 2014; FFAW-Unifor 2017). Figure 4.124 shows the locations of the established "core" stations which are the principal focus of the survey in relation to the Study and Project Areas and other features. Recent discussions with DFO representatives indicate that the plans for the 2017 surveys are not yet available (D Mullowney, Fisheries and Oceans Canada, pers comm 2017).

Industry – DFO Shark Survey

DFO (Bedford Institute, Halifax), in cooperation with Nova Scotia swordfish harvesters, are planning to conduct a survey of sharks in set locations from Georges Bank to the eastern Grand Bank during June 2017, and potentially in future years during the temporal scope of this EA. The survey will consist of large-pelagic longline fishing for approximately eight hours (two hours to deploy, four to soak, two to haul) within 10 NMi of each of the locations shown in Figure 4.124 The timeframe for the survey is from June 14 until June 30. Active communications should be maintained with DFO in any potential survey year (H. Bowlby pers comm 2017).

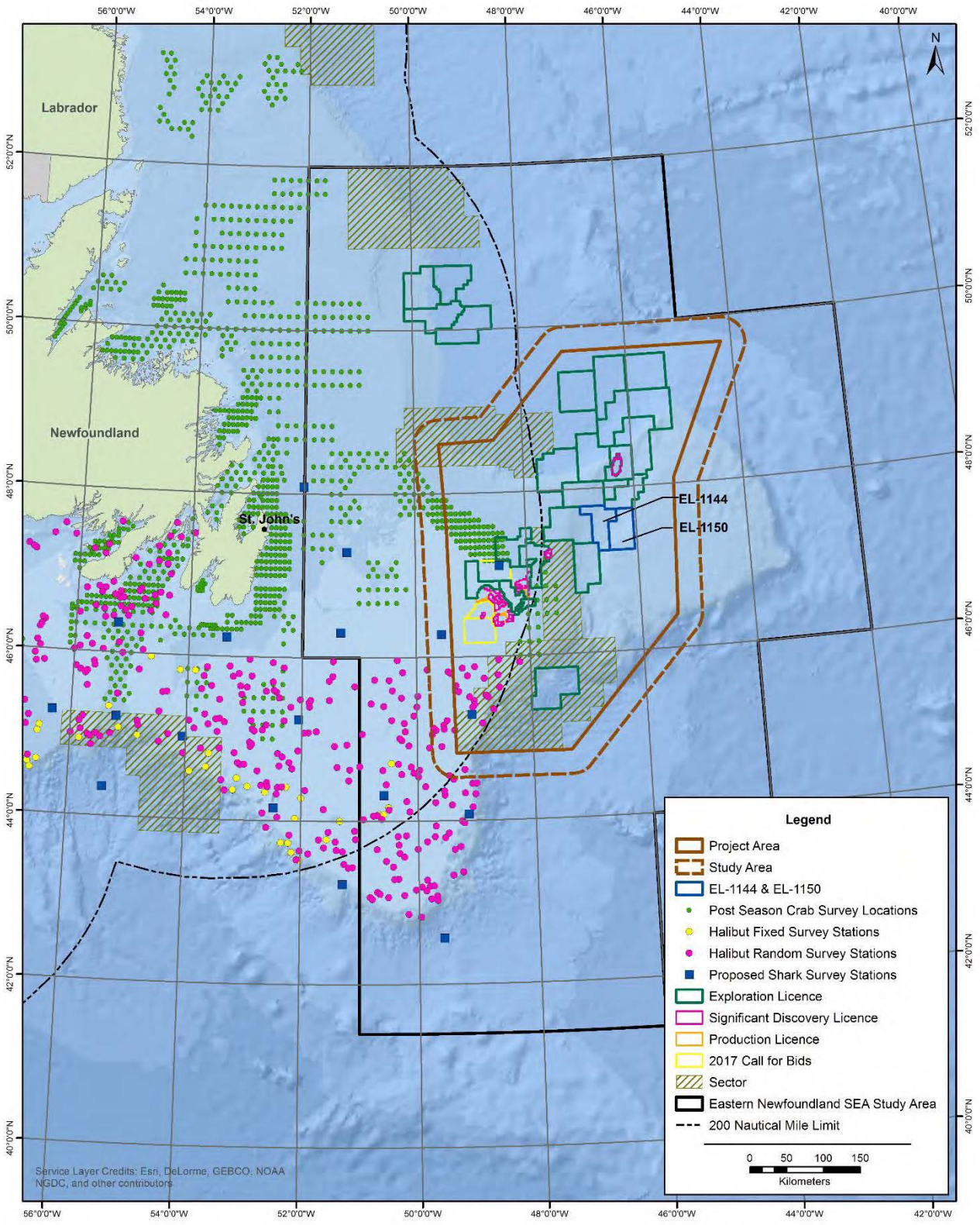
Industry-DFO Atlantic Halibut Survey

The annual Atlantic halibut abundance survey is a collaborative effort involving the FFAW-Unifor, the Eastern Shore Fisherman's Protective Association, the Shelburne County Quota Group and the Atlantic Halibut Council working with DFO. It occurs each summer from the end of May to the end of July, across the Scotian Shelf and southern Grand Banks Atlantic halibut management unit (3NOPs4VWX+5Zc). For 2017 and following years, the survey will expand its coverage in 3NOPs. The survey consists of fixed stations which are fished every year and additional random stratified stations that are chosen annually. Figure 4.124 shows the locations of both the fixed stations and the 2017 randomly chosen stations. The survey methodology varies slightly for the fixed vs. random sets, but both use halibut longlines approximately 5-km long on the sea floor, with about 1,000 hooks per line. Soak time is six to twelve hours, and the gear must be set between 0400 and 1200 local time (C. den Heyer, pers comm 2017).

CAPP Northern Shrimp Survey

To enhance research efforts, the Canadian Association of Prawn Producers (CAPP), a national Canadian organization representing the interests of at-sea producers of coldwater shrimp which conducts research and marketing activities on their behalf, and Northern Coalition have established the Northern Shrimp Research Fund (NSRF), a non-profit initiative that provides funding and a vessel for shrimp surveys from northern Shrimp Fishing Areas. Information is also collected from fishing vessels for the stock assessment process (DFO 2010e). The surveys utilize a Campelen 1800 research shrimp trawl with a cod end mesh size of 40 mm (DFO 2010e). However, for 2017 and the foreseeable future no related surveys are planned in areas south of SFA 4 (northern Labrador Shelf) (B. Chapman, pers comm 2017).

Figure 4.124 Locations of Industry - DFO Survey Stations



Groundfish Enterprise Allocation Council Survey

Groundfish Enterprise Allocation Council (GEAC) and DFO-GEAC surveys occurred annually from 1997-2001 and biannually after 2001, using bottom trawls and a commercial trawler. However, no surveys are presently planned for 2017 within or beyond in the Study Area (K. Vascotto, GEAC, pers comm. 2017).

4.3.1.10 Sealing

DFO issues some 16,000 seal harvester licences annually in Atlantic Canada, and quotas are allocated to provincially-based fleets. Approximately 12,500 licensed harvesters (78 percent) reside in Newfoundland and Labrador (DFO 2011). The provincial seal hunt is mainly for harp seals, for which the season is November 15 to June 14 annually. Within the Study Area, the harvest occurs at "The Front" in Sealing Zones 5, 6, 7, 8, and 9 which are adjacent to the Newfoundland and Labrador coastline (Figure 4.125). Approximately 70 percent of the Canadian harvest occurs at The Front, beginning around the second week of April and ending when individual quotas are achieved or ice conditions are unfavourable (DFO 2011). According to the DFO 2016 management decision for harp seals the Total Allowable Catch for the species for the 2016 season was set at 400,000 animals, which was a rollover from the 2015 TAC (DFO 2017e).

4.3.1.11 Aquaculture

There are currently more than 150 licences for aquaculture operations along the coastlines of Newfoundland, although none are near the Study Area (Figure 4.126), the closest being more than 200 km from the Study Area. In 2015, these coastal sites include 87 salmonid site licences, 51 shellfish operations, four hatcheries and 10 other ventures. The total value of production of the province's aquaculture industry in that year was worth $161 million, an increase of nearly 200 percent from the previous year (DFA 2014, 2015; DFLR 2017).

Figure 4.125 Seal Harvesting Zones

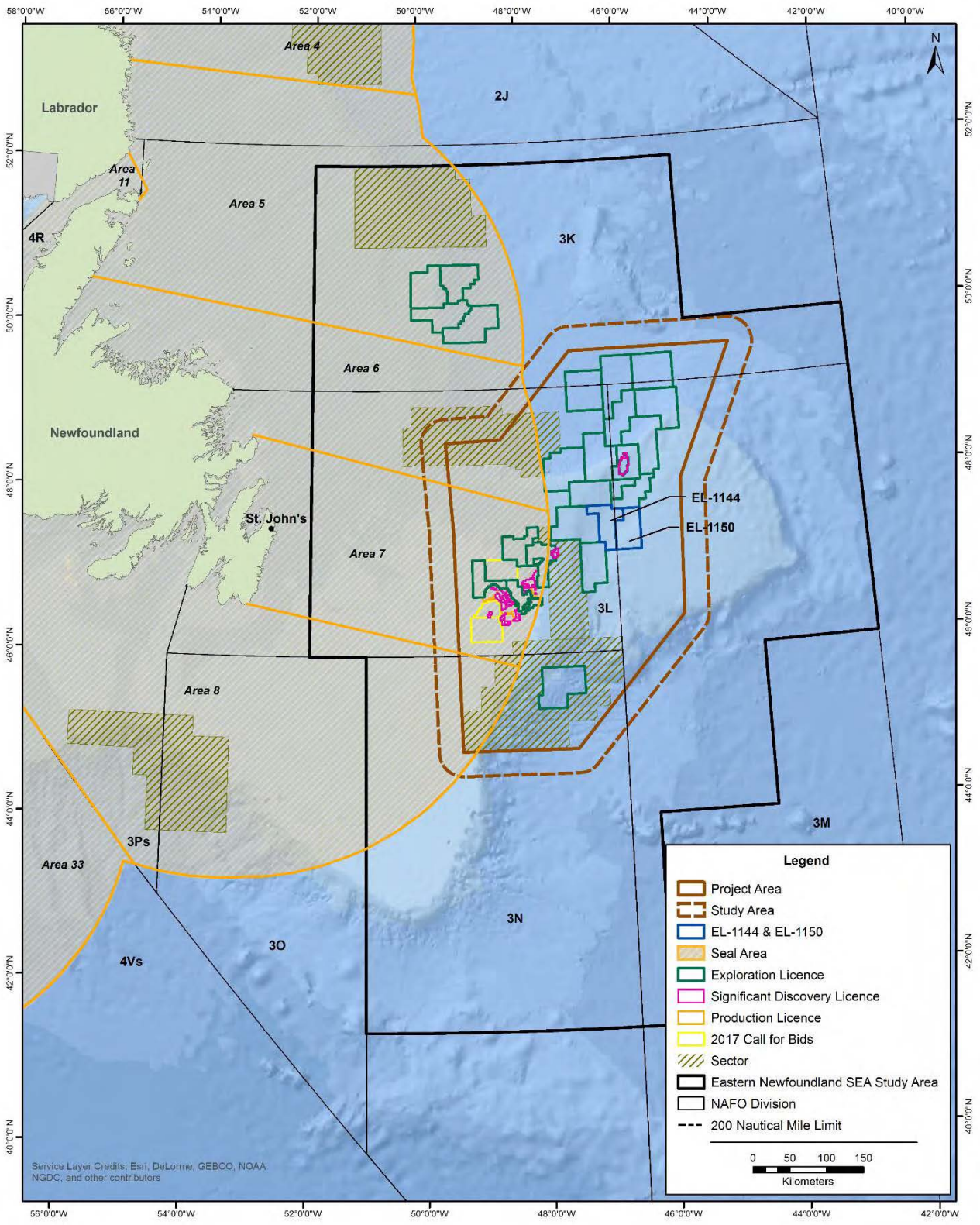
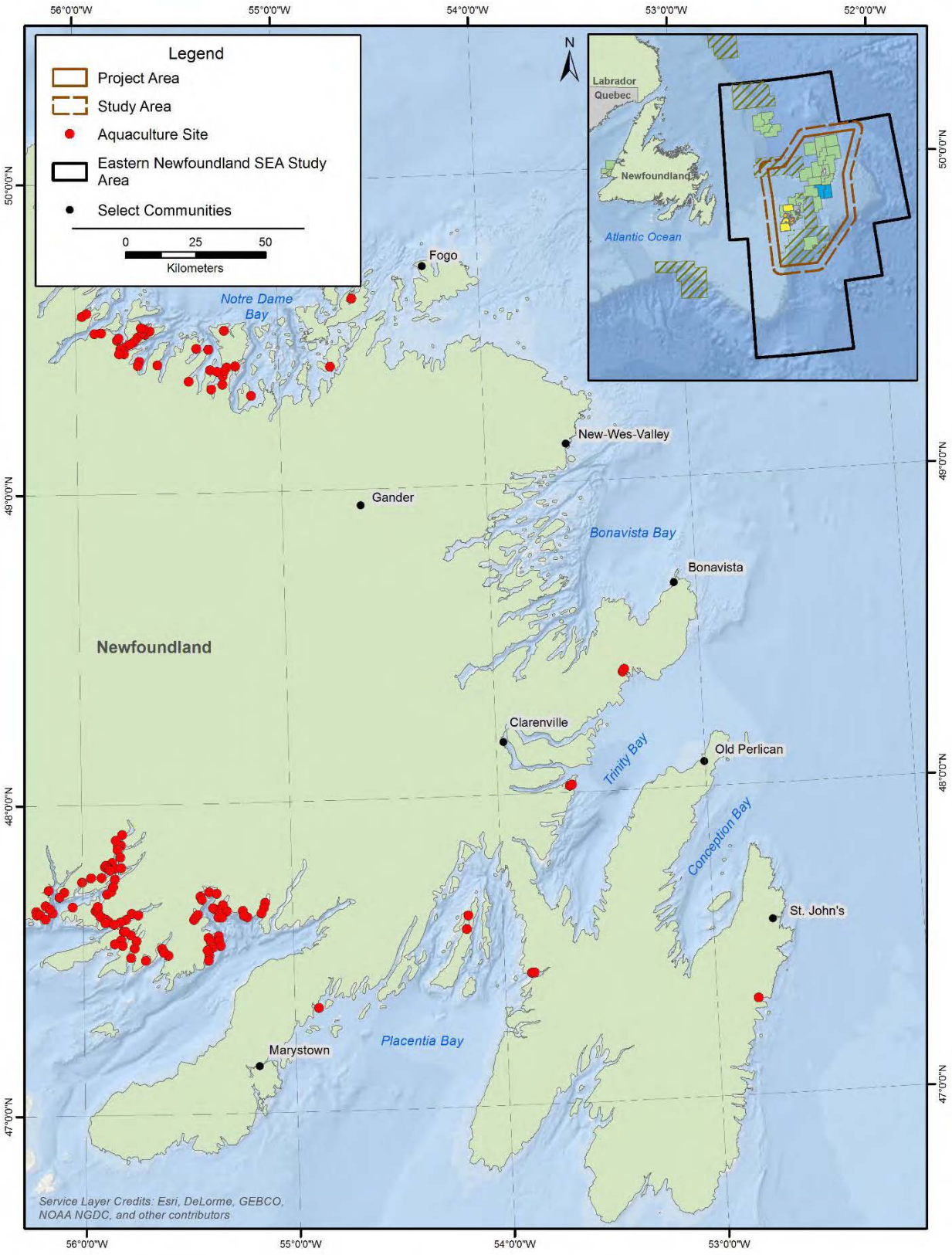


Figure 4.126 Aquaculture Sites on the Island of Newfoundland



4.3.2 Other Marine Components and Activities

The following sections describe and illustrate a number of human activities and components that occur or exist within the marine area off Eastern Newfoundland. More detailed descriptions of these activities and the socioeconomic environment of Eastern Newfoundland were provided in Section 4.3 of the Eastern Newfoundland SEA (Amec 2014), along with associated background information.

4.3.2.1 Marine Transportation and Shipping

Marine shipping in Eastern Newfoundland is mainly limited to sea ports with the required infrastructure and services for larger vessels (Figure 4.127). A number of marine shipping routes, particularly those on trans-Atlantic voyages, cross the Project Area and Study Area (DFO 2007a).

St. John's is the primary supply centre for the offshore oil and gas industry, a container terminal, fishing port and a cruise ship port-of-call. Other operations include those by the Canadian Coast Guard (CCG), military activity, ship repair, industrial fabrication and seafood landing. Cargo shipping at St. John's includes goods moved in and out of Oceanex's container ship facility, which operates weekly sailings to and from Halifax and Montreal (Figure 4.127) (SJPA 2016). Given the routes typically taken, these container ships are not likely to cross the Project Area or Study Area. Various ferry services operate in Eastern Newfoundland (Figure 4.127). These include four provincial ferry services to islands and remote communities, none of which cross the Project Area or Study Area. Eastern Newfoundland has a large number of small craft harbours (Figure 4.128). Core fishing harbours are maintained in support of the fishing industry (DFO 2017g).

In Eastern Newfoundland, CCG Marine Communications and Traffic Services (MCTS) Centres are located in St. John's and Placentia with various peripheral radio sites in other locations (Figure 4.129). Vessel traffic service areas are enforced around St. John's Harbour and in Placentia Bay and a vessel traffic separation scheme is enforced in Placentia Bay (CCG 2016a; CCG 2016b). Marine vessel traffic data are not available but marine vessels operating in Eastern Newfoundland may cross the Project Area, and/or Study Area if they cross the Atlantic Ocean.

4.3.2.2 Petroleum Exploration and Production Activity

The area off Eastern Newfoundland is subject to considerable oil and gas exploration activity, including geophysical surveys and drilling programs, with many thousands of kilometers of seismic survey data collected and several hundred wells having been drilled to date. Offshore oil production activities have also been occurring since the 1990s, including several producing oilfields (Hibernia, Terra Nova, White Rose) and another that is currently under development (Hebron) (Amec 2014, Figure 4.130). These offshore oil and gas exploration and development activities include a variety of ancillary and supporting activities as well (NOIA 2016; NLF 2017).

Figure 4.127 Marine Transportation and Shipping in Eastern Newfoundland

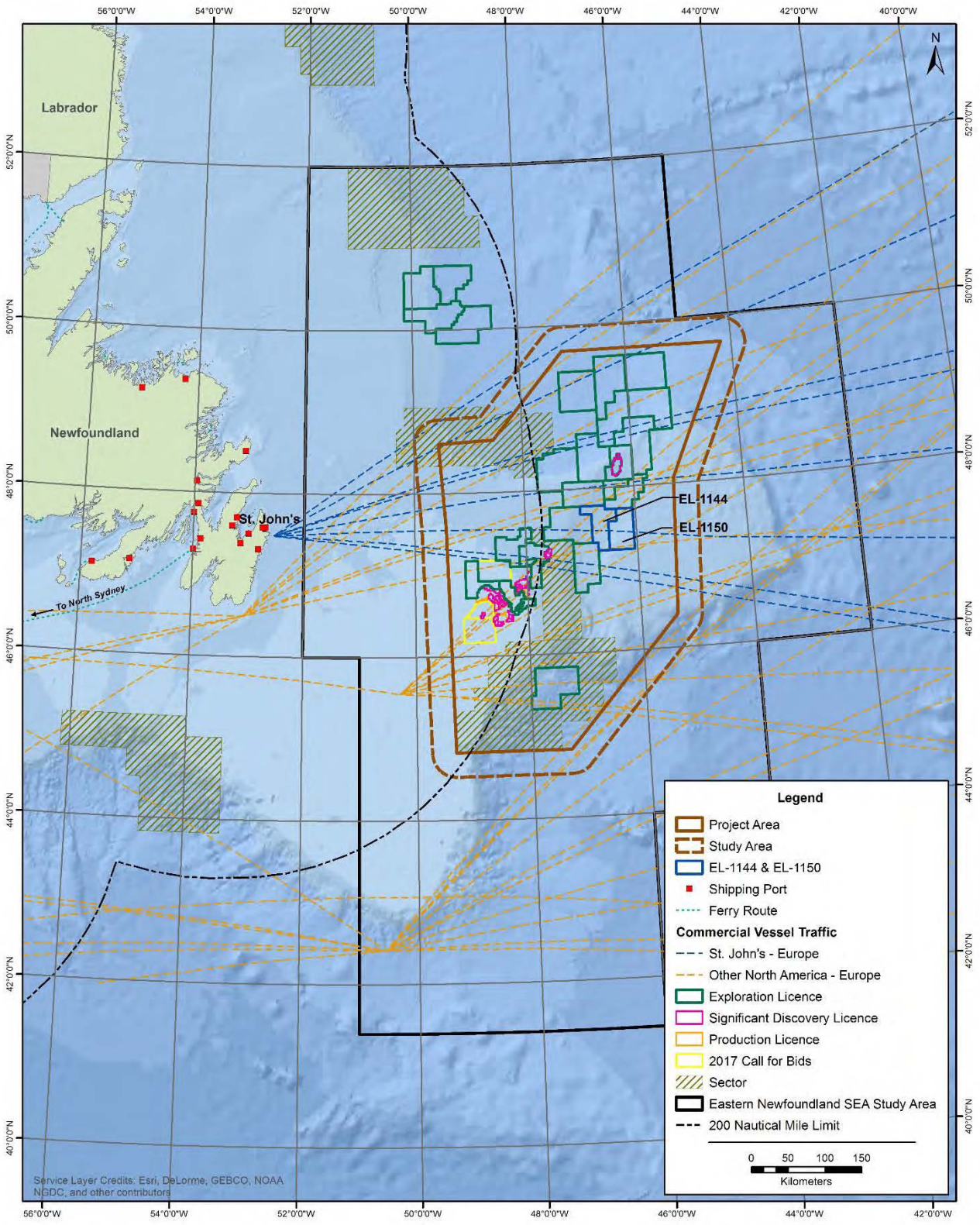


Figure 4.128 Small Craft Harbours in Eastern Newfoundland

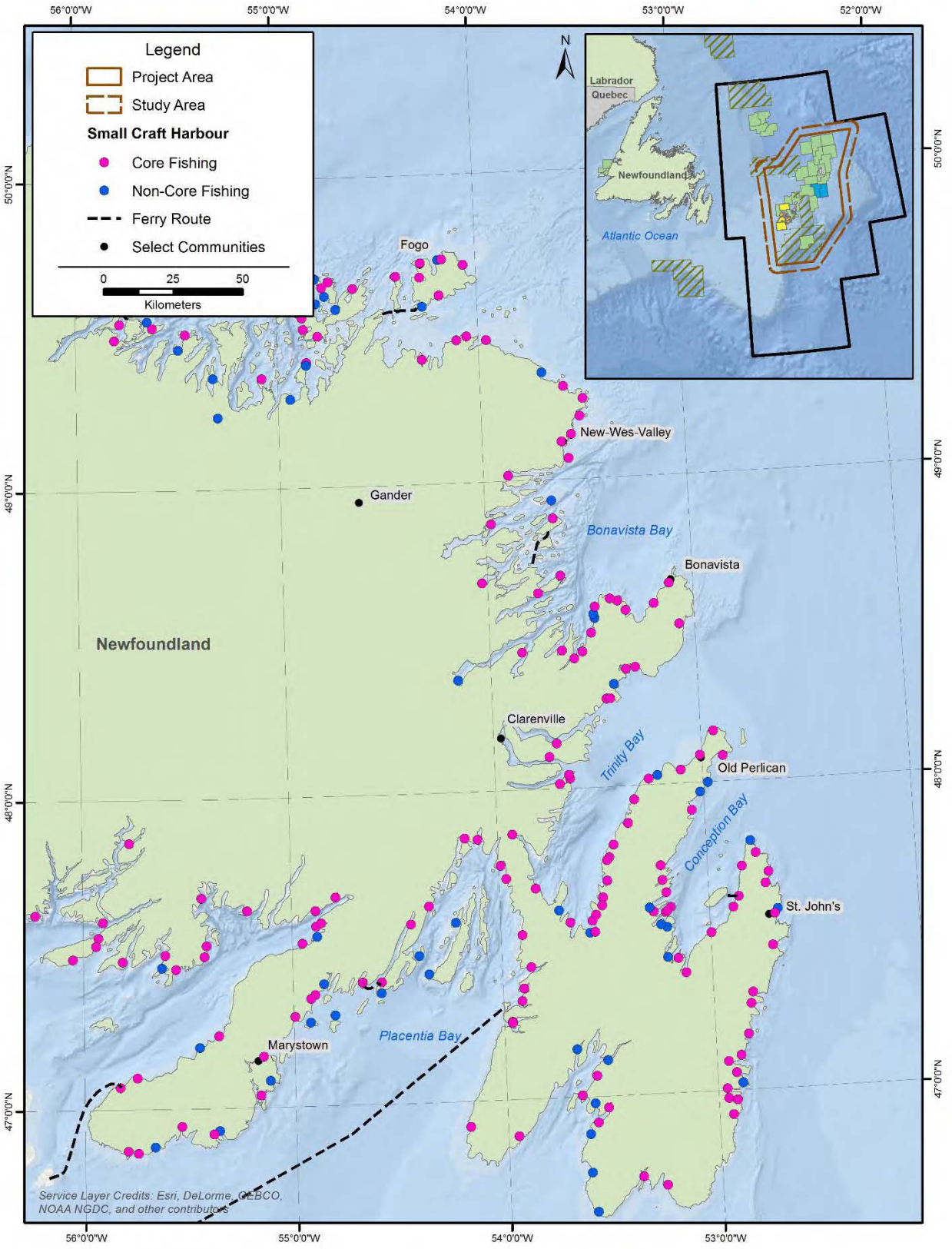


Figure 4.129 Marine Traffic Management in Eastern Newfoundland

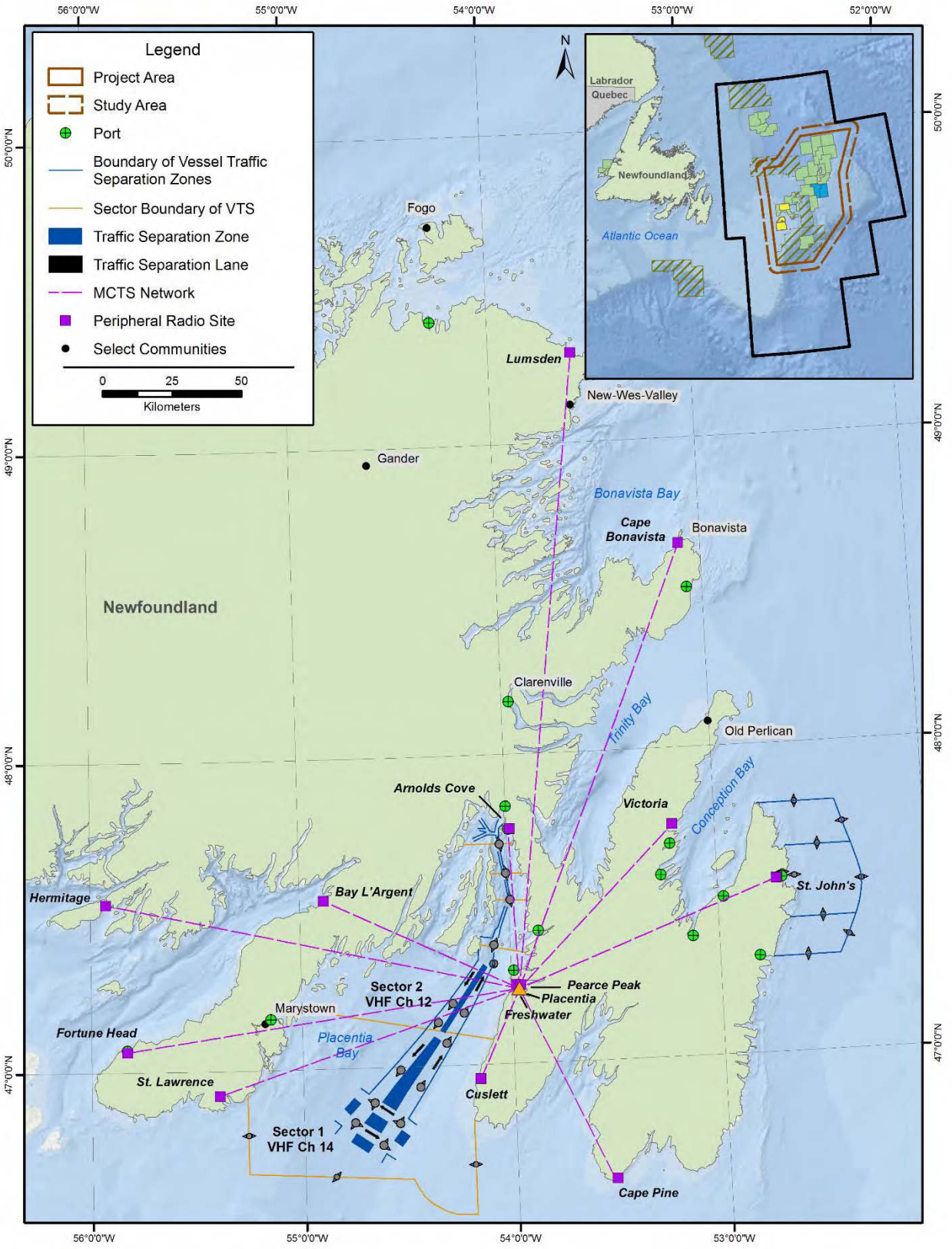
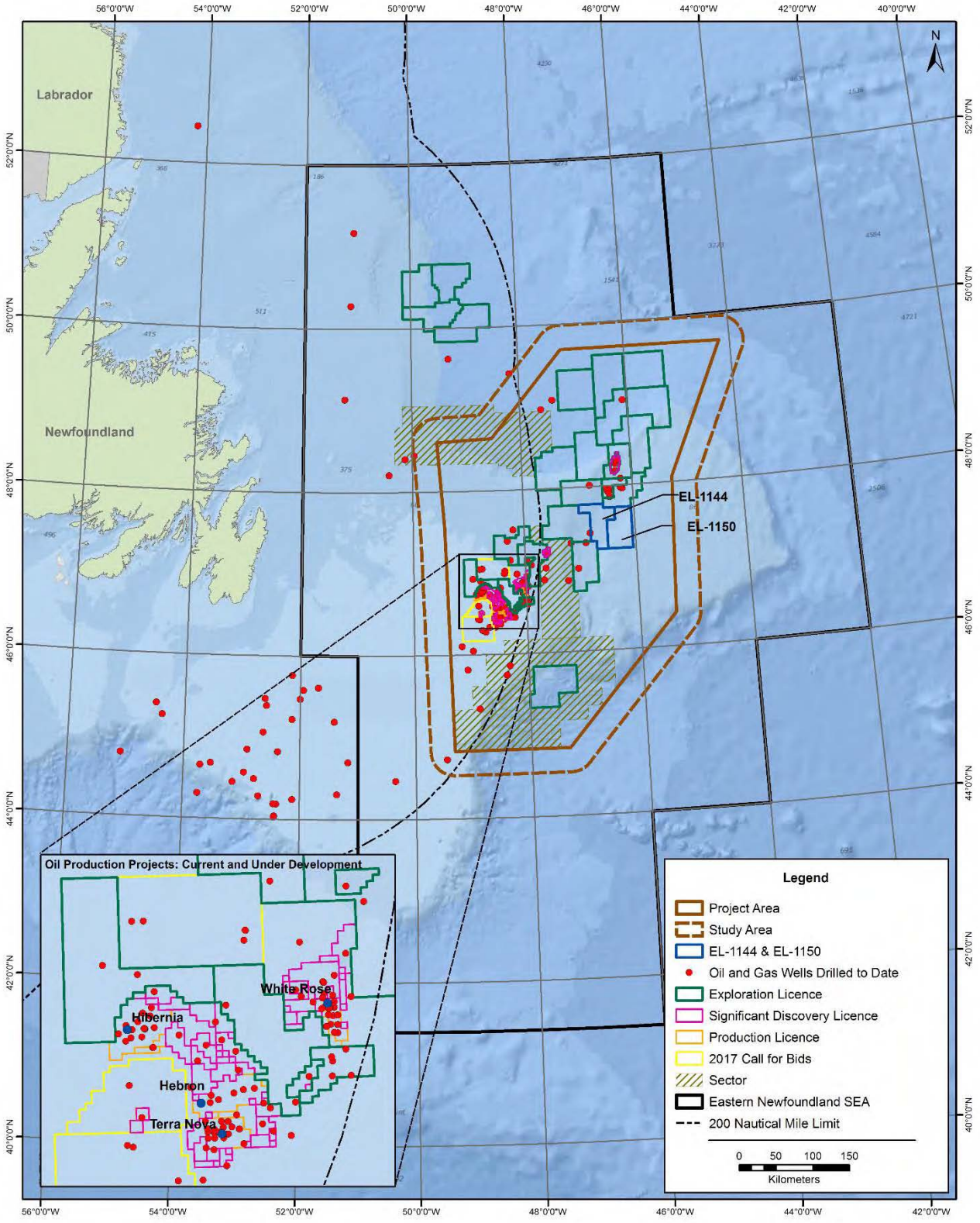


Figure 4.130 Oil and Gas Exploration and Production off Eastern Newfoundland



4.3.2.3 Military Activities

The Royal Canadian Navy operates in Canada's oceans and its Atlantic facilities include Canadian Forces Station St. John's, NL. The reservist fleet HMCS Cabot is mainly responsible for coastal surveillance and patrol, including search and rescue, law enforcement and natural resource (including fisheries) protection in Newfoundland and Labrador (DND 2016). Military activities including fisheries surveillance and Search and Rescue (SAR) operations may occur within the Project Area and Study Area.

4.3.2.4 Unexploded Ordnances and Legacy Sites

Various known unexploded ordnances (UXO) legacy sites and shipwrecks exist within the Newfoundland and Labrador offshore. These include legacy sites and explosive dumpsites, but the majority are shipwrecks (Amec 2014; DCC 2017). The current information indicates that none of these sites are located within the Project Area but two Legacy Sites are located on the edge of the Study Area (Figure 4.131).

4.3.2.5 Subsea Cables

A number of active, abandoned and proposed marine cables transect the waters off Eastern Newfoundland (Figure 4.132) (ICPC 2014; Mahlknecht 2016; SCN 2016). ExxonMobil Canada Properties (EMCP) and HMDC are in the process of installing a fibre-optic cable system for the Hibernia and Hebron projects off Eastern Newfoundland (EMCP 2015; M. Teasdale pers comm 2017). Six active subsea cables, two proposed cables and one inactive cable intersect with the Project Area and/or Study Area (Table 4.51).

Table 4.51 Marine Cables

Intersecting Lines	Status	Location
CANTAT-3 (1 line)	Inactive	Study Area/Project Area
AC-1 (1 line)	Active	Study Area/Project Area
TAT-14 (1 line)	Active	Study Area/Project Area
Hibernia Express (2 lines)	Active	Study Area/Project Area
ExxonMobil (2 lines)	Future	Study Area/Project Area
FLAG Atlantic (FA-1) (1 line)	Active	Study Area/Project Area
Emerald Express (1 line)	Future	Study Area/Project Area
Apollo (1 line)	Active	Study Area
TGN Atlantic (2 lines)	Active	Study Area/Project Area
Sources: Mahlknecht, G. (2016); SCN (2016); ICPC (2014); Teasdale, M. pers comm 2017		

4.3.2.6 Marine Based Tourism and Recreation

Marine-based tourism and recreational activities occur along the coastline of Eastern Newfoundland (Figure 4.133). Boat tours, sea kayaking routes, coastal hiking trails, marinas, beaches, bird watching areas, campsites, RV trailer parks and picnic sites are located in coastal areas (AFW 2014; MA 2014; NLT 2017), all of which occur far outside of the Project Area and Study Area. In 2016, St. John's was the main port-of-call in Eastern Newfoundland (CNL 2016). Based on the 2016 itineraries, most cruise ships are not likely to cross the Project or Study Areas.

Figure 4.131 Legacy Sites, Explosive Dumpsites and Shipwrecks of Concern

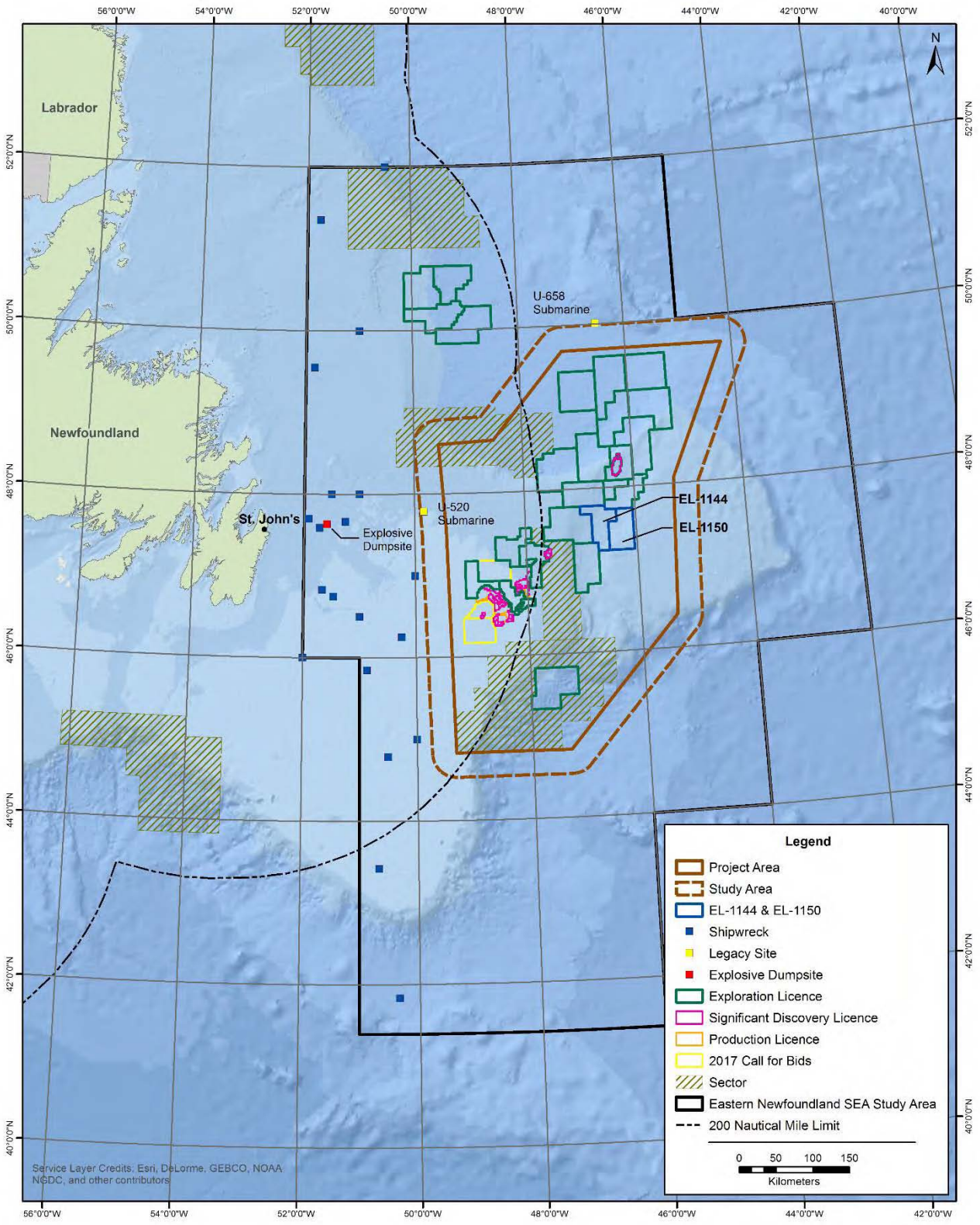


Figure 4.132 Subsea Cables in Eastern Newfoundland

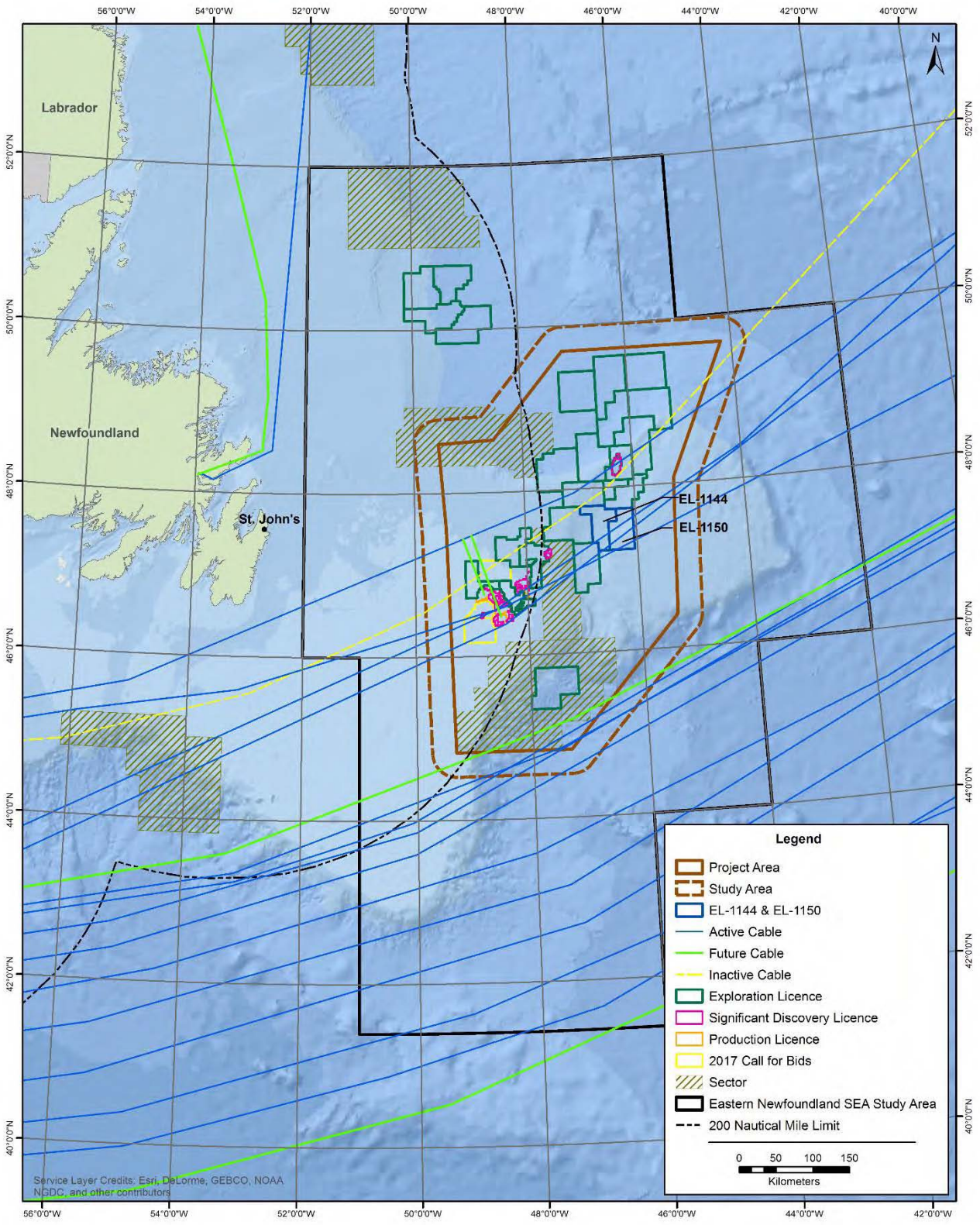
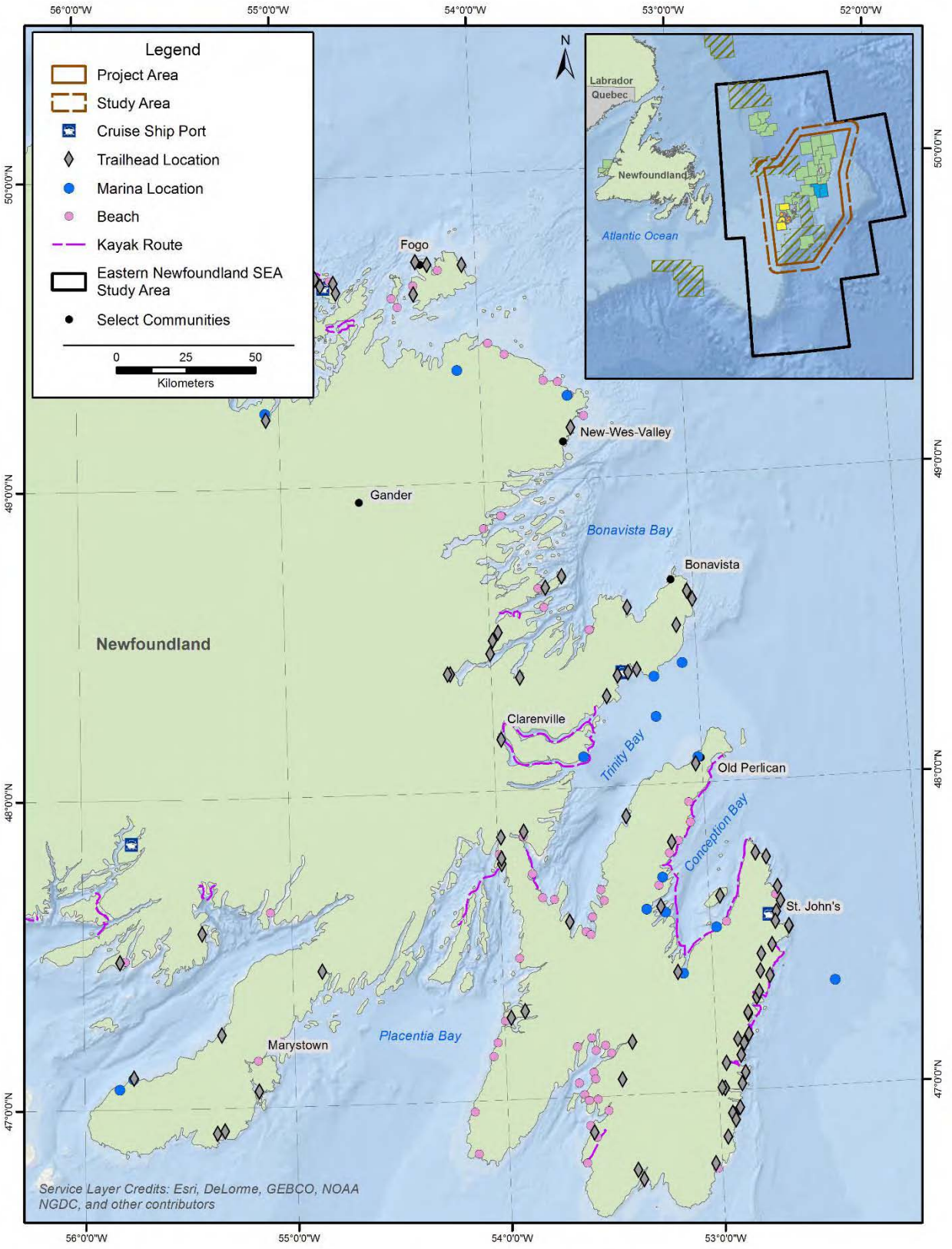


Figure 4.133 Select Marine-Based Tourism Sites and Facilities in Eastern Newfoundland



5 ENVIRONMENTAL EFFECTS ASSESSMENT

This Chapter includes an assessment and evaluation of the potential environmental effects of the Project on the identified VECs, each of which is covered in a separate subsection that follows the overall EA structure and methodology outlined previously (see Chapter 3).

5.1 Project Components, Activities and Key Environmental Considerations

An overview description of the proposed Project, including each of its key components and activities, was provided in Chapter 2. As described therein, the proposed Project will involve several types of exploration activities within the identified Project Area off Eastern Newfoundland. These may include 2D, 3D, and possibly 4D seismic data acquisition, as well as associated geochemical, environmental, geotechnical and well-site surveys. The Project will also include the operation of support craft, such as standby/guard vessels and aircraft. Pending eventual EA approval and the receipt of all other required permits and authorizations from relevant regulatory authorities, it is currently anticipated that in-field Project work will commence in 2018. Project activity will generally occur within the April to November period for each and all years of the proposed exploration program. It is possible that Nexen will concurrently conduct multiple surveys in any given year of the Project.

The various aspects of the Project that are particularly relevant to the environmental effects assessment therefore include the following:

- The presence and movement of the survey vessels and other supporting vessels and aircraft;
- The underwater sound energy generated by the 2D/3D/4D seismic source arrays and other Project related noise (vessels and equipment);
- The collection of sediment/core, water and other samples and imagery from and along the seabed or in the water column, including associated equipment mobilization, use and retrieval, as well as associated testing activities;
- Lighting on Project vessels and on-board equipment, and other associated air emissions (engine exhausts);
- The generation of solid and liquid waste materials and their management; and
- Potential accidental spills or the loss of equipment or other materials into the marine environment.

Based on these main Project elements, some key environmental considerations that may be associated with such marine exploration activities are listed below, with a primary focus on the VECs identified previously (adapted from Amec 2014):

- Potential injury or mortality of marine biota resulting from exposure to seismic sound energy at very close range;

- Possible avoidance by marine biota of locations that would otherwise be used, due to underwater noise or other disturbances during the survey program. This could alter the presence and abundance of marine animals as well as disturbing their movements, feeding, communication, and/or other activities;

- Attraction of marine biota to Project vessels and their lighting or other environmental discharges, with an associated increase in the potential for injury, mortality, contamination or other interactions;

- Possible contamination of marine biota and their habitats as a result of environmental discharges due to planned Project activities or accidental events;

- Changes in the availability, distribution or quality of feed sources or habitats as a result of Project activities and their environmental emissions or any associated seabed disturbance;

- Potential effects on fisheries, other marine activities and special areas due to possible biophysical effects on the marine environment (including resource abundance, distribution or quality);

- Potential damage to fishing gear, vessels or other equipment and infrastructure as a result of direct interactions with survey equipment, activities or environmental discharges; and

- Reduced access to preferred fishing or other marine areas during survey activities in certain locations, with possible decreases in activity success, efficiency, value or enjoyment.

As described in Chapter 2, gravity and magnetic data will be gathered passively as part of the proposed survey program. The use of this equipment will not result in environmental emissions or other disturbances, and therefore, these activities are not likely to interact with or otherwise adversely affect the VECs. No separate analysis or mitigation specific to this proposed Project activity is therefore required or proposed.

5.2 Study Areas for the Environmental Effects Assessment

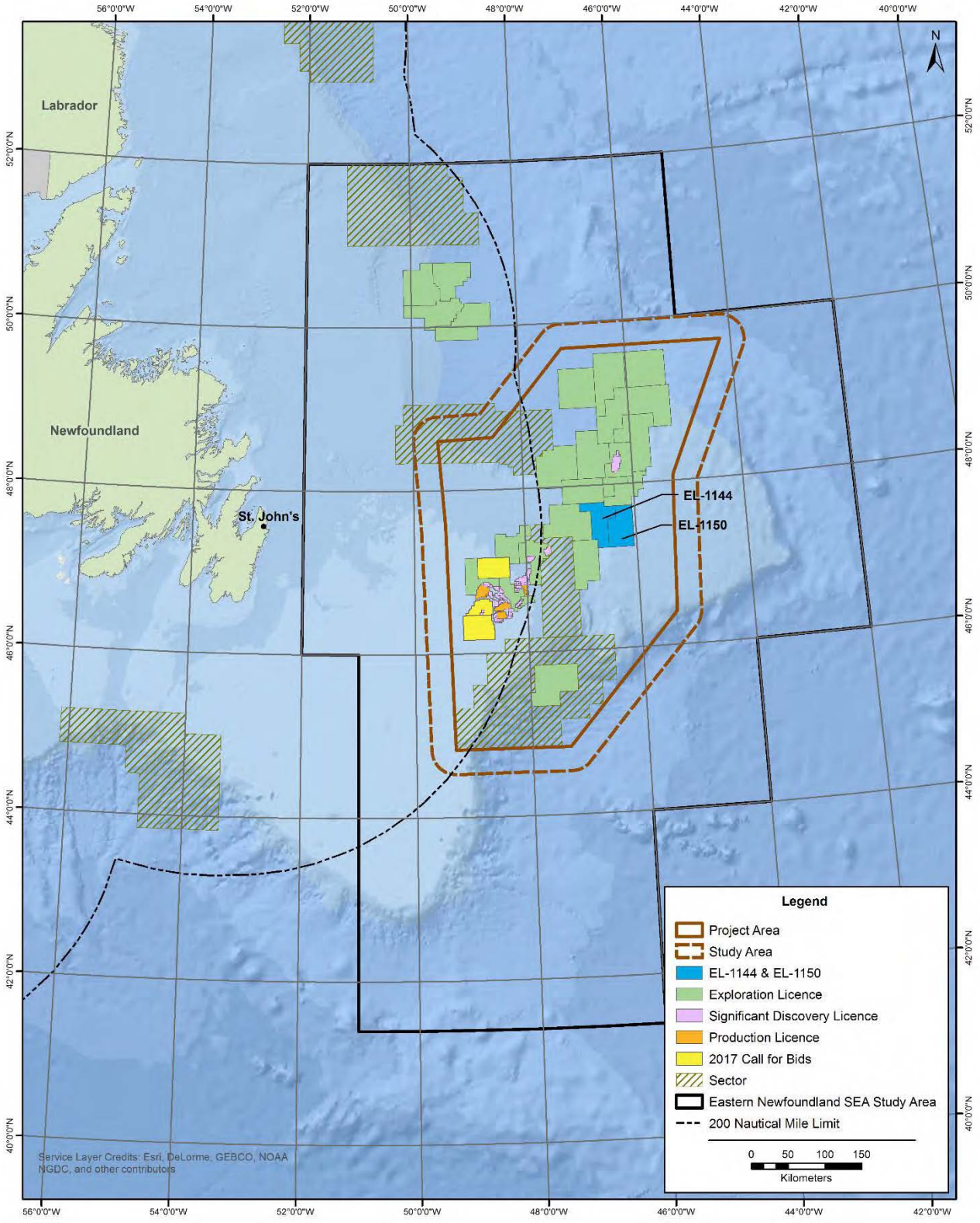
As described previously (Section 3.4.3), the environmental effects assessment for all VECs generally focuses upon a number of spatial boundaries, (Figure 5.1) including the:

Project Area, which encompasses the overall marine area within which the proposed survey activities (data acquisition and vessel turns with equipment deployed) will take place; and the

Study Area, which fully encompasses the Project Area and the likely environmental zone of influence of any Project related emissions and other disturbances (conservatively set at 40 km beyond the Project Area).

In addition to the above described generic spatial boundaries for the Project and its EA, the environmental effects assessment also considers the particular characteristics, distributions and movements of the individual VECs under consideration, including the larger *Regional Areas* within which they occur and function (as presented in Chapter 4).

Figure 5.1 Project Area and Environmental Assessment Study Area



In terms of these larger *Regional Areas*, ecological characteristics and extents (distributions and movements) for the biological VECs vary between the various species and species groups that occupy the Study Area, due to difference in their life histories, ranges, habitat preferences, movement patterns and other key requirements and activities. Marine biota are present in the Study Area throughout the year, with many species occupying particular areas (habitats) and moving in and out of the area at different times according to their particular characteristics, habitat preferences and seasonal activities. Existing and available information on the presence and geographic and seasonal occurrence of marine fish, birds, mammals and reptiles in and near the region is presented in Chapter 4, which indicates that many species have widespread distribution patterns, although ranges and activities vary considerably.

The EA therefore assesses potential effects to marine biota (individuals and populations) which are known or likely to use the Study Area during the period of planned survey activities, including those that occur in the water column or near the water's surface or seafloor. In conducting the assessment, particular consideration has been given to the overall timing of species presence within the Study Area, as well as any particularly important or sensitive time periods. The environmental effects assessment also considers the nature, extent and timing of likely Project-VEC interactions and the associated spatial and temporal zones of influence of Project-related disturbances in the marine environment.

For special areas, the environmental effects assessment includes consideration of the location, size and extent of any such areas that overlap in whole or part with the Study Area, as well as the overall geographic characteristics and distributions of the ecological and/or socio-cultural components and processes that have been relevant to the identification/designation and overall integrity and value of these areas.

The environmental effects assessment for marine fisheries and other activities likewise includes consideration of the overall geographic extent and distribution of fishing and other human activities within and adjacent to the Study Area, as well as the seasonality of particular activities, including any key times of the year and associated core areas.

The temporal boundaries for the EA encompass the likely timing and duration of Project-related (in-field) activities in the Project Area, as well as the likely duration of any resulting environmental effects. In conducting the assessment, special consideration is also given to timing of VEC presence within the Study Area, including any particularly important or sensitive periods.

5.3 Environmental Planning, Management and Mitigation

Each of the potential environmental issues and interactions that may be associated with the proposed Project can be avoided or otherwise mitigated through the use of good planning and sound operational practices and procedures, supported by standard mitigations that are well established and outlined in relevant regulatory procedures and guidelines (see Section 1.3 and associated mitigation below in Section 5.3.2). These mitigations have been routinely and successfully applied to similar marine exploration programs off Eastern Newfoundland and elsewhere in recent years. These planning and management measures, in combination with Nexen's own environmental management systems and associated policies, plans and procedures, are designed to help avoid or reduce potential adverse environmental effects.

These environmental planning, management and mitigation measures are considered integrally in the environmental effects assessments that are presented in this Chapter. This includes those that have

been “built-in” to the Project through its on-going planning and design in order to proactively mitigate potential environmental effects (Chapter 2) as well as the other VEC-specific environmental protection measures which are further identified and described in this Chapter.

5.3.1 Nexen Environmental Policies, Plans and Procedures

Health, safety and environmental protection are core values at Nexen and the success of every activity undertaken by Nexen is measured on the ability to execute work safely each and every day. Nexen’s business objectives are to operate safely and responsibly without causing harm to employees, contractors, joint venture partners or the communities in which Nexen operates and to minimize the environmental impacts of Nexen’s activities. Nexen is committed to promoting a culture of Safety First; striving for best-in-class health, safety and environmental performance.

The Nexen Health, Safety, Environment & Assurance (HSE&A) Policy commits to the following:

- Regulatory requirements, of the jurisdictions in which we operate, shall be met or exceeded to protect employees, contractors, the environment and communities’ health, safety, security and well-being.
- An HSE&A focused culture shall be promoted, sustained and continuously improved across Nexen.
- Formal processes for identifying hazards, managing risks and ensuring compliance shall be developed, documented and implemented.
- Incidents and any departures from planned arrangements shall be promptly and effectively investigated, appropriate actions taken and findings shared to prevent recurrence.
- HSE&A policies, standards, processes and procedural aids shall be met or exceeded by all employees, contractors and their subcontractors undertaking work.

Nexen has developed an Integrated Management System (Nexen Management System, NMS) that consists of 13 fundamental Elements to enable and assure leading performance in all business units within the organization:

1. Leadership
2. Full Asset Lifecycle Operations
    - 2.1. Explore
    - 2.2. Develop
    - 2.3. Produce
    - 2.4. Market
    - 2.5. Abandon
3. Business Development
4. Risk Management
5. Organization & People
6. HSE&A
7. Social Responsibility
8. Financial Management
9. Supply Chain Management
10. Information Management

11. Legal
12. Continuous Improvement
13. Change Management

The East Coast Canada region's management system will incorporate all of the fundamental elements of the NMS, and will include (but will not be limited to) specific regional procedures for environmental management (to ISO 14000), ice management, oil spill response, aviation, fishing gear compensation programs, emergency response and communications.

5.3.2 Required and Planned Mitigation Measures

The C-NLOPB's *Geophysical, Geological, Environmental and Geotechnical Program Guidelines* (June 2016) include various requirements and measures related to environmental planning, mitigation, monitoring and reporting that are intended to help avoid or reduce the potential effects of seismic noise in the marine environment, as well as interactions with other ocean users and other issues. Nexen confirms its intent to adhere to the requirements of these Guidelines in planning and implementing the proposed Project.

These Guidelines include the *Statement of Canadian Practice with Respect to the Mitigation of Seismic Sound in the Marine Environment* (DFO 2007b), which sets out a series of mitigation and monitoring requirements that pertain to these activities, including measures related to the:

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

In planning and implementing the proposed Project, Nexen has been and will continue to be guided and informed by these and other such requirements and approaches, as well as the various mitigation measures that have been identified through the Eastern Newfoundland SEA prepared for the C-NLOPB (Amec 2014).

Nexen recognizes that the careful and thorough implementation of, and adherence to, these and other such measures will be important for ensuring that the Project does not result in unacceptable environmental consequences. This section describes the mitigation measures that will be established and applied for this Project, some of which are again founded in regulations, guidelines, or industry "best practices" as outlined above, while others have been developed specifically for this Project. These measures will be adhered to in each survey year, with adjustments as necessary.

The following mitigation measures will be implemented to avoid or reduce any potential adverse environmental effects resulting from the Project:

- Project survey activities are planned for offshore locations that avoid the potential for adverse interactions with on-land or near shore environmental components or activities.

- Future operational planning will also include attempting to avoid any known and observed significant aggregations of marine animals where possible in the planning and conduct of the marine exploration activities that comprise this Project.

- Seismic sound levels will be kept at the minimum level possible for the survey, based on the vessel's seismic sound source capability and associated requirements.

- A 30 minute observation for the presence of marine mammal will be followed by a gradual "ramp-up" (or soft-start) procedure of the seismic source array over a minimum 20 minute period at the commencement of seismic survey activity, to allow any mobile marine animals to move away from the area.

- A planned shut-down of the seismic sound sources or reduction to firing the smallest, single source element during survey line changes and maintenance activities. During line turns a single source element will be fired at least once every 30 minutes.

- During the seismic surveys a "safety zone" will be established that will comprise a circle with a radius of at least 500 m as measured from the center of the air source array.

- An operational monitoring program for marine mammals and sea turtles within the safety zone will be planned and implemented in accordance with the C-NLOPB's *Geophysical, Geological, Environmental and Geotechnical Program Guidelines.* During daylight hours a qualified Marine Mammal Observer (MMO) will continuously observe the safety zone starting at least 30 minutes before seismic source array start up when the safety zone is visible, and will maintain a regular watch of the safety zone at all other times when the array is active, including adhering to the relevant provisions of the Guidelines related to operations in low visibility (see Appendix 2 of the Guidelines). The specifics of the program design will be made available to the C-NLOPB and/or DFO once available, including in any subsequent EA Updates.

- The Project will be planned and implemented so as to avoid or minimize environmental discharges and emissions from planned operations and activities. This will be achieved through compliance with relevant regulations and standards and company procedures regarding material selection and use, waste management, discharge prevention and management and other potential liquid, solid or air emissions.

- Project equipment selection will include the planned use of gel filled or solid streamers to prevent potential hydrocarbon spills into the marine environment in the event of a streamer tear or break.

- The amount, duration and frequency of lighting used on offshore vessels and equipment will be minimized to the degree possible, while at the same time ensuring and maintaining the safety of the crews and other marine users. This will occur particularly during periods when migratory birds are especially vulnerable to disturbance and associated effects (such as during spring and fall migration and in inclement weather).

- Protocols and programs will be established and implemented for the collection and release of any marine birds that become stranded on offshore vessels, which will be implemented by qualified and experienced personnel and in compliance with associated regulatory guidance and

applicable *Migratory Birds Convention Act* (MBCA) permit conditions including associated reporting requirements.

- Prior to undertaking seabed sampling work in areas that have been identified as having a high probability of occurrence of corals and sponges (see Section 4.2.1.6) a representative seabed characterization (reconnaissance) drop camera/video system survey transect will be acquired to investigate the potential presence of these sensitive benthic organisms.

- Should the above referenced drop camera/video surveys indicate the presence of sensitive benthic organisms within a planned area of seabed sampling, the appropriate mitigative response to this finding will depend on a variety of factors, including: the type of organism(s) observed; their relative abundance and overall size of area occupied; the (relatively small) footprint of the seabed sampling equipment and the presence of suitable, alternative sampling locations nearby; the locational precision of the drop camera/video survey (due to water depths, currents, cable lengths and associated sway); and other factors. Should such organisms be observed on-site during the conduct of the field program, the relevant technical crew and Nexen representatives will discuss to determine the appropriate mitigation approach. In any cases where sampling activities are planned to occur within identified high potential areas for the occurrence of such species, Nexen will discuss this with relevant DFO representatives in advance of the survey mobilization to discuss and consider potential mitigation approaches in the event that such species are observed at planned sampling locations in the field.

- Minimizing the amount of helicopter traffic and the avoidance of low-level aircraft operations to the extent possible;

- Avoiding known and observed bird colonies and significant aggregations of avifauna wherever possible, including avoiding helicopter use near seabird breeding colonies during the period from May to September).

- Nexen will continue to consult with the Department of National Defence to obtain and consider the latest information on UXOs/shipwrecks within the Project Area and to implement and adhere to associated mitigations and communications protocols.

- All Project vessels will have spill prevention procedures and materials in place. This will include appropriate equipment and procedures to help prevent such accidental spills into the marine environment, as well as an Oil Spill Response Plan in the unlikely event of a spill.

- Communications and coordination procedures with regulatory authorities, stakeholders and key ocean users will be used throughout the operational life of the Project. This will include:

    - On-going information gathering on key fishing areas and times and continued monitoring of fishing activity (through the presence of a Fisheries Liaison Officer (FLO) on the acquisition vessel and review of DFO VMS data and other sources) and associated survey and logistical planning to minimize interference with fishing activities;

    - The presence, active participation and advice of the FLO on board the seismic ship, and a shore-based Single Point of Contact (SPOC), which will be communicated to relevant

agencies and organizations once identified. The FLO will be a FFAW – Unifor member, and will be responsible for communicating with fishing vessels at sea and relaying information to shore as needed. FLOs will serve as the primary at-sea liaison between the commercial fishing industry and the seismic survey program.

- The issuance of Notices to Mariners/Notices to Shipping and other notifications and direct industry communications (e.g., CBC Fisheries Broadcast) throughout the periods of Project operations;

- Regular communication of planned survey activities with key industry representatives, and on-going liaison with FFAW-Unifor/One Ocean contacts;

- A standby or guard vessel will be used to scout for hazards and for interacting and communicating with other users of the area about the survey and associated equipment (especially streamers), and to assist in communicating and working with active fishers in the area (if any). The guard vessel will also provide a means for towing the seismic vessel in the case of a loss of propulsion.

- Ensuring appropriate spatial and temporal avoidance of active fisheries science survey areas through on-going planning updates, discussion and coordination with DFO and industry contacts.

- Establishment and implementation of a Fishing Gear Damage or Loss Compensation Program and communication of this and its associated procedures (through SPOC and otherwise), should there be gear damage caused by direct interactions with seismic streamers or other Project equipment, or in the unlikely event of an offshore spill.

These and other planned mitigation measures to avoid or reduce any potential adverse effects that may result from the proposed Project are identified and described as part of the environmental effects assessment for each of the individual VECs under consideration.

5.4 Marine Fish and Fish Habitat: Environmental Effects Assessment

Fish and their habitats are important considerations in any assessment of proposed projects and activities that occur within, and which may affect, the marine environment, particularly as a result of the ecological, economic and/or socio-cultural importance of many fish and invertebrate species and populations. This VEC includes finfish and shellfish, as well as plankton, algae and other benthos given the key interrelationships between these various ecological components and their habitats.

An overview of marine fish and fish habitat in the Study Area was provided in Section 4.2.1. This baseline information has been used to identify and evaluate the key potential interactions of the Project with this VEC and any resulting environmental effects and required mitigations to avoid or reduce these.

5.4.1 Environmental Assessment Study Areas and Effects Evaluation Criteria

As described in Section 5.2, the EA focuses upon a number of spatial boundaries, including the:

> *Project Area*, which encompasses the overall marine area within which the proposed survey activities (data acquisition and vessel turns with equipment deployed) will take place; and the
>
> *Study Area,* which fully encompasses the Project Area and the likely environmental zone of influence of any Project related emissions and other disturbances (conservatively set at 40 km beyond the Project Area).

In addition to the above described spatial boundaries for the Project and its EA, the environmental effects assessment also considers the particular characteristics, distributions and movements of marine fish and their habitats, including the larger Regional Areas within which they occur. Although these are not specifically “mappable” per se for the VEC overall, key aspects of marine fish movements and distributions as they relate to the Project Area and Study Area are as presented in Chapter 4. Ecological boundaries for marine fish and fish habitat vary between species in the Study Area, due to difference in their ranges, habitat preferences, movement patterns and key activities. The EA assesses potential effects to fish (individuals and populations) which are known or likely to use the EA Study Area during the period of planned survey activities, including those that occur in the water column or near the water’s surface or seafloor. The environmental effects assessment also considers the nature of likely Project-VEC interactions and the associated zone of influence of Project-related disturbances in the marine environment (particularly the propagation of sound from the seismic array).

The temporal boundaries encompass the potential timing of Project survey-related activities and the overall lifespan of the proposed Project, as well as the likely duration of any potential resulting environmental effects. In conducting the assessment, consideration is also given to timing of fish presence within the EA Study Area, any particularly sensitive or critical periods, and other potentially relevant factors.

The Project’s likely environmental effects on this VEC are assessed and their significance is evaluated applying the above described spatial and temporal boundaries.

Significant environmental effects are considered to be those that could cause a change in a VEC that would alter its status or integrity beyond an acceptable and sustainable level. For the purposes of this

EA, significant environmental effects on marine fish and fish habitat are defined as those that would cause one or more of the following:

- Mortality or life-threatening injury to individuals of a designated (protected) fish species at risk, or destruction or alteration of the critical habitat of any such species;

- Effects to fish (of any species) within the area of Project-related emissions/disturbances, such that size, health, ecological function and/or sustainability of a fish population would be measurably and adversely affected; or

- Destruction of, or displacement of fish from, important feeding, spawning, nursery grounds, migratory routes or other essential habitats, during time periods and for durations over which the size, health, ecological function and/or sustainability of a fish population would be measurably and adversely affected.

5.4.2 Potential Environmental Issues, Interactions and Existing Knowledge

The potential environmental interactions between offshore oil and gas exploration activities and marine fish and their habitats may be both direct and indirect in nature, and can include the following (adapted from Amec 2014):

- Possible injury or mortality due to exposure to seismic signals at very close range (particularly, immobile fish species), including temporary or permanent hearing threshold shifts;

- Behavioural changes by fish and invertebrates in response to insonification of the water column as a result of seismic energy, which could displace individuals and alter feeding, migration, predator avoidance and reproduction activities;

- Interference with (and the masking of) sounds that originate from and/or are interpreted by marine fish, such as in communication and the identification and detection of predators and prey;

- Potential contamination of fish and invertebrates and their habitats due to environmental discharges during routine activities (e.g., hydrocarbons or other deleterious substances in deck drainage);

- Changes in the presence, abundance, distribution and/or health of fish and invertebrates as a result of accidental spills from exploration vessels (through physical exposure, ingestion, effects on prey and habitats, etc); and

- The introduction or further spread of invasive species (such as through attachment to the ship and seismic array).

An overview of the potential (material) interactions between each of the main Project components and activities and the various key indicators and parameters that have been identified for this VEC is presented in Table 5.1, in order to help focus and frame the environmental effects assessment.

Table 5.1 Marine Fish and Fish Habitat: Potential Project-VEC Interactions

Project Component/Activity	Key Indicators and Parameters				
	Presence and Abundance	**Habitat Availability and Quality**	**Feeding (Availability and Quality)**	**Migration and Reproduction**	**Health (Individuals or Populations)**
Presence and Use of Vessels/Aircraft and Equipment	●	●		●	●
Seismic Sound	●	●	●	●	●
Seabed and Environmental Sampling Activities	●	●			●
Air Emissions					
Lighting	●				
Solid Waste					
Liquid Waste					●
Potential Accidental Spills	●	●	●		●
Onshore Supply and Servicing					

The possible effects on this VEC resulting from sound in the marine environment due to offshore geophysical surveys may be behavioural (avoidance, other changes in distribution or activities) or involve injury to or mortality of individual fish. A considerable amount of research has been conducted on the effects of offshore seismic surveys (including various sound types and intensities) and other anthropogenic activities on marine fish. This has included scientific research, monitoring studies and anecdotal reports of observed reactions by various fish species.

Although overall knowledge and understanding of the effects of seismic and other anthropogenic noise on marine fish and invertebrates remain incomplete in some areas (see Table 5.2 below), the effects of seismic activities and other noise sources have been documented in a variety of fish and invertebrate species in numerous studies. It should be noted, however, that many of the studies occur within a laboratory setting with captive animals, and the documented effects may not replicate natural conditions as individuals are unable to move away from sound disturbances. Furthermore effects are often species-specific as they are based on individual species hearing thresholds. Table 5.2 provides a more detailed overview of this literature and associated sources/references, the key findings of which are summarized below:

- Studies indicate that plankton, eggs or larval mortality (if it occurs) would be limited to within a few metres of a seismic array. There is little indication or evidence that direct physical damage to fish occurs at distances greater than several meters from the source, particularly due to the avoidance behaviour exhibited by mobile marine organisms (Sætre and Ona 1996).

- A variety of behavioural responses by marine fish to seismic source arrays have been reported in the published literature and through anecdotal reports (Popper and Hastings 2009 ; Carroll et al 2017). For the most part, however, any such responses (if they do occur) are localized and temporary, and likely of low ecological significance (except possibly in instances where key habitats or life stages such as reproductive activity are significantly and repeatedly affected).

- Limited seismic effects have been observed in pelagic invertebrates as demonstrated by low avoidance or tissue damage (Carroll et al 2017). Some species may even become habituated to noise (Boeger et al 2006; Samson et al 2014; Mooney et al 2016). Sessile or low mobility benthic invertebrates with may exhibit temporary stress responses to seismic activities that may weaken individuals with chronic exposure (Solan et al 2016).

- Recent reviews reiterate that research results and observations are highly dependent on species specific hearing capabilities and extrapolation of effects to distant taxonomic groups must be done with caution (Popper and Hastings 2009). Inconsistent findings on species responses to seismic sources indicates that current knowledge of the effects of anthropogenic noise on fish and invertebrates remains incomplete (Hawkins et al 2015).

- Seismic activity has been shown to influence catch rates of fish in some areas (Løkkeborg 1991; Skalski et al 1992; Engås et al 1996; Vold et al 2009). The observed effects of seismic activities appear to vary, however, by species, gear type and other factors. In some cases catches have appeared to temporarily decrease while in others they did not change or even increased during seismic activities (Parry and Gason 2006; Thomson et al 2014; Przeslawski et al 2015).

- Seismic sound levels and their observed effects vary depending upon levels and the distance away from the source, and the effects of seismic exposure also appear to vary by species and particular life stage. Behavioural responses of fish typically begin to occur at sound levels above 155 dB (McCauley et al 2000a), whereas auditory damage typically starts at 180 dB, recoverable injuries at 203 dB, and mortal injury or mortality may start to occur at 210 dB (Popper et al 2014). Some invertebrate species show injury at levels as low as 217 dB while others can experience louder noises with no observable consequence.

- Depending on seismic source levels and accounting for sound attenuation in the marine environment, behavioural effects could occur from less than one kilometer to dozens of km from the noise source (McCauley et al 2000a; Popper and Hastings 2009; Popper et al 2014).

This summary is intended to provide a brief overview of the known and likely potential environmental issues and interactions, as background and context for predicting potential Project effects and for identifying and proposing mitigation. More detailed reviews of such information are available through other sources, including the Eastern Newfoundland SEA (Amec 2014). A key focus of the literature review undertaken for this EA and summarized below has therefore been on identifying and incorporating any additional studies and associated literature that have become available in the past 2-3 years, in order to update previously completed reviews, particularly as related to the understood effects of seismic sound on marine biota.

Table 5.2 Potential Environmental Effects on Marine Fish and Fish Habitat: Summary of Existing Knowledge

Potential Issue/Interaction	Overview of Relevant Studies
Vessel Traffic/Other Equipment Use and Their Potential Environmental Emissions	The environmental interactions that may be associated with vessel traffic and other equipment use during offshore oil and gas exploration activities include disturbances such as possible avoidance or attraction by marine fish, as well as possible contamination of fish or alteration of their habitats.

Potential Issue/Interaction	Overview of Relevant Studies
	Noise generated by vessel traffic can be transmitted through water, causing avoidance by some species, and physiological and reproductive effects have been reported when fish are continually exposed to noise (Clark et al 1996; Røstad et al 2006). Noise from marine structures or activities may cause avoidance by some species, with short term and low frequency noises appearing to elicit temporary avoidance due to startling effects and with longer-term avoidance if the noise is of higher frequency or continuous (Misund et al 1996; Wilson and Dill 2002). Given the opportunity, fish will generally avoid areas where noise levels exceed their threshold of hearing by 30 dB or more (ICES 1995). Noise from vessels has been shown to mask the acoustic sensory environment of fish and invertebrates and affect behaviour (Slabbekoorn et al 2010, Wale et al 2013a, 2013b; Morley et al 2014). The effects of anthropogenic noise in the marine environment can be short-lived, however and the reduction or removal of noise sources may decrease the potential for any direct, detrimental effects (Williams et al 2015). Overall, there remains an incomplete understanding of the overall potential environmental consequences of these disturbances (Slabbekoorn et al 2010; Morley et al 2014). Vessel lighting is required during operations for the safety of marine operations and personnel. Lighting emissions have the potential to attract phototaxic plankton and foraging fish and may support foraging opportunities and increase predator-prey interactions (Keenan et al 2007; Cordes et al 2016). However, these potential effects would be limited for a transitory vessel. Other potential issues include the possible introduction and spread of aquatic invasive species and resulting habitat degradation (Morris et al 2010). Invasive species can threaten aquatic ecosystems, occupying habitats or out-competing native species, introduce new diseases and altering ecosystem processes (Bax et al 2001). These species may show rapid population growth in the absence of natural predators and may soon become established to the point where eradication is difficult or impossible. Local and international marine transport in general is implicated in many of the accidental introductions of marine invasive species, as ship hulls and bilge water serve as vectors for the range expansion of such species (Bax et al 2001; McKenzie et al 2010; Benoit et al 2012). Offshore vessels and platforms may also serve as “stepping-stone” locations for expansion of invasive species (Cordes et al 2016). Several invasive alien species have been identified off Newfoundland and Labrador (Templeman 2010), all of which have been shown to have detrimental effects on the native species and ecosystems, although these effects are generally thought to be more important to the benthic coastal communities as compared to in the open ocean (Templeman 2010). Accidental spills of hydrocarbons or other substances into the marine environment can cause contamination, taint, toxicity and bioaccumulation issues for marine fish and their habitats. Fuel spills can have lethal and sublethal impacts on a variety of taxa including phytoplankton and zooplankton, benthic invertebrates and fish (Teal and Howarth 1984). Spill effects depend on a variety of factors, including: the amount and type of material, environmental conditions, species and life stage, lifestyle, exposure levels and durations, fish condition and others (LGL Limited 2005; Barron 2012; Jung et al 2012).

Potential Issue/Interaction	Overview of Relevant Studies
Seismic Noise: Potential Fish Mortality or Injury	A variety of studies have investigated potential injury to fish as a result of seismic air source arrays, such as damage to hearing structures (e.g. Popper et al 2005; Popper and Hastings 2009; Popper and Fay 2011; Carroll et al 2017) and/or mortality of fish, fish eggs or larvae (e.g. Parry and Gason 2006). Most studies have found that stationary fish affected by seismic surveys had to be located very close to the seismic array (usually caged close to the source and subjected to multiple passes of the array) to be affected (see McCauley et al 2003 and Turnpenny and Nedwell 1994 for a review). Studies using caged fish have also noted that the response of the fish is usually a strong attempt to move away from the sound (e.g. McCauley et al 2003). Due to the spectrum of hearing capabilities of fish (see below), seismic noise activities may have varying effects (Popper and Hastings 2009; Popper and Fay 2011). In some species seismic activities have been shown cause a temporary threshold shift (TTS) in hearing sensitivity (Popper et al 2005; Popper and Hastings 2009; Carroll et al 2017) which may result in reduced abilities for communications, predator or prey detection, and assessing the environment (Carroll et al 2017). There is little information on permanent threshold shifts (PTS) in fish hearing. In one experiment, airgun emissions damaged hearing sensory structures in pink snapper with no recovery 58 days after exposure (McCauley et al 2003). However, this type of seismic air gun injury to fish has not be observed in other species (Popper et al 2005; Song et al 2008). The effects of seismic surveys on marine phytoplankton, zooplankton and the planktonic life stages of various marine fish species have also been investigated (see, for example, Dalen et al 2007 for a review). Mortality of fish, fish eggs, and larvae has been observed only within a few metres of seismic air source arrays (Kostyuchenko 1973; Dalen and Knutsen 1987; Matishov 1992; Kosheleva 1992; Holiday et al in Turnpenny and Nedwell 1994; Parry and Gason 2006) and immediate mortality is unlikely (Worcester 2006). Some species may also become habituated to underwater noise levels (Popper and Hastings 2009, Carroll et al 2017). High intensity seismic noise can have lethal or sublethal effects on plankton at short range (less than 5 m; Ostby et al 2003, in Boertmann and Mosbech 2012). Davis et al (1998) estimated that up to one percent of the ichthyoplankton in the top 50 m of the water column within close proximity to the sound source could be killed during 3D seismic surveys off Nova Scotia. Kenchington et al (2001) also estimated a plankton mortality rate of six percent if they were concentrated in the upper 10 m in close proximity to the sound source. In Norway, it was estimated that 0.45 percent of planktonic organisms in the top 10 m of water could be killed by high intensity seismic noise (Sætre and Ona 1996). Mortality of fish eggs, caused by exposure to seismic array noise, was very low compared to natural mortality and was considered not significant to fish recruitment (Sætre and Ona 1996). Payne et al (2008) indicated that there was no evidence for delayed mortality or egg loss in snow crab exposed under the conditions of an actual seismic program in deep waters off Cape Breton. In snow crab, over a period of days to several months, there were no observed effects of delayed mortality or damage to mechano-sensory systems associated with animal equilibrium and posture. There was also no evidence of leg loss or other appendages (Payne et al 2008).

Potential Issue/Interaction	Overview of Relevant Studies
	A snow crab test group exposed to seismic sound showed elevated bruising of the hepatopancreas, bruising of ovaries, and dilated oocytes with detached chorions (DFO 2004). The timing and location of seismic activity and proximity to the array is a key factor in the likelihood and potential degree of the effect. Christian et al (2003, 2004) also did not observe any acute or chronic mortality in adult snow crab experimentally exposed to variable seismic sound levels, although a higher proportion of less developed eggs was noted for experimentally exposed egg masses in comparison to unexposed egg masses. Seismic air source arrays operating in areas and times of strong seasonal stratifications or upwelling may affect more planktonic material because of their high densities (Boudreau et al 2001). Although it is recognized that marine invertebrates (including juvenile stages) can be quite sensitive to sound (Williams et al 2015; Edmonds et al 2016; Kunc et al 2016; Nedelec et al 2016), recent field-based studies on adult populations revealed no evidence of increased mortality due to airgun exposure in scallops up to ten months after exposure, clams after two days after exposure, or lobsters up to eight months after exposure (Carroll et. al 2017). Although it is evident that fish often respond to sounds emitted from seismic air source arrays (see below), little direct physical damage to fish occurs at distances greater than a few meters from the source. Due to the avoidance behaviour by free-swimming fish, they typically do not suffer physical damage from seismic surveys (Gausland 1993). Indeed, there are no documented cases of fish mortality under exposure to seismic sound under field operating conditions (DFO 2004; Payne 2004; Popper et al 2014; Carroll et al 2017), nor have FLOs or other seismic ship personnel reported observing dead fish around survey operations. Overall, exposure to seismic sound is considered unlikely to result in direct fish mortality (DFO 2004). It has been noted, however, that non-injurious (behavioural) effects can still be of concern if they accumulate to have population-level implications (Williams et al 2015).
Seismic Noise: Behavioural Responses	When exposed to an operating seismic array, mobile marine fish may exhibit a variety of responses, including alarm responses and temporary avoidance of the area (eg, McCauley et al 2000a, 2000b). When exposed to operating seismic air source arrays, mobile marine fish may swim deeper, mill in compact schools or become more active (eg, Slotte et al 2004). Indeed, behavioural reactions to exposure to seismic noise have been widely documented in marine organisms (Popper and Hastings 2009; Slabbekoorn et al 2010; Hawkins et al 2015; Carroll et al 2017). There are well documented observations of fish and invertebrates exhibiting behaviours that appeared to be in response to exposure to active seismic air source array noise levels. These include startle responses, changes in swimming direction and speed, or changes in vertical distribution (Blaxter et al 1981; Schwartz and Greer 1984; Pearson et al 1992; McCauley et al 2000a, 2000b; Wardle et al 2001; Hassel et al 2003; Samson et al. 2014; Solan et al 2016). Gadoids, for example, have been shown to leave the area during seismic surveys (Skalski et al 1992, Løkkeborg and Soldal 1993, Engås et al 1996, Slotte et al 2004, Parry and Gason 2006). Species such as cod, herring, rockfish and whiting have been reported to change

Potential Issue/Interaction	Overview of Relevant Studies
	depth in response to seismic noise (Skalsi et al 1992; Pearson et al 1992; Wardle et al 2001; Slotte et al 2004). Other studies have found that many species of fish dive to avoid intense sound (Protasov 1966; Schwartz and Greer 1984; Knudsen et al 1992). McCauley et al (2000a, 2000b) describes a more intense "generic" fish alarm startle response of seeking shelter in tight schools and moving near the bottom. Anthropogenic noise appears to have a more pronounced effect on larger fish (Engås et al 1996) and invertebrates (Wale et al 2013a, 2013b) than smaller individuals. In contrast, other studies indicate that fish do not change behaviour when exposed to an active seismic air source array (eg, Pickett et al 1994; Wardle et al 2001; Andriguetto-Filho et al 2005). Wardle et al (2001), for example, report that neither finfish nor invertebrates showed signs of moving away from a reef on the west coast of Scotland after four days of seismic air source array firing. Similarly, Peña et al (2013) indicated that feeding herring were undeterred by seismic activity as they approached to within two kilometers of seismic survey operations. Marine benthic invertebrates exposed to seismic sounds have been observed to respond to seismic noise with startle or stress behaviours (Solan et al 2016), but often do not necessarily undergo avoidance behaviours (Carroll et al 2017). Snow crab located 50 m from a seismic source did not exhibit alarm responses, changes in physiology (Christian et al 2004). There was no evidence of effects on snow crab egg hatch time although the proportion of less developed eggs were higher in exposed egg masses (Christian et al 2003, 2004; Payne et al 2008). Hawkins and Popper (2014) illustrate that seemingly similar species respond differently to the same anthropogenic noise source. They also indicate that the response can differ within a species depending on the time of day and other factors. Some studies indicate that any behavioural changes that do occur are very temporary while others imply that marine animals might not resume pre-seismic behaviours or distributions for several days (Engås et al 1996; Løkkeborg 1991; Skalski et al 1992; Hassel et al 2004; Solan et al 2016). Most available literature (Blaxter et al 1981; Dalen and Raknes 1985; Pearson et al 199; Davis et al 1998; McCauley et al 2000a, 2000b) indicates that the effects of noise on fish are brief and if the effects are short-lived and outside a critical period, they are expected not to translate into biological or physical effects. However, Slabbekoorn et al (2010) and Hawkins et al (2015) emphasize that the understanding of anthropogenic noise effects on fish remains incomplete. Radford et al (2014) recently reviewed the effects of anthropogenic noise on fish communication. They highlight that communication plays an important role in the ecology of many fish (e.g. territorial disputes, mating, predatory attacks, aggregating for spawning) and masking these sounds could affect survival and reproductive success. Furthermore, non-masking sounds have the potential to stress fish and/or reduce performance of many activities. These authors and others (eg Hawkins et al 2015) emphasize that there remains relatively little empirical data regarding seismic effects on fish, particularly given the vast number of species involved and that such effects vary across fish taxa, based on their physiology, ecology and adaptation (Radford et al 2014; Carroll et al 2017).

Potential Issue/Interaction	Overview of Relevant Studies
Seismic Noise: Observed Effects on Fish Presence (and Fishing Activity)	A number of studies have documented changes in fishing success rates during and following nearby seismic survey activity. Skalski et al (1992), for example, cite seismic activity as a contributing factor for decreased redfish abundance, and Løkkeborg (1991) observed reduced catches in fish for days following 2D/3D seismic survey exposure as a result of changes in fish behaviour. Similarly, reduced catches of haddock and Atlantic cod within several kilometres of seismic activity continued for days after seismic activity stopped (Engås et al 1996; Engås and Løkkeborg 2002). Catches for some species/gear types (such as gillnet catches of orange rockfish and halibut) have actually increased during seismic activity, whereas others (such as longline catches of haddock) have been observed to decrease. At larger scales, regions with seismic survey activity had decreased catches for only a few species for certain gear types (eg, saithe and haddock with gill nets; Vold et al 2009). There also has been evidence of increased catch rates of fish 30-50 km away from seismic activities indicating avoidance by migrating fish (Popper and Hastings 2009). Seismic noise effects have not been demonstrated on catch rates of Australian rock lobster, snow crab, lobster, shrimp and some reef invertebrates (Carroll et al 2017). A desktop study of four species (gummy shark, tiger flathead, silver warehou, school whiting) in Bass Strait, Australia, found no consistent relationships between catch rates and seismic survey activity in the area, although the large historical window of the seismic data may have masked immediate or short-term effects which cannot therefore be excluded (Thomson et al 2014). A subsequent desktop study targeting a single seismic survey found that of the 15 commercial species examined, six species showed higher catch following the survey, three species showed reduced catch, and five species showed no change (Przeslawski et al 2015). In Newfoundland waters, anecdotal information from fishers indicated reduced catch rates of snow crab were observed after a pass by seismic survey vessels (Christian and Bocking 2013). Fishers also observed temporary avoidance to deeper waters by a school of shrimp in response to a seismic sound source (Christian and Bocking 2013). The potential effects of seismic survey activity on fish catch rates therefore appear to vary by species and gear type (Hirst and Rodhouse 2000; Løkkeborg et al 2012; Worcester 2006; Vold et al 2012). More locally, fishers that utilize the EA Study Area have also expressed concern that seismic survey activity may affect catch rates and the results of research surveys (Amec 2014).
Seismic Noise: Sound Levels that may Affect Fish and Invertebrates (Physical or Behavioural)	Studies of fish reactions to anthropogenic noise in the marine environment have produced a range of results across different sound levels and between species. For context, container shipping and oil platform production can reach levels of 198 dB (Ross 1976). Subtle behavioural changes of rockfish exposed to seismic sounds, for example, commenced at 149 dB and alarm response became significant at 168 dB (Pearson et al 1992). Eastern striped grunter displayed persistent C-turn startle responses at 182 – 195 dB (McCauley et al 2000a, 2000b), whereas various fish showed startle responses to noises ranging from 183 - 207dB (Wardle et al 2001). The onset of 'alarm' behaviours typically begin at 156 – 161 dB (McCauley et al 2000a, 2000b). Blaxter et al (1981) found that schooling herring changed direction with a sudden noise level of 144 dB re 1

Potential Issue/Interaction	Overview of Relevant Studies
	µPa. Løkkeborg and Soldal (1993) estimated that avoidance behaviour in fish occurs between 160 and 171 dB re 1 µPa. Engås et al (1996) noted that mild behavioural effects can extend to tens of kilometres from the seismic source. This is supported by DNV Energy (2007, in Hurley 2009) which states that scare effects have been demonstrated in a radius of more than 30 km from the seismic sound source. As with fish, some invertebrates may become habituated to sound, with squid showing fewer alarm responses with subsequent exposure to noise from airguns, cuttlefish habituating to repeated 200 Hz tone pips (Samson et al 2014), and squid showing decreased responses over sound exposure trials (Mooney et al 2016). There is also some indication of habituation in crabs to vibrations (Roberts et al 2016). Some select examples of studies which have investigated physical and physiological damage to fish as a result of exposure to different levels of seismic sound are provided below. It is noteworthy that many of these studies were conducted in the laboratory and therefore may not always reflect effects experienced by free ranging organisms in the wild. • In comparison to controls, there were no mortalities one to four days post exposure to seismic airguns in monkfish larvae (205 dB re 1 µPa) and capelin eggs (199 dB re 1 µPa) (Payne et al 2009). • Cod eggs exposed to seismic shots (202 – 220 dB) showed no signs of injury (Dalen and Knutsen 1987). • Cod larvae (220 dB) and fry (234 dB) were shown to experience immediate mortality, but eggs showed no signs of injury (Dalen and Knutsen 1987) • No injury to red mullet eggs occurred at 210 dB but eight percent were injured at 230 dB (Kostyuchenko 1973). • Kostyuchenko (1973) reported more than 75 percent survival of fish eggs at 0.5 m from the source (233 dB at 1 m) and more than 90 percent survival at 10 m from the source. • Pollock eggs (242 dB) have been observed to show delayed mortality (Booman et al 1996). • Swimbladders of anchovy larvae were ruptured at 238 dB (Holiday et al, in Turnpenny and Nedwell 1994). • Matishov (1992) showed that five day old cod experienced delimitation of retina at 250 dB. • Caged freshwater pallid sturgeon and paddlefish that were exposed to a single pulse from a small seismic airgun array (10,160 cm^3) showed

Potential Issue/Interaction	Overview of Relevant Studies
	no mortality or mortal injury either immediately or within seven days of exposure (Popper et al 2016, Carroll et al 2017). • European seabass exposed to playbacks of pile-driving or seismic noise for 12 weeks no longer responded with an elevated ventilation rate to the same noise type, and showed no differences in stress, growth or mortality compared to those reared with exposure to ambient-noise playback (Radford et al 2016). • Popper et al (2005) reported exposure to seismic airguns (186 dB re 1 μPa^2s) resulted hearing TTS in freshwater lake chub and northern pike with recovery within 18-24 hours. In the same study, no effects were observed on broad whitefish, another freshwater species. • Hastings (1990) reported that lethal threshold for fish occurs at 229 dB and a stunning effect in the 192 to 198 dB range. • Caged pink snapper had extensive sensory hair damage with no recovery or repair 58 days after exposure in response to peak seismic sound levels of 165-209 dB re 1 µPa (McCauley et al 2003). • Kosheleva (1992) reported no obvious physiological effects of fish beyond 1 m from a source of 220 to 240 dB. • Brown shrimp exposed to 190 dB showed no injury (Webb and Kempf 1998). • There were no acute or chronic mortalities 12 weeks after exposure in captive adult snow crab associated with variable seismic noise (sound peak levels (SPL) 191-221 dB re 1 μPa_{0-p}, and sound energy levels (SEL) <130-187 dB re 1μPa^2s) (Christian et al 2003, 2004). • At 217 dB, Matishov (1992) observed shell damage in Iceland scallops while urchins lost 15 percent of their spines. • No detectable differences were observed in mussels, crustaceans or periwinkles within 30 days after exposure to 229 dB seismic arrays (Kosheleva 1992). • At 231 dB, Dungeness crab larvae molt times and long term survival were not affected (Pearson et al 1994). In recent research, Hawkins et al (2014) studied the response of mackerel and sprat schools to repeated impulsive sounds. Incidence of response increased with sound levels but responses were different across species (mackerel changed depth while sprat dispersed). The sound level where 50 percent of fish schools responded was 163.2 and 163.3 dB re $1mPa^2$ (peak to peak) and 135 and 142 dB re $1mPa^2$ for single strike for sprat and mackerel, respectively.

Potential Issue/Interaction	Overview of Relevant Studies
	Popper et al (2014) established sound exposure guidelines for seismic activities for fishes with and without swim bladders. It was estimated that potential hearing TSS would occur at 186 dB SEL and recoverable injuries would occur at 203-216 dB SEL or 207-213 dB SPL. Mortality or potential mortal injury sound exposure guidelines ranged from 207-219 dB SEL and 207-213 dB SPL
Seismic Noise: Detection Ability of Fish and Invertebrates	Many fish species and invertebrates are capable of emitting noise that share frequencies with those of seismic noise (Myrberg 1980; Turnpenny and Nedwell 1994; Engen and Folstad 1999; Hawkins and Amorin 2000; Slabbekoorn et al 2010). Some species use acoustic communication during reproduction and predator interactions (Slabbekoorn et al 2010). Some fish are also able to distinguish and interpret competing sounds (MMS 2004). Fish can be categorized based on their hearing capability and method of transmission for particle motion and sound pressure detection (Popper et al 2014). Fish with no swim bladder including sharks and flatfish hear through direct sound transmission to the otolith and sensory hairs, restricting detection to the particle motion component of sound. The swim bladder is a gas filled structure that may contract or expand relative to the rest of the fish in a sound field (Christian and Bocking 2013). Fish with swim bladders not associated with hearing including Atlantic cod and Atlantic salmon, also detect the particle motion component of sound but may be susceptible to barotrauma (Carroll et al 2017). Fishes with connections between the inner ear and the swim bladder include squirrel fish, mormyrids and herring. These fish have increased hearing sensitivity and may be and may be more susceptible to sound pressure (Christian and Bocking 2013; Carroll et al 2017). Marine invertebrates typically lack organs that detect pressure waves but some species (e.g. marine crabs, squid, and echinoderms) have statocysts that are capable of sound detection through particle motion (Popper et al 2001; Morley et al. 2014). Cephalopods and decapod crustaceans have sensory hairs that also aid in particle motion detection (Carroll et al 2017). Organisms that rely exclusively on particle motion (as in most invertebrates) to detect sound are more resilient to anthropogenic noise exposure (Morley et al. 2014). Laboratory studies show that some crustaceans (e.g. Norway lobster) will respond to sounds that are within the frequency range of that used in seismic surveys (Goodall et al 1990). Hearing sensitivities of finfish are reviewed by Popper and Carlson (1998) and Popper et al (2003). Cod, salmon, America plaice and herring have hearing sensitivity between 80 and 200 Hz, with a sensitivity threshold at 80 to 100 dB re to 1µPa (Mitson 1995). Deep water species and those lacking swim bladders may be less vulnerable to effects from seismic survey activities (Boertmann and Mosbech 2012). Larger fish are also potentially more susceptible to injury than smaller fish resulting from differences in swim bladder resonance (Carroll et al 2017).

5.4.3 Environmental Effects Assessment

The following provides an assessment and evaluation of the potential effects of the Project on Marine Fish and Fish Habitat, including the associated vessel traffic, seismic source energy, seabed and other environmental sampling activities and the various potential environmental emissions associated with vessel operations that may be associated with the planned Project activities.

Mitigation measures to prevent or reduce adverse effects upon this VEC were identified and summarized in Section 5.3, and these are considered in an integrated manner within and throughout the environmental effects analysis as applicable.

5.4.3.1 Presence and Movement of Project Vessels and Survey Equipment

The various proposed exploration activities that comprise this Project will involve vessel traffic in the Project Area within the April – November period over multiple years. This will include the presence and movement of the seismic survey vessel(s) itself as well as any associated support ships. As is the case for all marine traffic, the operation of these vessels will introduce a number of potential disturbances into the environment, including the noise, lights and other possible emissions that are typically associated with such activities.

Although the presence of these marine vessels may result in some degree of attraction, avoidance or other behavioural responses by individual fish (depending upon the species involved) (Røstad et al 2006; De Robertis and Handegard 2013), marine fish will likely not be disturbed by Project-related vessel activity, due to its transitory nature and thus its short-term presence at any one location, and because the Project's vessel movements will create noise types and levels that are similar to daily and frequent marine traffic in the area. Vessel noise will therefore not be a material or detectable contributor to any possible effects on marine biota.

5.4.3.2 Seismic Sound Energy

As summarized above, a variety of physiological and behavioural responses by marine fish to seismic sound have been reported in the literature and through anecdotal reports. Previous studies indicate that such effects vary by species, life stage, intensity of sound, distance from seismic source and in the case of fishing effects, by gear type and other factors (Popper and Hastings 2009; Carroll et al 2017).

Individual species differ in their sensitivity and reactions to underwater noise, with some groups of organisms (such as finfish) having elevated vulnerability due to the presence of hearing organs and/or air filled structures (swim bladders), whereas many invertebrates show much more limited effects of exposure to seismic survey activity, typically even at very close range (Popper et al 2014; Carroll et al 2017). More mobile fish species and life stages are able to avoid possible effects of seismic survey noise exposure by moving away from the seismic source array, whereas some larval stages and immobile species may be unable to avoid such exposure. Even in very close proximity (a few metres), however, these have been shown to exhibit only modest levels of mortality, particularly in comparison to natural causes. There is no indication that any direct physical damage to fish occurs at distances greater than several meters from the source. The avoidance behaviour exhibited by mobile fish species further reduces the potential for such effects, and there have been no reports of observed fish mortality under exposure to seismic survey activity in the field. A range of behavioural responses to seismic air source array noise have been observed and reported, however, including altered distributions and

changes in activity such as increased refuge seeking or schooling. Although past studies and reports that these have not provided definitive or consistent findings due to the species-specific nature of seismic activity effects, any such responses (if they do indeed occur) are expected to be somewhat localized (up to several tens of kilometres from the source) and temporary in nature.

Operational procedures, such as the use of a gradual “ramp-up” or soft-start procedure over a minimum period allows mobile marine animals to move away from the area if they are disturbed by the underwater sound levels associated with the seismic survey. This will help to further avoid fish injury or morality, as will the planned shut-down of the seismic array (reduction to the smallest source element, firing intermittently) during line changes and any required maintenance activities.

In the case of the planned 2D seismic survey activity, the very localized and short-term nature of these underwater disturbances at any one location and time during the seismic program and the typically wide spacing of the seismic acquisition lines also considerably reduces the potential for adverse effects through either injury or disturbance/avoidance. With the seismic ship moving continuously, the vessel and associated survey equipment will be tens of kilometers away from any particular location within a few hours. Once it departs a 2D survey location, the vessel will not return to that site except for grid crossing points although any Project presence at those locations will be separated by days, weeks or even longer. Similarly, in the case of 3D/4D activity and for any required wellsite surveys using 2D seismic, with the survey vessel moving continuously, the re-occurrence interval of firing the seismic source within proximity to a particular survey point will be at least several hours. This minimizes the potential for localized and repeated environmental disturbances at any particular location, and affecting a particular environmental receptor. If multiple seismic vessels are utilized, they will survey along separate tracks and not overlap survey areas to minimize exposure to any single area.

It is therefore very unlikely that any fish will be displaced from key habitats or disrupted during key activities over extended areas or periods, or be otherwise affected in a manner that causes negative and detectable effects to fish at a population or regional level.

5.4.3.3 Other Potential Environmental Emissions and Interactions

Other potential environmental emissions from survey vessels and equipment relate to the possible release of discharges such as deck drainage, liquid and solid wastes, air emissions from exhausts, and other possible sources of environmental discharges from offshore vessels (Cordes et al 2016). Any such potential discharges to the marine environment will be managed through strict adherence to applicable regulations and standards (Chapter 2), designed to prevent adverse effects to fish and their habitats.

Atmospheric emissions during offshore activities would originate from vessel exhausts, although these would be negligible overall. Each of the vessels involved in this Project will manage and dispose of their waste products in accordance with applicable regulations and standards, and will have a Waste Management Plan in place that will be strictly adhered to throughout the life of the Project.

The offshore seismic survey activities that are planned to be undertaken as part of this Project will not result in any physical contact with the seabed, and will therefore not directly interact with or disturb benthic animals or their habitats. Although core, grab and seabed samples may also be acquired to determine seabed sediment characteristics, as well as other geochemical and environmental data acquisition using a towed seabed camera/video system, gravity or piston core, box corer, vibro-corer,

or water sampler, these activities have a very short duration, and those which involve contact with the seabed will have a very small footprint (up to several meters at most). Prior to undertaking seabed sampling work in areas that are protected and/or have been identified as having a high probability of occurrence of corals and sponges (see Section 4.2.1.6) a representative seabed characterization (reconnaissance) drop camera/video system survey transect will be acquired to investigate the potential presence of these sensitive benthic organisms.

Although the potential for, and possible magnitude of, accidental events that could occur during a marine geophysical program are far lower than those that may occur with offshore drilling (exploration or production), one potential source of spills into the marine environment that is somewhat unique to seismic programs is an accidental release of fluid from a streamer. Both solid and fluid-filled streamers are used at times in the offshore oil and gas industry. Although the potential for, and possible environmental implications of, such a spill is relatively low (especially due to the high volatility and relatively small volume of the spilled streamer fluid), only solid or gel filled streamer sections will be used for this Project. This will avoid any risk of streamer fluid being accidentally discharged into the marine environment at any time during the survey program.

Again, because the proposed geophysical program will not result in the recovery of oil and gas resources from the seabed, the potential for, and likely magnitude of, any such accidental spill is relatively low as compared to other types of offshore exploration and production activities, and the possible spills would be no greater in nature or volume than for an equivalent sized cargo or fishing ship. There will, however, be limited amounts of marine fuel and oils onboard the seismic and support vessels that could potentially be spilled into the ocean. Each of the vessels involved in this Project will use, store and handle fuels, oils and other such materials in accordance with applicable regulations and standards. The vessels will have appropriate equipment and procedures in place to prevent any such accidental spills into the marine environment, as well as an Oil Spill Response Plan in the unlikely event of a spill.

As with any ocean-going vessel and associated marine traffic, the presence and use of Project-related vessels in the Study Area could result in the accidental introduction and spread of invasive species (Cordes et al 2016). Prevention is considered to be key in controlling the introduction and spread of such species, as control of established populations is often costly and ecologically risky (Bax et al 2001). The likelihood of introduction of invasive species will depend on the recent sailing history of the vessel and its operational practices (cleaning schedule, ballast water management, etc.). Vessels from foreign waters that are biofouled have greater potential to serve as vectors for such species (Benoit et al 2012). Ships will comply with applicable International Maritime Organization (IMO) anti-biofouling guidelines to mitigate potential spread of invasive species. It is also important to note that seismic ships do not carry or use ballast water since they are not container carriers or tankers, and therefore do not require ballasting. Although the likelihood that a Project vessel will result in the introduction and spread of an invasive species is therefore low, all Project vessels will comply with the requirements of the *Canada Shipping Act*, including– in the unlikely event that one is carrying ballast - the associated *Ballast Water Control and Management Regulations.*

A summary of the potential (residual) environmental effects of the Project on marine fish and fish habitat is provided in Table 5.3 below.

Table 5.3 Marine Fish and Fish Habitat: Residual Environmental Effects Assessment Summary

Project Activity and Potential Effect(s)	Environmental Effect Descriptors						
	Nature	**Magnitude**	**Extent**	**Duration**	**Frequency**	**Reversibility**	**Certainty**
Presence and Use of Vessels/Aircraft and Equipment • Disturbance • Habitat alteration (eg, invasive species)	A	L	2	1	1	R	H
Seismic Sound • Potential injury • Disturbance	A	L	2-3	1	1	R	H
Seabed and Environmental Sampling Activities • Disturbance	A	L	1	1	1	R	H
Air Emissions • Exposure, contamination	A	N	2	1	1	R	H
Lighting • Attraction, disturbance	A	N	2	1	1	R	H
Solid Waste • Exposure, contamination	N	-	-	-	-	-	H
Liquid Waste • Exposure, contamination	A	N	2	1	1	R	H
Potential Accidental Events • Exposure, contamination	A	L	2	1	1	R	H
Onshore Supply and Servicing	N	-	-	-	-	-	H

Overall, Resulting Effect(s) of Project on the VEC	**Evaluation of Significance**
• Project effects, if they occur, are likely to entail low level, localized, and ephemeral disturbance to individual fish and invertebrates. • The Project is not anticipated to have material, negative effects on any species, especially, at the population level.	• The proposed Project is not likely to result in significant adverse environmental effects on marine fish and fish habitat

Nature/Direction:	**Magnitude**:	**Geographic Extent**:	**Duration**:	**Frequency**:
A = Adverse N = Neutral or No Effect P = Positive	N = Negligible or No Effect L = Low M = Medium H = High	1 = < 1 km^2 2 = 1-10 km^2 3 = 11-100 km^2 4 = 101-1,000 km^2 5 = 1,001-10,000 km^2 6 = >10,000 km^2	1 = < 1 month 2 = 1-12 months 3 = 13-36 months 4 = 37-72 months 5 = > 72 months	1 = <11 events/year 2 = 11- 50 events/year 3 = 51-100 events/year 4 = 101-200 events/year 5 = >200 events/year 6 = Continuous

Project Activity and Potential Effect(s)	Environmental Effect Descriptors						
	Nature	**Magnitude**	**Extent**	**Duration**	**Frequency**	**Reversibility**	**Certainty**
Reversibility: R = Reversible I = Irreversible	**Certainty in Prediction:** L Low M Moderate H High						

NOTES

- In all cases, the above referenced effect descriptors refer to the resulting potential environmental effect to a particular environmental receptor, not to the Project activity or associated disturbance that creates the effect.
- The residual environmental effects predictions that are summarized above include integral consideration of the mitigation measures described in the preceding sections and in detail in Section 5.3

As described and summarized above, and with the implementation of the mitigation measures identified and committed to in this EA Report, the proposed Project is not likely to result in significant adverse environmental effects on marine fish and fish habitat.

5.4.4 Cumulative Environmental Effects

The environmental effects of individual projects and activities are not necessarily mutually exclusive of each other, but can accumulate and interact in environmental systems to result in cumulative environmental effects. The C-NLOPB's Scoping Document for this EA requires an assessment of the "cumulative environmental effects of the Project that are likely to result from the project in combination with other projects or activities that have been or will be carried out".

Marine fish and their habitats in the Study Area and in the larger Northwest Atlantic have been and are being affected by a variety of natural and anthropogenic factors and processes. These include past and on-going fishing activity, offshore petroleum exploration and production, general vessel traffic and other human activities (both planned and routine, as well as illegal activities and accidental events), as well as the effects of climate change and other natural and anthropogenic processes. These have all collectively influenced the presence, distribution and abundance of fish and invertebrate species in particular areas, depths and times, as well as the overall size and health of fish populations. The effects of previous and on-going projects and activities within the Study Area (and elsewhere) are thus reflected in the existing (baseline) environmental conditions for this VEC, as described in Section 4.2.1.

As described in the preceding sections, offshore oil and gas activities may affect marine fish and fish habitat through direct and indirect influences. This includes possible injury, mortality or behavioural effects due to noise or other disturbances in the marine environment, possible contamination resulting from routine activities (discharges) or unplanned and accidental events (spills), and through the alteration of marine habitats. The proposed Project that is the subject of this EA will have the potential to interact with fish within and adjacent to the proposed Project Area, although as described above it will entail a very short-term, infrequent and relatively mild environmental disturbance at any one location and time. With the implementation of the various mitigation measures outlined in this EA, the Project will itself not likely result in significant adverse effects to marine fish and fish habitat.

In terms of other on-going and future projects and activities which may affect fish and fish habitat within the Study Area, the commercial fishing industry will continue to be a key influence, resulting in fish catches (mortality) and habitat disturbance through current and future fishing activities, practices and management processes. The rather dynamic nature of fishing activity throughout the region (in terms

of fishing locations, seasons, gear types and key species) makes it difficult to predict specific areas and times from year to year for both domestic and foreign fleets, and thus, the potential for interactions between activities and their effects. The Eastern Newfoundland Offshore Area is also subject to on-going and planned offshore oil and gas development and exploration activities (particularly, in the Jeanne d'Arc Basin and Flemish Pass areas), including a number of proposed offshore seismic programs which were being subject to EA review by the C-NLOPB as of the time of writing (Section 3.4.7). Offshore petroleum exploration and development activities also have associated vessel traffic, and there are vessel movements associated with fishing vessels, cargo transport, and other marine activities that will continue to occur throughout the region. The widespread and migratory nature of many species also increases the potential for fish populations to be affected by multiple perturbations, and therefore, for cumulative environmental effects to occur.

The vessel presence and movements and survey activity associated with the proposed Project would represent a very small fraction of the total marine activity off Eastern Newfoundland. Although the often extensive survey areas covered by some types of offshore seismic surveys can increase the potential for spatial interactions between their effects and those of other projects and activities in the marine environment, the proposed survey activities will again operate for a very short period of time in any one location, resulting in a short-term disturbance within a relatively limited zone of influence. This will reduce the potential for particular individuals and populations to be affected through multiple interactions with this Project and other activities in the marine environment, and for species to be affected simultaneously and repeatedly by multiple projects and activities. As part of the planning and implementation of its survey activities over the course of this Project, Nexen will also continue to communicate and coordinate with relevant marine users and other stakeholders, including other oil and gas exploration companies operating in the area, in order to plan and coordinate activities in an effort to ensure that appropriate spatial and temporal separation is maintained for technical (data quality), safety and environmental reasons.

As a result, the proposed Project is not likely to result in significant adverse cumulative environmental effects on fish and fish habitat in combination with other projects and activities that have been or will be carried out. Moreover, the relative contribution of this Project and its potential effects to any overall effects on this VEC within the Study Area will be very low, and will not likely be perceptible.

5.4.5 Environmental Monitoring and Follow-up

Nexen is committed to obtaining all required authorizations for the proposed Project, and to complying will all applicable regulations, guidelines and mitigations as identified and committed to in the preceding sections, the implementation of which will be planned, managed and monitored in accordance with Nexen's existing operational procedures and policies.

No additional and specific follow-up related to the marine fish and fish habitat VEC is considered necessary in relation to the proposed Project.

5.5 Marine/Migratory Birds: Environmental Effects Assessment

A variety of bird species occur within the Study Area and in adjacent marine and coastal regions, including seabirds and other avifauna that inhabit the region at particular or extended periods for breeding, feeding, migration and other activities. A number of important habitats for birds have also been identified at locations along the coastline of Eastern Newfoundland, adjacent to but well outside of the proposed Project Area.

5.5.1 Environmental Assessment Study Areas and Effects Evaluation Criteria

As described in Section 5.2, the EA focuses upon a number of spatial boundaries, including the:

> *Project Area*, which encompasses the overall marine area within which the proposed survey activities (data acquisition and vessel turns with equipment deployed) will take place; and the
>
> *Study Area,* which fully encompasses the Project Area and the likely environmental zone of influence of any Project related emissions and other disturbances (conservatively set at 40 km beyond the Project Area).

In addition to the above described generic spatial boundaries for the Project and its EA, the environmental effects assessment also considers the particular characteristics, distributions and movements of the individual VECs under consideration, including the larger Regional Areas within which they occur.

Birds are present in the Study Area throughout the year, with many species moving in and out of the area at different times according to their particular characteristics, habitat preferences and seasonal activities. Existing and available information on the presence and geographic and seasonal occurrence of birds in and near the region is presented in Section 4.2.2. Many avifauna have widespread distribution patterns, although ranges and activities vary considerably between individual species. This EA assesses potential effects to marine and migratory birds (individuals and populations) which are known or likely to occur within the EA Study Area during the period of proposed Project activities. In conducting the assessment, consideration is given to the timing of avifauna presence within the Study Area, as well as any particularly important or sensitive time periods for marine/migratory birds.

The Project's potential environmental effects are assessed and their significance is evaluated based on the above described spatial and temporal boundaries. For the purposes of this EA, significant environmental effects on the Marine/Migratory Bird VEC are defined as those that would result in one or more of the following:

- Mortality or life-threatening injury to any individuals of a designated (protected) bird species at risk, or destruction or alteration of the critical habitat of any such species;
- Effects to individual birds (of any species) within the area of Project-related emissions/disturbances, such that size, health, ecological function and/or sustainability of a population would be measurably and adversely affected; or the

- Destruction of, or displacement of birds from, important feeding or breeding areas or migratory routes during time periods and for durations over which the size, health, ecological function and/or sustainability of a population would be measurably and adversely affected.

5.5.2 Potential Environmental Issues, Interactions and Existing Knowledge

The main potential environmental interactions between offshore oil and gas exploration activities such as those which comprise this Project and marine/migratory birds include (adapted from Amec 2014):

- Attraction of, or disturbance to, birds as a result of the presence and movement of survey and supply vessels and their associated disturbances (lights, noise), including possible injury or mortality (strikes, strandings, disorientation, increased energy expenditure, increased predation);

- Potential injury as a result of exposure to seismic noise within the water column (particularly diving birds) or other associated disruptions to and changes in their feeding and other behaviours;

- Changes in the availability, distribution and/or quality of food sources or habitats for birds; and

- Changes in the presence, abundance, distribution or health of birds as a result of exposure to marine spills, which may affect individuals (physical exposure, ingestion), populations and important habitats.

An overview of the potential interactions between each of the main Project components and activities and the various key indicators and parameters that have been identified for this VEC is presented in Table 5.4.

Table 5.4 Marine/Migratory Birds: Potential Project-VEC Interactions

Project Component/Activity	Key Indicators and Parameters				
	Presence and Abundance	**Habitat Availability and Quality**	**Feeding (Availability and Quality)**	**Migration and Movements**	**Health (Individuals or Populations)**
Presence and Use of Vessels/Aircraft and Equipment	●	●	●	●	●
Seismic Sound		●	●	●	●
Seabed and Environmental Sampling Activities	●			●	
Air Emissions					●
Lighting	●		●	●	●
Solid Waste	●				
Liquid Waste			●		●
Potential Accidental Spills		●	●	●	●
Onshore Supply and Servicing					

A summary overview of some existing and available information from the literature and other sources regarding these potential environmental interactions and effects is provided below.

- Although there has been limited research to date on the physiological and behavioural effects of seismic sound on marine birds, studies and observations reported in the literature to date do not indicate that birds are directly and adversely affected by underwater sounds.

- Of particular concern in relation to planned and routine offshore oil and gas activities, lights can attract night-flying seabirds and possibly result in injuries or death.

- Particularly sensitive times for potential effects on migratory birds include the spring and fall migration periods, as well as during specific meteorological conditions such as fog or inclement weather.

- Discharges from offshore vessels, such as spills and waste materials, may also interact with birds both directly and indirectly.

Table 5.5 provides a more detailed overview of this literature and associated sources/references.

Table 5.5 Potential Environmental Effects on Marine/Migratory Birds: Summary of Existing Knowledge

Potential Issue/Interaction	Overview of Relevant Studies
Vessel Traffic/Aircraft/Other Equipment Use and Potential Environmental Emissions	Marine birds have long been observed to be attracted to offshore vessels as well as petroleum drilling and production platforms in or near the marine environment, which may lead to injury or mortality through collisions with equipment and infrastructure (Baird 1990; Montevecchi et al 1999; Wiese and Montevecchi 2000, Huppop et al. 2016). In addition to direct interactions and any associated bird injury or mortality, the lighting and other environmental disturbances associated with offshore vessel traffic can affect marine birds through behavioural changes such as the avoidance of disturbed areas (Bramford et al 1990), as well as disorientation which can lead to increased energy expenditures, changes in feeding or migration patterns, and increased susceptibility to predation (Wiese et al 2001; Jones and Francis 2003; Schummer and Eddleman 2003). Similar behavioural (and resulting health-related) effects may also occur as a result of aircraft overflights (Ellis et al 1991; Komenda-Zehnder et al 2003). Noise may deter birds from favourable habitats and may alter migration paths, resulting in greater energy expenditure (Larkin 1996; Beale 2007). Overt behavioural responses in response to helicopter traffic, such as flushing, may occur at distances of up to several hundred meters for Common Murres (Rojek et al. 2007), although there is inherent variability in behavioural responses between species and even within species (Blumstein et al 2005; Hoang 2013). The effects of lighting on marine birds may be increased during times of poor weather, such as fog and drizzle, although in such situations coastal lighting can be more of an influence as birds fly closer to land (Weir 1976, Blomqvist and Peterz 1984, Chaffey 2003, Day et al 2015). Moisture droplets in the air during conditions of drizzle and fog refract the light and increase the illuminated area, enhancing the attraction of vessel lighting for birds (Wiese et al 2001). Collisions

Potential Issue/Interaction	Overview of Relevant Studies
	of migrating seabirds (e.g., shearwaters, dovekies, murres and Leach's storm-petrel) are also often more of an issue with structures such as lighthouses, communication towers, illuminated buildings and large stationary offshore platforms (Gauthreaux and Belser 2006; Montevecchi 2006). Discharge of organic wastes (sewage and food scraps) may result in enhancement of the local food supply and attraction of birds to vessels and platforms, increasing the potential for interactions (Wiese et al 2001). Any effects to the fish species upon which avifauna depend may also indirectly affect birds. This potentially positive effect may be offset by increased exposure to risk of collision/strandings or predation, as well as energetic costs due to deviation from normal movement/migration patterns (Ronconi et al 2015). Operational discharges from all marine vessels and other offshore activities may lead to sheens of crude oil and other substances on the water's surface, and avifauna (especially pelagic seabirds) that are exposed to such materials can be subject to changes in their feather weight and microstructure (O'Hara and Morandin 2010) and other effects. Of particular concern is the overall (cumulative) effects of chronic small scale oil discharge from seagoing vessels, which can be an important cause of seabird mortality (Wiese and Roberston 2004).
Seismic Sound	There have been no known studies that have tested the levels of sound that cause injury to marine birds, although temporary hearing impairment can occur in avifauna that are exposed to sound in air (Saunders and Dooling 1974). The available evidence suggests that the underwater hearing of birds is poorer than in air, given that the middle ear constricts under the increased pressure associated with diving (Dooling and Therrien 2012). Studies have found that avian species vary in their susceptibility to hearing damage due to noise exposure (Ryals et al 1999), although they are generally more resistant to damage than mammals (Dooling and Popper 2007). In addition, birds (unlike mammals) can regenerate sensory hair cells in the ear (Dooling and Popper 2007). Unlike some other marine biota, seabirds are not known to communicate vocally underwater, and a heightened auditory sensitivity in water is thus unlikely to have developed. A number of sources also indicate that there is no evidence of negative behavioural effects on various bird species resulting from seismic sound (see, for example, Davis et al 1998; MMS 2004). For example, a study of moulting Long-tailed Ducks in the Beaufort Sea found no changes in movements or diving behaviour during seismic surveys, although the authors noted that smaller-scale behavioural changes could not be ruled out based on the study design (Lacroix et al 2003; Flint et al 2003). In the Davis Strait, Stemp (1985) studied three species also found in the Project Area, Thick-billed Murre, Northern Fulmar and Black-legged Kittiwake, and found no evidence of effects of seismic surveys on marine bird mortality or distributions in the offshore. As well, shearwaters have been observed close to a seismic sound array with their heads underwater, and no behavioural response was observed (Parsons 1980, in Stemp 1985). Research in the Irish Sea also indicated no evidence that seabirds were attracted to or repelled by offshore seismic survey activity (Evans et al 1993).

Potential Issue/Interaction	Overview of Relevant Studies
	Deep-diving birds (such as the alcids - murres, dovekies, puffins) and other bird species that spend considerable amount of time underwater, swimming or plunge diving for food may be at somewhat higher risk of injury or disruption due to exposure to underwater noise during seismic exploration. These species dive from a resting position on the water in search of small fish and invertebrates, and are capable of reaching depths of 20 to 60 m for considerable periods of time (25 to 40 seconds; Gaston and Jones 1998). Unlike fish or marine mammals, diving birds typically place their heads under the water suddenly in pursuit of prey, thus could potentially be exposed to high noise levels without the benefit of a steady gradient or associated ramp up procedure. Consequently, they would find it difficult to predict or avoid excessively high sound levels in the water column. This interaction may be further accentuated by the known attraction of many bird species to offshore vessels.

The above summary is again intended to provide a brief overview of the known and possible environmental issues and interactions, as background and context for predicting potential Project effects and for identifying and proposing mitigation. More detailed reviews of such information are available through other documents, including the Eastern Newfoundland SEA (Amec 2014) as well as other sources.

5.5.3 Environmental Effects Assessment

The following sections provide an assessment and evaluation of the potential effects of the Project on marine/migratory birds. Mitigation measures to prevent or reduce adverse effects upon this VEC were identified and summarized in Section 5.3, and these are considered integrally within and throughout the environmental effects analysis that follows, as applicable.

5.5.3.1 Presence and Movement of Project Vessels/Aircraft and Survey Equipment

The implementation and conduct of the proposed offshore exploration program will involve vessel use (presence and movements), including the seismic survey vessel, other survey ships and equipment, and support vessels within the Project Area at various times over multiple years. Overall, the marine bird species that occupy the Study Area will not likely be disturbed by Project-related vessel activity (or any associated aircraft use), due to its transitory nature and thus, its short-term presence at any one location, and because it is generally in keeping with the overall marine traffic that has occurred throughout the region for years. The planned survey area is several hundred kilometers offshore, and therefore the Project is not expected to interact with or otherwise adversely affect coastal breeding colonies.

On-board lighting will be required for any and all Project activities that occur at night, and these must be in place and activated for safety and regulatory compliance reasons. Marine birds can be attracted to offshore lighting, and some avifauna (such as storm-petrels and other species) can fly into vessel lights and other equipment resulting in possible injury or mortality due to strikes/strandings. Birds may also be affected through disorientation and associated energy expenditure, which may interfere with foraging, migration or other important activities and requirements in the life histories of certain species. The distance at which Project-related lighting in the offshore environment will be visible (and thus, its

likely zone of influence) will be influenced by on site and time specific factors, and any such disturbances appear to occur most frequently during periods of drizzle and fog (Weise et al 2001).

During Project operations, efforts will be made to minimize the use of high-intensity work lights in the evening, and lighting may be turned off in inclement weather (low cloud cover, overcast skies, fog and drizzle conditions), where this is possible and practical without affecting operation and/or posing safety risks. Overall, however, the presence of these Project-related vessels in the Eastern Newfoundland Offshore Area as part of this Project would be a negligible addition of night lighting in this region, especially as compared to the fishing boats, commercial traffic and other vessel movements that transit the Study Area year round.

The planned timing of the survey activities (April to November) also decreases risk of interactions with sea ducks such as Common Eiders, scoters and several species at risk because these species are most abundant in the winter months in this region. For example, in Newfoundland the endangered Ivory Gull is usually seen only in the winter and is typically associated with pack ice, and it is therefore very unlikely that they will be affected by Project activities. Routine checks will be undertaken, and protocols for the collection and release of any birds that become stranded will be implemented, in accordance with applicable regulatory requirements and governmental guidance and any associated bird handling permits.

The use of helicopters as part of the proposed Project (if required) would involve very infrequent flights to and from the seismic or support vessels, such as may be required in the transportation of required technical personnel, the unplanned removal of a crew member in an emergency situations (such as a medical evacuation) or to transport critical parts or equipment to a Project vessel. This potential helicopter use is most relevant to the marine/migratory birds VEC, with the main potential environmental issue being possible disturbance effects of aircraft overflights on birds. Overall, the very low frequency and volume of possible helicopter activity that may be associated with this Project and its operations will be a negligible addition to the overall level of aircraft movements that occur within the Study Area year round. In order to further avoid or reduce the potential for any adverse environmental effects, however, the following mitigation measures will be implemented and adhered to:

- Minimizing the amount of helicopter traffic and the avoidance of low-level aircraft operations to the extent possible; and

- Avoiding known and observed bird colonies and significant aggregations of avifauna wherever possible, including avoiding helicopter use near seabird breeding colonies during the period from May 1st – August 31st (with an end-date of September 30th for Northern Gannet Colonies).

5.5.3.2 Seismic Sound Energy

There is little or no evidence that marine birds are adversely affected by marine geophysical surveys, particularly the underwater sound energy that is associated with these exploration activities. This is likely to especially be the case for birds during times when they are in the air or on the water's surface. Because seismic pulses are directed downward and highly attenuated at the surface, near surface feeding and even diving birds would not likely be exposed to sound levels that would result in mortality or injury. Above the water, the sound is reduced to a muffled shot that should have little or no effect on birds that have their heads above water or are in flight. It is possible that birds on the water at close range would be startled by the sound, although the presence of the vessel and associated gear dragging

in the water should have already warned the bird of unnatural visual and auditory stimuli. Any such disturbances, if they occur at all, would be intermittent and very short-term at any one location.

Deep-diving birds (such as the alcids - murres, dovekies, puffins) and other bird species that spend considerable amount of time underwater, swimming or plunge diving for food may be at somewhat higher risk of injury or disruption due to exposure to underwater noise during seismic exploration. These species dive from a resting position on the water in search of small fish and invertebrates, and are capable of reaching great depths (20 to 60 m) and spending considerable time (25 to 40 seconds) underwater (Gaston and Jones 1998). Unlike fish or marine mammals, diving birds typically place their heads under the water suddenly in pursuit of prey, and could therefore potentially be exposed to high noise levels without the benefit of a steady gradient or associated ramp up procedures. Consequently, they would find it difficult to predict or avoid excessively high sound levels in the water column. This interaction may be further accentuated by the known attraction of many bird species to offshore vessels.

As described previously, there is relatively little information available on the effects of intense underwater noise levels on diving birds, and there have been no known investigations of the auditory effects of same on avifauna. The limited available information suggests that avian hearing underwater is poorer than in air, and likely to be much less sensitive than that of cetaceans. Bird auditory systems are broadly similar to those of other vertebrates, and presumably would be vulnerable to over-stimulation and consequent hearing loss although birds (unlike mammals) can regenerate sensory hair cells in the ear. The very localized and short-term nature of these underwater disturbances at any one location and time during the seismic program, however, considerably reduces the potential for individuals and populations to be affected, either through injury or disturbance/avoidance. Also, many of the deep-diving birds that may be somewhat more likely to interact with underwater noise from a seismic survey airgun, including murres and dovekies, are most common in the Study Area during the winter months (November to February), which is mostly outside of the planned timing of Project activities (April to November). It is unlikely that non-diving marine species within the Study Area, such as gulls, shearwaters and storm-petrels, would be affected by the seismic source arrays.

Effects of noise disturbance on the nesting or foraging behaviour of surface-feeding seabirds are also unlikely, given that the above-water noise levels of airguns are minimal. Because the Project activities will be quite far offshore, it is also unlikely that birds at nesting sites will be subject to any disturbance due to noise from seismic activities, including adult attendance at nests.

Although diving species such as alcids and Northern Gannets, as well as pursuit plungers such as shearwaters, spend some amount of time below the water surface, sound is not believed to be important for seabirds in securing food, and available evidence suggests that avian hearing is relatively poor underwater. Underwater noise from seismic surveys could also adversely affect surface-feeding and diving seabirds indirectly, through potential changes in the presence, abundance or concentration of prey and potential displacement from key foraging areas. As described in Section 5.4, however, extensive and persistent changes to fish resources are not expected to occur as a result of the Project, and so changes in the availability, location or quality of food sources for marine birds are not likely to occur as a result of this Project.

No additional mitigation specific to the seismic airguns and birds other than those generic measures outlined in Section 5.3 is therefore required or proposed, nor are any such measures outlined in the Statement of Canadian Practice with Respect to the Mitigation of Seismic Sound in the Marine Environment (DFO 2007b).

5.5.3.3 Other Possible Environmental Discharges (Routine or Accidental)

Atmospheric emissions during offshore activities would originate from vessel exhaust and from the burning of fuel in any other on-board equipment. Any emissions produced by the proposed exploration activities will not exceed applicable regulatory air quality standards.

Other potential effects relate to the chronic release of oily water and discharges such as deck drainage, bilge water and other possible sources of emissions from offshore vessels. Any such potential discharges to the marine environment will be managed through strict adherence to applicable regulations and standards (Chapter 2), which will prevent adverse effects upon the various components of the marine environment that pertain to marine bird habitats and food sources. Moreover, as any such chronic oil discharges from marine vessel traffic in general are generally not associated with formation of a large surface slick, no direct effect on marine birds is anticipated.

The organic wastes and other materials that may be generated and discharged by offshore vessels can attract some marine bird species, which may increase the potential for interactions with offshore activities, as well as affect predation, increasing the possibility of exposure to contaminants, and other disturbances. The discard of inorganic wastes, such as plastics, can also result in harmful effects through ingestion or entanglement. As discussed previously, each of the vessels involved in this Project will manage and dispose of their waste products in accordance with applicable regulations and standards, and will have a Waste Management Plan in place that will be strictly adhered to throughout the operational life of the Project. Waste food and sewage will be macerated to maximum particle size (six millimeters), and discharged overboard after treatment in accordance with the *Offshore Waste Treatment Guidelines* and MARPOL, and is therefore expected to be quickly degraded after release.

The main possible effects of offshore petroleum activities on marine birds are associated with potential accidental oil spills, with the actual effects of any such oil spill being dependent on factors such as the time of year, sea conditions, the volume and type of material spilled, and type of spill (i.e., surface or sub-surface), and the nature and degree of interaction between the spilled material and marine birds and their habitats. Again, because the proposed geophysical program will not result in the recovery of oil and gas resources from the seafloor, the potential for, and likely magnitude of, any such accidental spill is relatively low as compared to other types of offshore exploration and production activities. In addition, solid or gel filled streamer sections will be used for this Project, which will avoid any risk of streamer fluid being accidentally discharged into the marine environment at any time during the program.

There will be limited amounts of marine fuel and oils onboard the seismic and support vessels that could potentially be spilled into the ocean, and the potential for a marine spill and associated pollution incident is therefore very low for this proposed Project. Again, each of the vessels involved in this Project will use, store and handle fuels, oils and other such materials in an environmentally acceptable manner, in accordance with applicable regulations and standards. The vessels will have appropriate equipment and procedures in place to prevent any such accidental spills into the marine environment, as well as an Oil Spill Response Plan in the unlikely event of a spill.

A summary of the predicted (residual) environmental effects of the Project on marine/migratory birds is provided in Table 5.6 below.

Table 5.6 Marine/Migratory Birds: Residual Environmental Effects Assessment Summary

Project Activity and Potential Effect(s)	Environmental Effect Descriptors						
	Nature	**Magnitude**	**Extent**	**Duration**	**Frequency**	**Reversibility**	**Certainty**
Presence and Use of Vessels/Aircraft and Equipment • Disturbance	A	L	2	1	1	R	H
Seismic Sound • Disturbance	A	N	1	1	1	R	H
Seabed and Environmental Sampling Activities • Disturbance (Vessels and Equipment)	A	N	1	1	1	R	H
Air Emissions • Exposure, contamination	A	N	2	1	1	R	H
Lighting • Disturbance	A	L	2	1	1	R	H
Solid Waste • Exposure, contamination	A	L	1	1	3	R	H
Liquid Waste • Exposure, contamination	A	N	2	1	1	R	H
Potential Accidental Events • Potential injury • Exposure, contamination	A	L	2	1	1	R	H
Onshore Supply and Servicing	N	-	-	-	-	-	H

Overall, Resulting Effect(s) of Project on the VEC	**Evaluation of Significance**
• The Project is not anticipated to have material, negative effects on any species, especially, at the population level.	• The proposed Project is not likely to result in significant adverse environmental effects on marine/migratory birds

Nature/Direction:
A = Adverse
N = Neutral or No Effect
P = Positive

Magnitude:
N = Negligible or No Effect
L = Low
M = Medium
H = High

Geographic Extent:
1 = < 1 km^2
2 = 1-10 km^2
3 = 11-100 km^2
4 = 101-1,000 km^2
5 = 1,001-10,000 km^2
6 = >10,000 km^2

Duration:
1 = < 1 month
2 = 1-12 months
3 = 13-36 months
4 = 37-72 months
5 = > 72 months

Frequency:
1 = <11 events/year
2 = 11- 50 events/year
3 = 51-100 events/year
4 = 101-200 events/year
5 = >200 events/year
6 = Continuous

Reversibility:
R = Reversible
I = Irreversible

Certainty in Prediction:
L Low
M Moderate
H High

Project Activity and Potential Effect(s)	Environmental Effect Descriptors						
	Nature	Magnitude	Extent	Duration	Frequency	Reversibility	Certainty

NOTES

- In all cases, the above referenced effect descriptors refer to the resulting potential environmental effect to a particular environmental receptor, not to the Project activity or associated disturbance that creates the effect.
- The residual environmental effects predictions that are summarized above include integral consideration of the mitigation measures described in the preceding sections and in detail in Section 5.3

As described and summarized above, and with the implementation of the mitigation measures identified in this EA Report, the proposed Project is not likely to result in significant adverse environmental effects on marine/migratory birds.

5.5.4 Cumulative Environmental Effects

The distribution, abundance and health of marine birds and their populations are often influenced by both natural phenomena such as weather, food availability and oceanographic variation, as well as human activities and their associated disturbances including hunting, fishing activity, vessel traffic, offshore structures and pollution. Vessel movements associated with fishing activity and general marine traffic throughout the region, as well as previous offshore exploration, may have, to varying degrees, affected marine bird populations in the Study Area, and hunting activity (both legal and illegal) also puts pressure on some bird populations. In addition to these local disturbances, migratory bird species may also be affected by a variety of activities and associated effects within their often very extensive ranges, including hunting, pesticides and other pollution. The widespread and migratory nature of many marine bird species also therefore increases the potential for avifauna populations to be affected by multiple perturbations, and therefore, for cumulative environmental effects to occur. The effects of previous and on-going projects and activities within the Study Area (and elsewhere) are reflected in, and considered as part of, the existing (baseline) environmental conditions for this VEC.

Potential interactions with, and effects on, marine birds as a result of the proposed Project relate primarily to possible disturbances from the lights, noise and possible waste materials associated with the seismic survey ship and other related vessel and aircraft traffic. Any potential interactions with marine birds as a result of the Project will, however, entail a very localized and short-term disturbance at any one location and time, which reduces the potential for particular individuals and populations to be affected repeatedly through multiple interactions with this Project, as well as the potential for, and degree and duration of, any overlap between the effects of this Project and other activities in the marine environment. The vessel presence and movements associated with the proposed Project would represent a very small fraction of the total marine activity in the Eastern Newfoundland Offshore Area. As part of the planning and implementation of its survey activities over the course of this Project, Nexen will also continue to communicate and coordinate with relevant parties, including other oil and gas operators working in the area, to plan and coordinate activities to ensure appropriate spatial and temporal separation is maintained, for technical (data quality), safety and environmental reasons, as well as with other vessel traffic, fishing activity and other activities occurring in this marine environment.

As a result, the proposed Project is not likely to result in significant adverse cumulative environmental effects on marine/migratory birds in combination with other projects and activities that have been or will be carried out. Moreover, the relative contribution of this Project and its potential effects to any overall, cumulative effects on this VEC will be very low, and will not likely be perceptible.

5.5.5 Environmental Monitoring and Follow-up

Nexen will develop and implement an operational monitoring program for marine birds throughout the course of the Project (Section 5.3). A qualified and experienced Environmental Observer will be onboard to record marine bird (and marine mammals) sightings during Project operations, which will be undertaken in accordance with the Canadian Wildlife Service's (CWS's) pelagic seabird monitoring protocol (Gjerdrum et al 2012), and will utilize other available information and sources, including the guide for pelagic seabirds of Atlantic Canada. A report of the seabird monitoring program, together with any recommended changes, will be submitted to the CWS on a yearly basis in the format recommended by the regulator.

No specific follow-up related to the marine/migratory birds VEC is considered necessary in relation to the proposed Project.

5.6 Marine Mammals and Sea Turtles: Environmental Effects Assessment

A number of marine mammal species are known or considered likely to occur within the Study Area, including a number of mysticetes (baleen whales), odontocetes (toothed whales and porpoises) and pinnipeds (seals) as well as several sea turtle species. These differ considerably in their likelihood of presence and in the particular locations and habitat types that they utilize and the times at which they occur in or pass through the region. Given that a number of these species have been designated as species at risk under relevant legislation or are otherwise considered to be of conservation concern, they are typically a key consideration in the EA review and eventual implementation of offshore seismic survey programs.

5.6.1 Environmental Assessment Study Areas and Effects Evaluation Criteria

As described in Section 5.2, the EA focuses upon a number of spatial boundaries, including the:

> *Project Area*, which encompasses the overall marine area within which the proposed survey activities (data acquisition and vessel turns with equipment deployed) will take place; and the
>
> *Study Area,* which fully encompasses the Project Area and the likely environmental zone of influence of any Project related emissions and other disturbances (conservatively set at 40 km beyond the Project Area).

In addition to the above described spatial boundaries, the environmental effects assessment also considers the particular characteristics, distributions and movements of the individual VECs under consideration, including the larger Regional Areas within which they occur. Marine mammals are present in the Study Area throughout the year, with many species utilizing and moving into and out of the region for various activities at different periods, and sea turtles may be present in the area from spring to fall. Available information on the known geographic and seasonal occurrence of these species in and near the region is presented in Section 4.2.3, which reflects that many species have widespread distributions and differing migration patterns. The following sections assess the potential effects of the Project on marine mammals and sea turtles (individuals and populations) which occur within the EA Study Area during the period of proposed Project activities, and consider any particularly important and/or sensitive time periods. The environmental effects assessment also considers the nature of likely Project-VEC interactions and the associated zone of influence of Project-related disturbances in the marine environment (particularly, the attenuation of sound from the seismic array).

The Project's likely environmental effects are assessed and their significance is evaluated based on the above described spatial and temporal boundaries. For the purposes of this EA, significant environmental effects on the marine mammals and sea turtles VEC are defined as those that would cause one or more of the following:

- Mortality or life-threatening injury to any individuals of a designated (protected) species at risk, or destruction or alteration of the critical habitat of any such species;
- Effects to individuals within the area of Project-related emissions/disturbances, such that size, health, ecological function and/or sustainability of a population would be measurably and adversely affected; or

- Destruction of, or displacement of individuals from important areas or migratory routes during time periods and for durations over which the size, health, ecological function and/or sustainability of a population would be measurably and adversely affected.

5.6.2 Potential Environmental Issues, Interactions and Existing Knowledge

Potential environmental interactions between offshore oil and gas exploration activities such as those being planned as part of this Project and marine mammals and sea turtles include (adapted from Amec 2014):

- Temporary hearing impairment or permanent injury or mortality from exposure to loud underwater noise after coming into close contact with a seismic sound source;

- Behavioural effects (avoidance) due to Project-related noise emissions or other disturbances, altering the presence, abundance and overall distribution of marine mammal and sea turtles and their movements, feeding and other activity;

- Interference with (and the masking of) sounds within the marine environment that originate from and/or are used by marine biota, such as in communication between individuals, the identification and detection of predators and prey, echolocation and other activities and requirements;

- The possible attraction of individual animals to offshore survey and supply vessels, resulting in increased potential for injury or mortality through collisions or other interactions;

- Possible changes in the availability, distribution or quality of feed sources and/or habitats for marine mammals and sea turtles; and

- Changes in the presence, abundance, distribution and/or health (injury or mortality) of marine mammals and sea turtles as a result of accidental spills (through physical exposure, ingestion, effects on prey and habitats).

An overview of the potential interactions between each of the main Project components and activities and the various key indicators and parameters that have been identified for this VEC is presented in Table 5.7.

Table 5.7 Marine Mammals and Sea Turtles: Potential Project-VEC Interactions

Project Component/Activity	Key Indicators and Parameters				
	Presence and Abundance	Habitat Availability and Quality	Feeding (Availability and Quality)	Migration and Movements	Health (Individuals or Populations)
Presence and Use of Vessels/Aircraft and Equipment	●	●	●	●	●
Seismic Sound	●	●	●	●	●
Seabed and Environmental Sampling Activities	●	●			●

Project Component/Activity	Key Indicators and Parameters				
	Presence and Abundance	**Habitat Availability and Quality**	**Feeding (Availability and Quality)**	**Migration and Movements**	**Health (Individuals or Populations)**
Air Emissions					●
Lighting	●				
Solid Waste			●		
Liquid Waste			●		●
Potential Accidental Spills	●	●	●	●	●
Onshore Supply and Servicing					

A considerable amount of research has been conducted on the effects of offshore seismic surveys (of various types and intensities) on marine mammals, and to a lesser degree sea turtles (Nelms et al 2015). This has included experimental studies, effects monitoring and anecdotal reports of observed reactions to such activities and other sources of underwater noise by various species. An overview summary of some existing and available information from the literature and other sources regarding these potential environmental interactions and effects is provided below:

- There is little indication or evidence that direct physical damage to marine mammals or sea turtles has occurred as a result of seismic air source array noise, particularly due to the avoidance behaviour exhibited by many species.

- A wide range of behavioural responses have been reported in the literature and through anecdotal reports. Research results and observations have not provided conclusive or consistent findings, however, and knowledge of the behavioural effects resulting from seismic noise remains incomplete.

- For the most part, however, any such responses are expected to be localized (within one or perhaps up to several kilometres) and temporary, and of relatively low ecological significance, except possibly in instances where key habitats or life stages such as reproduction are significantly and repeatedly affected.

- Noise and other disturbances associated with marine vessel traffic may also cause behavioural responses in marine mammals and turtles. These responses are variable among species and are often reversible following removal of the disturbance source.

Table 5.8 provides a more detailed overview of this literature and associated sources/references.

Table 5.8 Potential Environmental Effects on Marine Mammals and Sea Turtles: Summary of Existing Knowledge

Potential Issue/Interaction	Overview of Relevant Studies
Physical and Behavioural Effects from Seismic and Vessel Noise	Anthropogenic noise in the marine environment has been shown to have a variety of effects on marine mammals and sea turtles, particularly in the case of relatively intense sounds at close ranges. These may be physical (injury or mortality) and/or behavioural (avoidance or other changes in distribution or activities) in nature. Vessel traffic and associated noise can be a source of chronic stress for marine mammal populations (Rolland et al 2012). Cetaceans and some seal species are known to adjust their movement behaviour around ships (Richardson et al 1995, Lalas and McConnell 2015), and to modify their vocal patterns (Clark et al 2009). Some cetacean species are also susceptible to injury or mortality from direct collisions with vessels (Williams and O'Hara 2010). Although permanent hearing damage can result in some instances (Nowacek et al 2007, Kunc et al 2016), hearing deterioration due to prolonged or repeated exposure to high levels of noise (also referred to as temporary threshold shift, or TTS) can also occur. The degree and duration of TTS is influenced by a range of factors including the individual or species involved, as well as the magnitude, frequency range, and duration of the noise source (Richardson et al 1995; Davis et al 1998, Kastelein et al 2016). Several previous studies have investigated this phenomenon (e.g., Finneran et al 2000, 2002, 2010; Southall et al 2007; Lucke et al 2009; Gedamke et al 2011), although the noise levels that cause TTS for most marine biota are not known, including the sound levels required to cause injury as well as the specific distances within which these may be produced for particular noise levels and other conditions. Studies related to potential TTS resulting from offshore seismic surveys have cited distances of less than 100 m from the sound source (Ridgway et al 1997), to several hundred meters (as described in LGL Limited 2005) to one km or more (Madsen et al 2006; Gedamke et al 2011). In a recent study, Finneran et al (2015) investigated the auditory effects of multiple underwater impulses on bottlenose dolphins by measuring hearing thresholds before and after exposure to 10 impulses produced by a seismic air gun. Exposures began at relatively low levels and gradually increased over a period of several months. At the cessation of the study, no significant increases were observed in psychophysical thresholds. Behavioural effects may also occur as a result of marine seismic survey activity and these have been documented in a variety of species and situations. Such interactions occur when animals are disturbed or otherwise affected by intense noise, including the possibility that the sounds emitted and/or used by these animals may be interfered with. Other, indirect effects may also occur when underwater noise results in changes in the location or abundance of food sources. Some of the behavioural effects that underwater noise sources have been observed to have on marine mammals include changes in vocalizations (Parks et al 2007; Holt et al 2009; Miller et al 2000, 2009; Di Iorio and Clark 2010; Risch et al 2012); respiration, swim speed, diving, and foraging behaviour (Stone and Tasker 2006); displacement and avoidance (Castellote et al 2012, Weir

Potential Issue/Interaction	Overview of Relevant Studies
	2008, Finneran 2015); shifts in migration paths, stress and immune depression (Romano et al 2004) and strandings (Gentry 2000; Malakoff 2002; Weilgart 2007). Some species utilize underwater sounds to communicate and for other uses and activities (LGL 2013). These sounds may be "masked" or interfered with by anthropogenic sources (including seismic activity), particularly when these frequency ranges overlap (Richardson et al 1995). Several recent studies have documented this occurrence (Gedamke et al 2011; Nieukirk et al 2012; Blackwell et al 2013, Erbe et al 2015) and have observed that species utilizing low-frequency ranges (such as baleen whales) are particularly sensitive (Clark et al 2009). The behavioural responses of marine mammals to seismic noise have been shown to be highly variable among species and across a range of environmental conditions (Weilgart 2007; Miller et al 2009). Consequently, any generalizations on the effects of anthropogenic noise on animal behaviour are difficult to identify (Wood et al 2012, Finneran 2015). For example, some cetaceans have been known to utilize seismic survey areas for foraging (e.g. bottlenose dolphins; Barry et al 2012), whereas others have been shown to avoid operating seismic source arrays, although these zones of influence are quite variable (as reviewed by LGL 2005). Some recent studies have, however, indicated avoidance or other disturbances up to several hundred kilometres away from seismic airguns source arrays, and well after the survey is completed (Nieukirk et al 2004, 2012; Risch et al 2012; Castellote et al 2012). Wood et al (2012) for example, describe relatively high levels of behavioural reactions to seismic noise at relatively low intensity (e.g., 120−140 dB re: 1 µPa rms), although some species (such as minke whales) have been observed in close proximity (less than 100 m) to operating seismic source arrays (Boertmann and Mosbech 2012).The zones of influence for marine noise appear to be much larger for low frequency cetaceans compared to high frequency cetaceans (Laws 2012). Of particular concern is the potential for marine mammals disturbance associated with seismic surveys to interfere with species at risk and other rare species and small populations, particularly any associated disruption of animal movements, communication or other activities during key periods such as reproduction (Croll et al 2002; Beauchamp et al 2009). Seals have been observed to react behaviourally to seismic surveys and other human-induced noise in the marine environment, although if it occurs any such disturbance is usually localized in extent and is short-term in duration (Richardson et al 1995). Sea turtles have also been shown to exhibit short-term physical, physiological and behavioural effects as a result of noise-related disturbances (McCauley et al 2000a). The loggerhead turtle's hearing range overlaps with the sound frequencies produced by seismic activities (Martin et al 2012), as does that of leatherback turtles (Dow Piniak et al 2012). Temporary hearing loss has been reported in some instances (Moein et al 1994), as has a strong initial avoidance response to seismic air-gun operations (O'Hara and Wilcox 1990; McCauley et al 2000a).

Potential Issue/Interaction	Overview of Relevant Studies
	In recent research, Cerchio et al (2014) used marine autonomous recording units to track numbers of singing humpback whales. They determined that the number of singing whales was reduced during times of seismic noise. It was suggested that seismic surveys could disrupt breeding behaviours of these animals. Robertson (2014) determined that the response of bowhead whales to seismic activity was context dependent (i.e. dependent on the whale's circumstance and activity). This author also determined that bowhead whales spend less time at the surface, and are more difficult to observe and count when exposed to seismic activity. When accounting for these behavioural changes, it was suggested that seismic activity did not displace bowheads to the degree previously thought but rather primarily altered their dive behaviour. Pirotta et al (2014) used passive acoustic loggers to monitor vocalizations in harbour porpoises in an area where there had been no evidence of broad scale displacement of animals from seismic activity. The authors determined that such vocalizations declined by 15 percent in the seismic area and that the further animals were away from activity, the greater the likelihood of vocalizations. This paper also documents evidence of sub-lethal effects of seismic airguns on harbour porpoises and suggests that exposure to seismic activity could influence energy budgets through reduced foraging performance.

The above summary is again intended to provide a brief overview of known and potential environmental issues and interactions, as background and context for predicting Project effects and for identifying and proposing mitigation. More detailed reviews of such information are available elsewhere, including the Eastern Newfoundland SEA (Amec 2014) as well as other sources. A key focus of the literature review undertaken for this EA and summarized above has therefore been on identifying and incorporating any additional studies and associated literature that have become available in the past 2-3 years, in order to update previously completed reviews, particularly as related to the understood effects of seismic sound on marine biota.

5.6.3 Environmental Effects Assessment

The following sections provide an assessment and evaluation of the potential effects of the Project on marine mammals and sea turtles, with a particular focus on the noise that will be released into the marine environment during periods of seismic survey activity. The effects assessment also considers other Project components, activities and disturbances which may interact with and affect this VEC, including the associated vessel traffic, other potential emissions to the marine and atmospheric environment during planned Project operations, and possible accidental events (such as a spill).

As with each of the other VECs in this assessment, mitigation measures to prevent or reduce adverse effects upon this VEC were identified and summarized in Section 5.3, and these are considered within and throughout the environmental effects analysis that follows, as applicable.

5.6.3.1 Presence and Movement of Project Vessels and Survey Equipment

The proposed exploration program will involve vessel traffic, including the use of seismic survey vessels and other sampling and support ships at locations within the Project Area throughout each year of the

program. The marine mammal and sea turtles species that occur within the Study Area during these times will not be disturbed by Project-related vessel activity due to its transitory nature and short-term presence at any one location, and because it is generally in keeping with the overall marine traffic that has occurred throughout the region for years. Vessel noise will therefore not be a material or detectable contributor to any possible effects on marine biota. The avoidance behaviour exhibited by many marine mammals during seismic survey operations and the associated mitigations (such as the ramp-up/soft-start procedures outlined earlier and described further below) will further reduce the potential for direct interaction between individuals and Project equipment, including potential collisions.

5.6.3.2 Seismic Sound Energy

Of the various activities that may be associated with offshore oil and gas exploration and development, seismic surveys are often considered to have the highest potential for effects on marine mammals and sea turtles. The potential effects of the underwater noise that is associated with marine seismic surveys may be physical (injury or mortality) or behavioural (avoidance, other changes in distribution or activities) in nature.

Temporary threshold shift (TTS) is hearing deterioration due to prolonged or repeated exposure to high levels of noise and can last from minutes or hours to days, depending upon such factors as the receptor involved and the level and duration of noise exposure (Richardson et al 1995; Davis et al 1998). Permanent hearing impairment may also occur is some instances. Although a limited number of studies have investigated this issue, specific TTS thresholds for marine mammals and sea turtles are not currently known, including both the sound levels required to cause such injury as well as the distances at which these may be produced for air gun noise levels and oceanographic conditions.

There is, however, limited potential for mortality of or serious injury to marine mammals or sea turtles as a result of exposure to the anticipated levels of seismic noise that will be generated and released into the marine environment as part of this Project. The avoidance behaviour that has been observed by many species during offshore seismic programs will further reduce the potential for physical effects to occur. The proposed survey activities will be carried out in strict compliance with the operational procedures outlined in the *Statement of Canadian Practice with Respect to the Mitigation of Seismic Sound in the Marine Environment* (DFO 2007b) and other mitigations committed to in this EA, including:

- Reduction of airgun source levels in the design and implementation of offshore seismic programs to the minimum level practical for the survey, including the amount and frequency of energy used and its horizontal propagation;

- Establishment of a safety zone around the seismic air source array (with a radius of at least 500 m), which will be monitored by a qualified MMO and specific protocols regarding observation requirements and times and shut-down as required (see Section 5.3);

- The use of a gradual “ramp-up” (soft-start) procedure over a minimum period to allow mobile marine animals to move away from the area if they are disturbed by the underwater sound levels associated with a seismic survey; and

- The shut-down of the seismic sound source during transit to the survey area and line changes and maintenance activities.

As noted above, behavioural reactions to exposure to seismic noise have been widely documented in marine organisms (DFO 2004), including marine mammals and sea turtles (see Section 5.6.2). The available research indicates that individual species vary considerably in their sensitivity and reactions to seismic noise, with other factors such as time of year also appearing to influence these responses. Also, as summarized in Section 5.6.2, previous research and reported observations have not yielded conclusive, nor particularly consistent, results. This makes it somewhat difficult to state specifically and definitively whether, how, to what degree and for how long individuals or species will react to underwater noise levels such as those that will be generated through this Project. It is, however, expected that any individuals that may come into close contact with underwater sound from this seismic program will exhibit a behavioural response to same, including displacement for a period of time from the affected area.

The predicted zone of influence of seismic sound in the marine environment (especially for marine biota as receptors) is typically defined by the area within which specific received sound levels are exceeded (LGL 2013). These thresholds can be established in terms of a maximum level of underwater sound to which cetaceans and reptiles should be exposed, which has been stated in some sources at between 160 to 190 dB re 1 µPa (see LGL 2013), or as a minimum distance of separation, such as DFO (2007) which recommends a circle with a radius of at least 500 m as measured from the centre of the seismic air source array(s).

The localized, transient and short-term nature of underwater disturbance at any one location and time during the seismic program considerably reduces the potential for adverse effects upon marine mammals and sea turtles (individuals or populations) to occur. This minimizes the potential for extended and repeated environmental disturbances at a particular location affecting a particular environmental receptor. It is therefore very unlikely that any individuals will be displaced over extended areas or timeframes. Given that the likely zone of influence of the Project at any one time or location will represent a very small proportion of the feeding, breeding or migration area of any species, marine mammals and sea turtles will not be displaced from any key habitats or during important activities, or be otherwise affected in a manner that causes negative and detectable effects to overall populations in the region.

Underwater noise from seismic surveys could also adversely affect marine mammals and sea turtles indirectly, through potential changes in the presence, abundance or concentration of prey and potential displacement from key foraging areas. As described in Section 5.4, however, extensive and persistent changes to fish resources or other marine biota are not expected to occur as a result of the Project. Therefore, the availability, location or quality of food sources for marine mammals or sea turtles are not likely to be negatively affected as a result of this Project, and especially, not to a degree or for a duration that would translate into negative and detectable effects upon this VEC.

5.6.3.3 Other Possible Environmental Discharges (Routine or Accidental)

The organic wastes and other materials that may be generated and discharged by offshore vessels can attract marine biota, which may increase the potential for interactions with offshore activities. As discussed previously, each of the vessels involved in this Project will manage and dispose of their waste products in accordance with applicable regulations and standards, and will have a waste management plan in place that will be strictly adhered to throughout the life of the Project.

Other potential environmental emissions such as the release of oily water and discharges such as deck drainage, bilge water and other possible sources of emissions will be managed through strict adherence

to applicable regulations and standards. There will be limited amounts of marine fuel and oils onboard the seismic and support vessels that could potentially be spilled into the ocean, and solid or gel filled streamer sections will be used which will avoid any risk of streamer fluid being accidentally discharged into the marine environment at any time during the program. The potential for a marine spill and pollution incident is therefore very low for this proposed Project, and each of the vessels involved will use, store and handle fuels, oils and other such materials in an environmentally acceptable manner, in accordance with applicable regulations and standards. The vessels will also have appropriate equipment and procedures in place to prevent any accidental spills into the marine environment.

A summary of the potential (residual) environmental effects of the Project on marine mammals and sea turtles is provided in Table 5.9 below.

Table 5.9 Marine Mammals and Sea Turtles: Residual Environmental Effects Assessment Summary

Project Activity and Potential Effect(s)	Environmental Effect Descriptors						
	Nature	**Magnitude**	**Extent**	**Duration**	**Frequency**	**Reversibility**	**Certainty**
Presence and Use of Vessels/Aircraft and Equipment • Disturbance	A	L	3	2	1	R	H
Seismic Sound • Disturbance	A	L	3	2	1	R	H
Seabed and Environmental Sampling Activities • Disturbance	A	L	1	1	1	R	H
Air Emissions • Exposure, contamination	N	-	-	-	-	-	H
Lighting • Disturbance	A	N	2	2	1	R	H
Solid Waste • Exposure, contamination	N	-	-	-	-	-	H
Liquid Waste • Exposure, contamination	A	N	2	2	1	R	H
Potential Accidental Events • Potential injury • Exposure, contamination	A	L	2	2	1	R	H
Onshore Supply and Servicing	N	-	-	-	-	-	H
Overall, Resulting Effect(s) of Project on the VEC • The Project is not anticipated to have material, negative effects on any species, or especially, at the population level.				**Evaluation of Significance** • The Project is not likely to result in significant effects on marine mammals and sea turtles.			

Project Activity and Potential Effect(s)	Environmental Effect Descriptors						
	Nature	**Magnitude**	**Extent**	**Duration**	**Frequency**	**Reversibility**	**Certainty**
Nature / Direction: A = Adverse N = Neutral or No Effect P = Positive	**Magnitude**: N = Negligible or No Effect L = Low M = Medium H = High	**Geographic Extent**: 1 = < 1 km^2 2 = 1-10 km^2 3 = 11-100 km^2 4 = 101-1,000 km^2 5 = 1,001-10,000 km^2 6 = >10,000 km^2	**Duration**: 1 = < 1 month 2 = 1-12 months 3 = 13-36 months 4 = 37-72 months 5 = > 72 months	**Frequency**: 1 = <11 events/year 2 = 11- 50 events/year 3 = 51-100 events/year 4 = 101-200 events/year 5 = >200 events/year 6 = Continuous			
Reversibility: R = Reversible I = Irreversible	**Certainty in Prediction:** L Low M Moderate H High						

NOTES

- In all cases, the above referenced effect descriptors refer to the resulting potential environmental effect to a particular environmental receptor, not to the Project activity or associated disturbance that creates the effect.
- The residual environmental effects predictions that are summarized above include integral consideration of the mitigation measures described in the preceding sections and in detail in Section 5.3

As described above, and with the implementation of the mitigation measures identified in this EA Report, the proposed Project is not likely to result in significant adverse environmental effects on marine mammals and sea turtles.

5.6.4 Cumulative Environmental Effects

The potential environmental effects of planned offshore geophysical activities on marine mammals and sea turtles relate primarily to noise. Notably, however, as a result of existing marine activities in the Study Area (e.g., fishing vessels, general marine traffic) and naturally occurring oceanographic sounds, the region's underwater environment is likely already quite noisy at particular locations and times. Marine mammals and sea turtles may also be affected by other natural factors and processes, as well as the disturbances which may be associated with other types of human activities in the marine environment. These include general vessel traffic and commercial fishing activity, which may result in effects due to entrapment and entanglement in fishing gear, collisions with marine vessels, and through pollution and other environmental effects. The widespread and migratory nature of marine mammals and sea turtles increases the potential for individuals and populations to be affected by multiple environmental disturbances, and thus, for cumulative effects to occur. This is reflected in the fact that many of the marine mammals and sea turtles that comprise this VEC have been designated (and are therefore protected) as species at risk or are otherwise of conservation concern. Again, the effects of previous and on-going projects and activities within the Study Area (and elsewhere) are reflected in, and considered as part of, the existing (baseline) environmental conditions for this VEC.

The proposed Project that is the subject of this EA will involve survey vessels and equipment operating within a relatively large survey area over multiple years. The vessel presence and movements associated with the proposed Project would represent a very small fraction of the total marine activity in the eastern portion of the Canada-NL Offshore Area, and the vessel(s) and sound source will be present at any one location for relatively short periods of time. Any potential interactions with marine mammals and sea turtles as a result of the Project would therefore entail a localized, short-term and infrequent environmental disturbance, and Nexen will be implementing a number of key mitigation

measures to avoid or reduce possible effects on these species (Section 5.3). The proposed Project will therefore not likely result in significant adverse effects to this VEC.

Other on-going and future projects and activities which may affect marine mammals and sea turtles within the Study Area include the fishery, general vessel traffic, and other on-going and planned offshore oil and gas exploration and development activities. The additional noise created as a result of this planned seismic survey will add incrementally to underwater noise levels in the region, and the often extensive survey areas covered by offshore seismic surveys can increase the potential for spatial interactions between their effects and those of other projects and activities in the marine environment. Based on previous studies, most potential effects to marine mammals and sea turtles as a result of seismic surveys and drilling programs occur within relatively close proximity (several kilometres) of the noise source. Avoidance of an area by marine mammals or other effects as a result of a single program would therefore likely be relatively localized and temporary in nature. Similarly, the environmental emissions and discharges associated with oil and gas exploration drilling and production projects are typically restricted to a fairly focussed zone of influence around the offshore installation rig itself, and these are therefore unlikely to overlap in space or time. Nexen will communicate and consult with other marine users, including other oil and gas operators working in the area, to plan and coordinate activities to ensure appropriate spatial and temporal separation is maintained, for technical (data quality), safety and environmental reasons, as well as with other vessel traffic, fishing activity and other activities occurring in this marine environment. This will reduce the potential for particular individuals and populations to be affected repeatedly through multiple interactions with this Project, as well as the potential for, and degree and duration of, any interaction or accumulation or interaction between the effects of this Project and other activities in the marine environment.

The proposed Project is therefore not likely to result in significant adverse cumulative environmental effects on this VEC in combination with other projects and activities that have been or will be carried out. The contribution of this Project and its potential effects to any overall effects on this VEC will be very low, and will not likely be perceptible.

5.6.5 Environmental Monitoring and Follow-up

As described in Section 5.3, Nexen will develop and implement an operational monitoring program for marine mammals throughout the course of the Project. A qualified and experienced Environmental Observer will be onboard to record marine mammal (and marine bird) sightings during Project operations, and reports from these monitoring programs will be submitted to the relevant government authorities as required.

No specific follow-up related to the marine mammals and sea turtles VEC is considered necessary in relation to the proposed Project.

5.7 Species at Risk: Environmental Assessment Summary

A number of fish, bird, mammal and turtle species that are known or considered likely to occur within the Study Area have been designated as species at risk and are therefore protected under applicable legislation, or have otherwise been identified as being of special conservation concern under other relevant initiatives.

5.7.1 Legislative and Management Context

The Canadian *Species at Risk Act* (*SARA*) provides for the protection of species at the national level to prevent extinction and extirpation, facilitate the recovery of endangered and threatened species, and to promote the management of other species to prevent them from becoming at risk in the future. Designations under *SARA* consider the recommendations and advice provided by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC).

There are currently a number of schedules associated with the *SARA*. Species that have formal protection are listed on Schedule 1, which includes the following potential designations:

- *Extirpated*: A species that no longer exists in the wild in Canada, but exists elsewhere;
- *Endangered*: A species that is facing imminent extirpation or extinction;
- *Threatened*: A species that is likely to become endangered if nothing is done to reverse the factors leading to its extirpation or extinction; and
- *Special Concern*: A species that may become threatened or endangered because of a combination of biological characteristics and identified threats.

Schedule 1 of *SARA* is therefore the official federal list of species at risk in Canada. Once a species is listed, measures to protect and recover a listed species are established and implemented, including the development of a Recovery Strategy. Action Plans summarize the activities required to meet recovery strategy objectives and goals, and Management Plans set goals and objectives for maintaining sustainable population levels of one or more species that are particularly sensitive to environmental factors.

At the provincial level, the Newfoundland and Labrador *Endangered Species Act* (*NL ESA*) provides protection for indigenous species, sub-species and populations considered to be endangered, threatened, or vulnerable within the province. These potential designations under the legislation are defined as follows:

- *Endangered*: A species that is facing imminent extirpation or extinction;
- *Threatened*: A species that is likely to become endangered if nothing is done to reverse the factors leading to its extirpation or extinction; and
- *Vulnerable*: A species that has characteristics which make it particularly sensitive to human activities or natural events.

Designations are based on recommendations from COSEWIC and/or the provincial Species Status Advisory Committee (SSAC). Habitat that is important to the recovery and survival of endangered or threatened species can also be designated as critical habitat or recovery habitat, and protected under the *NL ESA*.

5.7.2 Consideration of Species at Risk within the EA

Species at risk have been identified, and their known or likely presence, abundance and geographic and temporal distribution are evaluated, as an integrated component of the description of the existing biophysical environment (Chapter 4). The potential effects of the Project on these species have also been assessed and evaluated within the marine fish and fish habitat, marine/migratory birds, and marine mammals and sea turtles VECs themselves.

However, as specified in the Scoping Document issued by the C-NLOPB, species at risk and potential effects on them are given special (and separate) attention and emphasis in the assessment, including in the identification and analysis of potential environmental effects and mitigation. Therefore, while the overall content and findings of each of the other biophysical VECs are applicable to the individual species at risk within them (and, for the purposes of efficiency, this information and analysis is not repeated in its entirely here) the following sections provide an overview and "species-specific" analysis and summary of the potential effects of the Project on each protected species.

5.7.3 Marine Fish Species at Risk

A total of four marine fish species that are known or likely to occur in the Study Area have formal designation and protection under *SARA*. These are: Atlantic wolffish, Northern wolffish, spotted wolffish and white shark. American eel also has provincial designation and protection under the *NL ESA*.

The potential environmental interactions between the Project and these species are the same as those for the marine fish and fish habitat VEC as a whole, as are the planned mitigation measures to avoid or reduce any such adverse interactions.

Further, information and analysis related to each of these species, and the potential for the Project to interact with, and affect, each of these species at risk is provided in Table 5.10:

Table 5.10 Marine Fish Species at Risk: Analysis of Potential Environmental Interactions and Effects

Species	*SARA*	*NL ESA*	Summary of Presence and Potential Interactions
Atlantic wolffish	Special concern	-	• Adults are abundant in the Flemish Pass and continental slopes. • Spawning occurs from September to October and species has pelagic larvae. • Potential interaction limited as it is a mobile species and through implementation of project mitigations.
Northern (Broadhead) wolffish	Threatened	-	• Adults aggregate in the Flemish Pass and northeast slopes of the Grand Banks. • Spawning occurs from September through November and species has pelagic larvae.

Species	*SARA*	*NL ESA*	Summary of Presence and Potential Interactions
			• Potential interaction limited as it is a mobile species and through implementation of project mitigations.
Spotted wolffish	Threatened	-	• Species common on Flemish Cap, eastern Grand Banks and Newfoundland shelf. • Spawning occurs from June to August and species has pelagic larvae. • Potential interaction limited as it is a mobile species and through implementation of project mitigations.
White shark	Endangered	-	• Adult sharks are pelagic and may pass through the study area. • Timing and location of spawning is unknown. • Potential interaction limited as it is a mobile species and through implementation of project mitigations.
American eel	-	Vulnerable	• Adults migrate to the Sargasso Sea to spawn. • Migration from freshwater occurs from June to November. • Larvae or adults may pass through the Study Area during migrations. • Potential interaction limited as it is a mobile species and through implementation of project mitigations.

All of these species are highly mobile, and with the implementation of Project mitigation measures (such as the associated ramp-up/soft-start procedures outlined previously) any individuals that may be present within the Project's zone of influence are likely to move out of the area if they are disturbed by the Project. The Project will not affect any identified critical habitat for any such species, and will not affect the residences of other key habitats of any individual or populations.

5.7.4 Marine/Migratory Bird Species at Risk

The potential environmental interactions between the Project and any bird species at risk are also the same as those for the Marine/Migratory Bird VEC as a whole, as are the planned and proposed mitigation measures to avoid or reduce any such adverse interactions. Additional species-specific information and analysis related to the potential for the Project to interact with and affect each of these species at risk is provided in Table 5.11.

Table 5.11 Marine/Migratory Birds Species at Risk: Analysis of Potential Environmental Interactions and Effects

Species	*SARA*	*NL ESA*	Summary of Presence and Potential Interactions
Barrow's Goldeneye (Eastern pop.)	Special Concern (Schedule 1)	Vulnerable	• Moults and overwinters in small numbers off the coast of Eastern Canada. • Known to congregate in relatively small geographic areas in important shipping corridors, therefore considered to be particularly vulnerable to being affected by accidental spills (Schmelzer 2006). • Unlikely to be present in offshore Project Area due to their preference for coastal habitats.

Harlequin Duck (Eastern pop.)	Special Concern (Schedule 1)	Vulnerable	• Breed inland, but occur in the coastal marine environment throughout the fall and winter months. Some non-breeding individuals may be found year-round at Cape St. Mary's. • Unlikely to be present in offshore Project Area due to their preference for coastal habitats.
Ivory Gull	Endangered (Schedule 1)	Endangered	• Breeds in the far north and winters offshore; found in small numbers in the waters off Eastern Newfoundland, typically among pack ice. • Potentially present; Ivory Gulls spend almost all of their time in the marine environment, including within the Project Area. • However, no critical habitat exists in the Project Area, and because they are typically found among pack ice, interactions with Project activities are unlikely.
Piping Plover (*Melodus* ssp.)	Endangered (Schedule 1)	Endangered	• During the nesting season, found on sandy coastal beaches. In Newfoundland, breeding population is concentrated in the southwest and western portions of the Island. • Unlikely to be affected by typical Project activities due to their preference for coastal habitats.
Red Knot (*Rufa* ssp.)	Endangered (Schedule 1)	Endangered	• Arctic breeders. Newfoundland is not considered to be a major migratory stopover location; nonetheless, sightings have been reported around much of coastal Newfoundland. • Unlikely to be present in Project Area due to their preference for coastal habitats.
Peregrine Falcon	Special Concern (Schedule 1)	Vulnerable	• Migrates along the coast of Newfoundland during the fall (particularly the west coast), preying on concentrations of migrating shorebirds. • Potentially present during fall migration, and some evidence suggests they may be attracted to platforms due to the abundance of prey species.
Common Nighthawk	Threatened (Schedule 1)	Threatened	• Does not breed in insular Newfoundland. • Unlikely to occur regularly in the Study Area.
Gray-cheeked Thrush (*minimus* ssp.)	none	Threatened	• An inland species, therefore unlikely to be affected by offshore activities at most times of year. • During fall migration, there is potential to be attracted to or disoriented by artificial light sources in the offshore environment.
Olive-sided Flycatcher	Threatened (Schedule 1)	Threatened	• An inland species, therefore unlikely to be affected by offshore activities at most times of year.

			• During fall migration, there is potential to be attracted to or disoriented by artificial light sources in the offshore environment.
Bobolink	none	Vulnerable	• Uncommon in Eastern Newfoundland. An inland species, therefore unlikely to be affected by offshore activities at most times of year. • During fall migration, there is potential to be attracted to or disoriented by artificial light sources in the offshore environment.
Short-eared Owl	Special Concern (Schedule 1)	Vulnerable	• Typically nests in coastal barrens and grasslands, and suitable habitat occurs in much of coastal Newfoundland. • Unlikely to occur regularly in the Study Area.

The Project will not affect critical habitat for any of these species, nor will it result in disturbance of coastline areas and any associated bird colonies given its far offshore location.

5.7.5 Marine Mammal and Sea Turtle Species at Risk

A number of marine mammal and sea turtle species at risk are known or likely to occur in the Study Area. Again, the main potential environmental interactions between the Project and these species are the same as those for the marine mammals and sea turtles VEC as a whole as are the planned mitigation measures to avoid or reduce any such adverse interactions.

Further, species-specific information and analysis related to the potential for the Project to interact with, and affect, each of these species at risk is provided in Table 5.12.

Table 5.12 Marine Mammal and Sea Turtle Species at Risk: Analysis of Potential Environmental Interactions and Effects

Species	*SARA*	*NL ESA*	Summary of Presence and Potential Interactions
Blue Whale (Atlantic pop.)	Endangered	none	• Found in coastal and pelagic waters, frequently at shelf edge where food production is high (Schoenherr 1991). • Critical habitat in the estuary and Gulf of St. Lawrence is currently being identified for the species (DFO 2016a). • Present in small numbers throughout the year; most common in the winter and early spring.
Fin Whale (Atlantic pop.)	Special Concern	none	• Coastal shelf edge and offshore (COSEWIC 2005); typically found in areas with high prey concentration (e.g., the Grand Banks) in the summer months. • Present year-round, most common in the summer months.
North Atlantic Right Whale	Endangered	none	• Prefers waters 100 – 200 m deep with surface temperatures between 8 and 15°C (Kenney 2001). • Two designated critical habitat areas in Canada: the lower Bay of Fundy and Roseway Basin on the Scotian Shelf (Brown et al 2009).

Species	*SARA*	*NL ESA*	Summary of Presence and Potential Interactions
			• Uncommon in Study Area; most likely to be present in the summer months.
Northern Bottlenose Whale (Scotian Shelf pop.; Davis Strait pop.)	Scotian Shelf pop.: Endangered Davis Strait pop.: none	none	• Deep-diving species found in waters 800 - 1500 m deep. • Three marine canyons, all along the Scotian Shelf, have been identified as critical habitat for the Scotian Shelf population (DFO 2010). • A recent observation of 50 individuals in the Sackville Spur area suggest there may be potentially a previously unknown population (CBC 2016). • Potentially present in small numbers in the area year-round; most sightings have been in the spring and summer.
Sowerby's Beaked Whale	Special Concern	none	• Deep-diving species found at continental edges and slopes in depths of 550 - 1500 m or more. • May be present year-round in deep water habitats.
Beluga Whale - (St. Lawrence Estuary pop.)	Threatened	none	• Coastal species; found near outlet of the Saguenay River in summer, while in the winter months, they disperse from estuarine habitats, regularly occurring as far downstream as the western end of Anticosti Island (COSEWIC 2014). • Critical habitat has been identified in the St. Lawrence Estuary and lower reaches of the Saguenay River (DFO 2012a). • Unlikely to interact with Project due to preference for coastal habitats. Very rare in the Study Area; seldom ranges far from the St. Lawrence estuary.
Leatherback Sea Turtle (Atlantic pop.)	Endangered	none	• Typically found in coastal shelf waters with depths of less than 200 m. • Critical habitat has not yet been identified, but DFO (2012b) observed three high-use feeding areas in Canadian waters: 1) waters east and southeast of Georges Bank, including the Northeast Channel near the southwestern boundary of the Canadian Exclusive Economic Zone; 2) the southeastern Gulf of St. Lawrence and waters off eastern Cape Breton Island, including Sydney Bight, the Cabot Strait, portions of the Magdalen Shallows and adjacent portions of the Laurentian Channel; and 3) waters south and east of the Burin Peninsula, including parts of Placentia Bay. • Occurs with some regularity in the Study Area from April to December.

Each of these species are highly mobile, and with the implementation of Project mitigation measures (such as the associated ramp-up/soft-start procedures outlined previously) any individuals that may be present within the Project's zone of influence are likely to move out of the area if they are disturbed by the Project. The Project will not occur within identified critical habitat for any of these species.

5.7.6 Summary of Environmental Assessment Results for Species at Risk

As a result of the above analysis, and with the implementation of the various mitigations outlined in Sections 5.3, the proposed Project is not likely to result in significant adverse effects upon any species at risk.

The EA Scoping Document (Section 5.2.7) makes specific reference to the following sections of *SARA*:

> *32. (1) 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*
>
> *33. 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, or that is listed as an extirpated species if a recovery strategy has recommended the reintroduction of the species into the wild in Canada.*
>
> *58. (1) Subject to this section, no person shall destroy any part of the critical habitat of any listed endangered species or of any listed threatened species - or of any listed extirpated species if a recovery strategy has recommended the reintroduction of the species into the wild in Canada - if*
>
> *(a) the critical habitat is on federal land, in the exclusive economic zone of Canada or on the continental shelf of Canada;*
> *(b) the listed species is an aquatic species; or*
> *(c) the listed species is a species of migratory birds protected by the Migratory Birds Convention Act, 1994.*

Based on the information and analysis provided in this EA Report, the Project and its potential environmental effects are not expected to contravene either of these prohibitions.

5.8 Special Areas: Environmental Effects Assessment

A number of marine and coastal areas within and adjacent to the Study Area have been designated as protected under provincial, federal and/or other legislation and processes, or have been identified as being otherwise special or sensitive due to their ecological, historical and/or socio-cultural characteristics and importance. These areas were identified and described in Section 4.2.4, and are given particular attention in the EA.

5.8.1 Environmental Assessment Study Areas and Effects Evaluation Criteria

As described in Section 5.2, the EA focuses upon a number of spatial boundaries, including the:

> *Project Area*, which encompasses the overall marine area within which the proposed survey activities (data acquisition and vessel turns with equipment deployed) will take place; and the
>
> *Study Area,* which fully encompasses the Project Area and the likely environmental zone of influence of any Project related emissions and other disturbances (conservatively set at 40 km beyond the Project Area).

In addition to the above described spatial boundaries for the Project and its EA, the effects assessment for the special areas VEC also includes consideration of the full size and extent of any such areas that overlap in whole or part with the Study Area, as well as the overall geographic distributions of the ecological and/or socio-cultural components and processes that are relevant to the identification, and overall integrity and value, of these areas.

Significant environmental effects are considered to be those that would cause a change in a VEC that will alter its status or integrity beyond an acceptable and sustainable level. Significant environmental effects on the special areas VEC are defined as those that would cause: *An adverse change in one or more of the important and defining ecological and socio-cultural characteristics of such an area, resulting in a decrease in the integrity, value or use of one or more such areas.*

5.8.2 Potential Environmental Issues, Interactions and Existing Knowledge

Environmental interactions between petroleum activities and special areas may be both direct and indirect in nature and cause (Amec 2014). Conducting an activity directly within or near such an area may, for example, have adverse implications through the presence of vessels, equipment and personnel and any associated noise and other emissions and resulting disturbances. Any associated decrease in the real or perceived integrity of these sites in the short or long term may, in turn, affect their ecological and/or socio-cultural importance, value and (where applicable) the use and enjoyment of these areas. Biophysical effects resulting from offshore oil and gas or other human activities may also affect these areas by affecting marine fish, birds, mammals or other environmental components and systems that are relevant to their identification and their key and relevant characteristics and importance.

An overview of the potential interactions between each of the planned Project components and activities and the various key indicators and parameters that have been identified for this VEC is presented in Table 5.13.

Table 5.13 Special Areas: Potential Project-VEC Interactions

Project Component/Activity	Key Indicators and Parameters	
	Ecological Features and Functions	**Socio-cultural Use and Value**
Presence and Use of Vessels/Aircraft and Equipment	●	●
Seismic Sound	●	●
Seabed and Environmental Sampling Activities	●	●
Air Emissions	●	●
Lighting	●	●
Solid Waste	●	●
Liquid Waste	●	●
Potential Accidental Spills	●	●
Onshore Supply and Servicing	●	●

5.8.3 Environmental Effects Assessment

A description (and mapping) of each of the marine and coastal areas within and adjacent to the Study Area that have been designated as special (protected, sensitive or otherwise) was provided in Chapter 4. The following sections provide an assessment and evaluation of the potential effects of the Project on these special areas. Again, the previously identified mitigation measures are identified and considered within the effects analysis, as relevant.

Table 5.14 provides a summary of the (minimum) distance between the edges of the proposed Project Area and Study Area and the various relevant special areas identified and mapped in Chapter 4. As indicated, the Project will occur in an offshore area which is many kilometres from shore. Project activities will therefore not occur within, or otherwise interact directly with, any of the identified existing provincial or federal parks or historic sites, ecological reserves, MPAs, Migratory Bird Sanctuaries, World Heritage Sites, IBAs, or other locations that have been designated as protected or otherwise special on the Island of Newfoundland (Section 4.2.4).

The proposed Project Area and Study Area do, however, overlap with several types of special areas in the offshore environment, for which there are no associated prohibitions of marine activities such as that being proposed as part of this Project. Categories of special areas with any sites that occur within 100 km of the Study Area and Project Area are shown in Table 5.14.

Table 5.14 Special Areas: Summary of Distances from the Project Area and Study Area

Special Area	Minimum Distance From	
	Study Area (km)	**Project Area (km)**
Ecologically and Biologically Significant Areas (EBSAs)		
Lilly Canyon-Carson Canyon	Overlaps	Overlaps
Southeast Shoal and Tail of the Banks	Overlaps	Overlaps
Northeast Shelf and Slope	Overlaps	Overlaps
Virgin Rocks	13	46
Orphan Spur	41	74
Eastern Avalon Coast	189	222
Southwest Shelf Edge and Slope	210	243

Special Area	Minimum Distance From	
	Study Area (km)	Project Area (km)
Notre Dame Channel	215	248
Fogo Shelf	235	268
Smith Sound	261	294
Placentia Bay Extension	298	331
Grey Islands	336	369
Labrador Slope	404	437
Labrador Marginal Trough	493	526
St. Pierre Bank	506	539
Laurentian Channel and Slope	519	552
Gilbert Bay	574	607
Hamilton Inlet	644	677
NAFO Fisheries Closure Areas		
Beothuk Knoll (3)	Overlaps	Overlaps
Sackville Spur (6)	Overlaps	Overlaps
Northern Flemish Cap (7)	Overlaps	Overlaps
Northern Flemish Cap (8)	Overlaps	Overlaps
Northern Flemish Cap (9)	Overlaps	Overlaps
Northwest Flemish Cap (10)	Overlaps	Overlaps
Northwest Flemish Cap (11)	Overlaps	Overlaps
Beothuk Knoll (13)	Overlaps	Overlaps
Northwest Flemish Cap (12)	Overlaps	Overlaps
Flemish Pass/Eastern Canyon (2)	Overlaps	Overlaps
Orphan Knoll Seamount	2	35
Northeast Flemish Cap (5)	12	45
Tail of the Bank (1)	19	52
Eastern Flemish Cap (14)	59	92
Eastern Flemish Cap (4)	66	99
Newfoundland Seamounts	74	107
3O Coral Area Closure	221	254
Fogo Seamounts (1)	332	365
Fogo Seamounts (2)	419	452
Vulnerable Marine Ecosystems (VMEs)		
Northern Flemish Cap	Overlaps	Overlaps
Sackville Spur	Overlaps	Overlaps
Northeast Shelf and Slope (within Canadian EEZ)	Overlaps	Overlaps
Deep Water Coral Area	Overlaps	29
Beothuk Knoll	Overlaps	Overlaps
Southern Flemish Pass to Eastern Canyons	Overlaps	Overlaps
South East Shoal and Adjacent Shelf Edge/Canyons	12	45
Flemish Cap East	102	135

Special Area	Minimum Distance From	
	Study Area (km)	Project Area (km)
Division 3O Coral Closure Area	221	254
Preliminary Representative Marine Areas (RMAs)		
South Grand Bank Area	Overlaps	Overlaps
Virgin Rocks	23	56
Northwestern Conception Bay	202	235
Southern Coast of Burin Peninsula and Southeastern Placentia Bay	415	448

The Fisheries Closure Areas/VMEs that overlap with the Study Area have been designated as such in order to help protect benthic areas from further disturbance from certain types of (particularly bottom dragging) fishing activity. Most of the offshore survey activities that are planned to be undertaken as part of this Project will not result in any direct contact with the seabed, and will therefore not physically disturb benthic animals or their habitats. Seabed core, grab and seabed samples may also be acquired to determine seabed sediment characteristics, as well as other geochemical and environmental data acquisition using a towed seabed camera/video system, gravity or piston core, box corer, vibro-corer or water sampler, these activities have a very short duration, and those which involve contact with the seabed will have a very small footprint. As referenced earlier, Nexen will undertake representative seabed reconnaissance prior to core drilling or other intrusive seabed sampling work in areas that have been identified as having a high probability of occurrence of sensitive corals and sponges.

In terms of the various EBSAs and RMAs that overlap with the Project Area and Study Area, the biophysical or socioeconomic environments within these areas will not be significantly affected by the Project. Again, most of the offshore survey activities that will be undertaken as part of this Project will not result in any direct contact with the seabed, and the nature, magnitude, location, frequency and duration of the planned exploration activities will mean that activities will occur at any one location for only a very short period of time, and will be generally in keeping with (and will make a negligible contribution to) the marine activity (especially, vessel traffic) that has occurred throughout the region for years. As described for the various preceding biophysical VECs, the proposed Project is not expected to result in any significant adverse effects upon marine fish, birds, mammals, sea turtles or their habitats. It will therefore not adversely affect the ecological features, processes and integrity of any marine or coastal areas, including the special areas that are part of this VEC. The implementation of the various environmental protection measures outlined throughout this EA Report (see Section 5.3), including those which are designed to avoid or reduce Project-related discharges and/or disturbances and their associated environmental effects, will also serve to help address any direct or indirect potential effects on overlapping or adjacent special areas.

A summary of the predicted (residual) environmental effects of the Project on special areas is provided in Table 5.15 below.

Table 5.15 Special Areas: Residual Environmental Effects Assessment Summary

Project Activity and Potential Effect(s)	Environmental Effect Descriptors						
	Nature	Magnitude	Extent	Duration	Frequency	Reversibility	Certainty
Presence and Use of Vessels/Aircraft and Equipment • Disturbance	N	-	-	-	-	-	H

Project Activity and Potential Effect(s)	Environmental Effect Descriptors						
	Nature	**Magnitude**	**Extent**	**Duration**	**Frequency**	**Reversibility**	**Certainty**
Seismic Sound • Disturbance	N	-	-	-	-	-	H
Seabed and Environmental Sampling Activities • Exposure, contamination • Disturbance (vessel related and habitats)	N	-	-	-	-	-	H
Air Emissions • Exposure, contamination	N	-	-	-	-	-	H
Lighting • Disturbance	N	-	-	-	-	-	H
Solid Waste • Exposure, contamination	N	-	-	-	-	-	H
Liquid Waste • Exposure, contamination	N	-	-	-	-	-	H
Potential Accidental Events • Potential injury • Exposure, contamination	A	L	2	1	1	R	H
Onshore Supply and Servicing	N	-	-	-	-	-	H

Overall, Resulting Effect(s) of Project on the VEC	**Evaluation of Significance**
• The Project is not anticipated to have adverse effects upon this VEC.	• The proposed Project is not likely to result in significant adverse environmental effects on this VEC

Nature/Direction:
A = Adverse
N = Neutral or No Effect
P = Positive

Magnitude:
N = Negligible or No Effect
L = Low
M = Medium
H = High

Geographic Extent:
1 = < 1 km^2
2 = 1-10 km^2
3 = 11-100 km^2
4 = 101-1,000 km^2
5 = 1,001-10,000 km^2
6 = >10,000 km^2

Duration:
1 = < 1 month
2 = 1-12 months
3 = 13-36 months
4 = 37-72 months
5 = > 72 months

Frequency:
1 = <11 events/year
2 = 11- 50 events/year
3 = 51-100 events/year
4 = 101-200 events/year
5 = >200 events/year
6 = Continuous

Reversibility:
R = Reversible
I = Irreversible

Certainty in Prediction:
L Low
M Moderate
H High

Project Activity and Potential Effect(s)	Environmental Effect Descriptors						
	Nature	**Magnitude**	**Extent**	**Duration**	**Frequency**	**Reversibility**	**Certainty**

NOTES

- In all cases, the above referenced effect descriptors refer to the resulting potential environmental effect to a particular environmental receptor, not to the Project activity or associated disturbance that creates the effect.
- The residual environmental effects predictions that are summarized above include integral consideration of the mitigation measures described in the preceding sections and in detail in Section 5.3

As described and summarized above, and with the implementation of the mitigation measures identified in this EA Report, the proposed Project is not likely to result in significant adverse environmental effects on special areas.

5.8.4 Cumulative Environmental Effects

The past, on-going and future environmental effects of offshore oil and gas, fishing and other human activities in the Study Area may interact with each other to result in cumulative environmental effects. Existing (and any future) protected areas in Newfoundland and elsewhere will not be subject to direct effects by such activities, given the prohibition of such activities within their boundaries. This will also be the case for this Project, which will not occur within or otherwise affect protected areas in Newfoundland and Labrador or elsewhere.

Any interactions with other identified sensitive or otherwise special areas in the marine environment as a result of the Project will entail a very localized and short-term disturbance at any one location and time, which reduces the potential for particular locations and their associated ecological or socio-cultural components to be affected by multiple disturbances. Again, the marine activity that will be associated with the proposed Project would represent a very small fraction of the total marine activity in the eastern portion of the Canada-NL Offshore Area. Therefore, the Project is not likely to result in significant adverse cumulative environmental effects in combination with other projects and activities that have been or will be carried out, and the relative contribution of this Project and any such potential effects will not likely be perceptible.

5.8.5 Environmental Monitoring and Follow-up

The various environmental monitoring initiatives proposed earlier in relation to relevant components of the biophysical environment will also be indirectly applicable to special areas (particularly, their ecological aspects). No additional and specific environmental monitoring or follow-up is considered necessary in relation to this VEC.

5.9 Marine Fisheries and Other Activities: Environmental Effects Assessment

Marine fisheries are an important and long-standing element of the socioeconomic environment of Newfoundland and Labrador, including many of the communities and regions that extend along the coastline of Eastern Newfoundland and elsewhere. A number of other anthropogenic components and activities also occur throughout the Study Area, including various commercial and recreational pursuits.

5.9.1 Environmental Assessment Study Areas and Effects Evaluation Criteria

As described in Section 5.2, the EA generally focuses upon a number of spatial boundaries, including the:

> *Project Area*, which encompasses the overall marine area within which the proposed survey activities (data acquisition and vessel turns with equipment deployed) will take place; and the
>
> *Study Area,* which fully encompasses the Project Area and the likely environmental zone of influence of any Project related emissions and other disturbances (conservatively set at 40 km beyond the Project Area).

In addition to the above described spatial boundaries for the Project and this EA, the effects assessment for this VEC also includes consideration of the overall geographic extent and spatial distribution of fishing and other human components and activities within and adjacent to the Study Area, as well as the seasonality of particular activities and these sectors as a whole, including any key times.

Significant environmental effects on the marine fisheries and other activities VEC are defined as follows:

- For *commercial activities*: Those that would cause a detectable reduction in the overall economic returns generated from fisheries and/or other marine activities undertaken within the Study Area over one or more years.

- For *recreational activities*: Those that would result in a decrease in overall activity levels and/or the enjoyment or cultural value of such activities for a community or region over multiple years.

5.9.2 Potential Environmental Issues, Interactions and Existing Knowledge

A description of commercial fisheries within the Project Area and Study Area was provided in Chapter 4, based upon existing and available catch statistics and geospatial data provided by DFO and other information sources. As illustrated, a variety of fisheries occur within and throughout the Study Area at various times of the year, and the region is characterized by a complex and somewhat dynamic spatial and temporal mosaic of fishing and other marine pursuits, including with regard to the location, timing and intensity of specific activities, the particular marine resources (species) of interest, the equipment types used, and other factors. Related to commercial fisheries resource assessment and management, several science surveys take place annually or according to other schedules throughout parts of the Project Area and Study Area. There are no aquaculture sites or activities within or near the far offshore marine environments that comprise the Project Area and Study Area. Similarly, recreational fisheries occur in nearshore areas quite far away from the deep sea environment that comprises the Study Area.

As described in Section 4.3.1, fishing enterprises associated with a number of Aboriginal organizations undertake commercial fishing activity within NAFO Divisions that overlap parts of the Project Area and Study Area. This includes fishing activity by the: 1) Labrador Inuit (Nunatsiavut Government) 2) Labrador Innu (Innu Nation), 3) NunatuKavut Community Council, 4) Miawpukek First Nation, 5) Qalipu First Nation Band, and 6) the Mi'kmaq Alsumk Mowimsikik Koqoey Association. As far as Nexen is aware, however, none of these nor any other Aboriginal groups undertake traditional activities in or near this area, nor do any Aboriginal groups hold, claim or otherwise assert Aboriginal or treaty rights offshore Eastern Newfoundland pursuant to Section 35 of the *Canadian Constitution Act, 1982*. Rather, it is understood that that these organizations undertake fishing activity in this area through commercial licences issued by the federal government under the *Fisheries Act* and its associated *Aboriginal Communal Fisheries Licencing Regulation*, as well as under other government policies and programs that are designed to involve Aboriginal people and communities in commercial fisheries in Canada. Moreover, there are no known or documented food, social, or ceremonial licences or activities within or near the Project Area. Fishing activity by Aboriginal groups off Eastern Newfoundland are therefore considered and addressed in this VEC in the context of overall commercial fisheries in this region.

Offshore oil and gas exploration and production activities have been occurring in the Eastern Newfoundland Offshore Area and elsewhere for decades. The views and insights of those involved in the fishing industry and other marine sectors as a result of their experiences to date, therefore, provide an important source of "existing knowledge" regarding potential issues and effects, mitigation measures and their effectiveness, and other factors relevant to the planning and possible conduct of future offshore oil and gas activities in the region. Possible interactions between offshore petroleum activities and other human activities may again be both direct and indirect in nature and cause, and include (adapted from Amec 2014):

- Potential damage to fishing gear, vessels, equipment or other components as a result of direct interactions with oil and gas related vessels, equipment, activities or their environmental discharges;

- Decreased access to preferred fishing grounds or other marine areas during offshore oil and gas activities, with possible resulting decreases in the success, efficiency, enjoyment or value of these pursuits;

- Indirect effects on fisheries or other uses of the marine environment due to possible biophysical effects on the presence, distribution, abundance or quality of marine fish or other resources or environmental features, resulting from planned activities or accidental events;

- Potential economic effects to individuals, businesses and communities as a result of the above; and

- Possible interference with governmental/industry fish survey activities, including direct disturbance and/or effects upon research results and associated management decisions (Because area science surveys basically involve "fishing" for the species of interest, the potential interactions, effects and mitigations related to fisheries science surveys are essentially the same as for commercial fisheries, as described in the sections that follow)

Beyond the various potential environmental issues and interactions outlined above, the Project and its potential environmental effects are - with respect to both Aboriginal and non-Aboriginal peoples - not

considered likely to extend to or otherwise affect health and socioeconomic conditions, physical and cultural heritage, the current use of lands and resources for traditional purposes, or any structure, site or thing that is of historical, archaeological, paleontological or architectural significance.

An overview of the key potential interactions between each of the main Project components and activities and the various key indicators and parameters that have been identified for this VEC is presented in Table 5.16.

Table 5.16 Marine Fisheries and Other Activities: Potential Project-VEC Interactions

Project Component/Activity	Key Indicators and Parameters				
	Distribution and Intensity of Marine Activities	Effectiveness and Efficiency of Marine Activities (including catch rates)	Abundance, Location and Quality of Marine Resources	Quality and Value of Marine Activities (Economic)	Quality and Value of Marine Uses (Socio-cultural)
Presence and Use of Vessels/Aircraft and Equipment	●	●	●	●	●
Seismic Sound		●	●	●	●
Seabed and Environmental Sampling Activities	●				
Air Emissions					
Lighting			●		
Solid Waste			●		
Liquid Waste			●		
Potential Accidental Spills	●	●	●	●	●
Onshore Supply and Servicing					

5.9.3 Environmental Effects Assessment

The following sections provide an assessment and evaluation of the potential effects of the Project on marine fisheries and other activities. As with each of the other VECs, mitigation measures to prevent or reduce adverse effects upon these activities were identified and summarized at the onset of this Chapter, and these are considered within and throughout the environmental effects analysis that follows, as applicable.

5.9.3.1 Presence and Movement of Project Vessels and Survey Equipment

The potential for the Project to interact with and affect marine fisheries and other human activities will depend upon the specific nature, location and timing of these activities, and the equipment or gear involved (such as the possible presence of fixed fishing gear, such as crab pots or pelagic longlines, along or near a survey line at the same time as planned Project activities). In general, however, the available data on fishing and other marine pursuits indicate that they occur throughout the planned Project timeframes (April-November). The planned timing of the offshore survey work that is being proposed as part of this Project will therefore inevitably overlap with periods of fishing and other offshore activities. Moreover, given the limited manoeuvrability of the seismic vessel during survey activity (due to the length of the deployed streamer and other factors), it is important that Project planning and

implementation be carried out so as to seek to prevent - or respond quickly and effectively to - potential interactions with other vessels. A greater potential for a conflicting interaction would be for fixed fishing gear (such as crab pots) that have been deployed along or near a survey line at the same time as planned Project activities. This will require advanced planning and collaboration to minimize the potential for affecting both Project activities and fisheries, as well as on-going cooperation and communication between the survey vessel and other marine vessels to avoid potential interactions for safety and other reasons.

Detailed and specific operational plans for the proposed survey work - including for each of the potential 10 years of activity - are not and cannot be available at this stage, since the specific location and other characteristics of a particular year's activities will depend on the previous year's survey and its findings, exploration interests and priorities, and other logistical considerations. At this stage it is therefore not possible to identify and specify particular locations and times at which Project activities will be undertaken or curtailed in order to avoid or reduce the potential for interactions with other marine users, and program planning will therefore continue to occur based on a variety of factors, primarily relying on industry communications and advice and applying the mitigations described herein. As is also a typical condition of EA approval for such marine exploration activities in the Canada-NL Offshore Area, Nexen will submit annual updates in relation to this multi-year program. These will describe the previous year's activities, recent and on-going stakeholder consultations, current-year science survey plans, outline the proposed survey work for the coming year and evaluate the continued applicability and validity of the EA predictions and associated mitigations.

The mobile and transitory nature, spatial extent and timing of the planned offshore survey activities that will be associated with this Project will mean that activity will occur at any one location for a relatively short period of time. Typically, only small portions of some of the planned survey lines would pass near key active fishing areas at any one time, which would therefore result in minimal (and likely very brief) potential interaction or disturbance at any particular site and time. On-going coordination and effective and timely communication between offshore oil and gas operators and the fishing industry and other marine interests, through the various processes and forums described above and as outlined in the One Ocean *Protocol for Seismic Survey Programs in Newfoundland and Labrador,* have been and remain the best means for ensuring that such activities are carried out in a safe and environmentally responsible manner. These measures are aimed at avoiding or reducing adverse interactions between offshore geophysical programs and other users of the marine environment, and are widely used (and effective) in the marine environment off Newfoundland and Labrador.

As outlined in detail in Section 5.3, this involves planned communications and coordination procedures involving the Operator/Contractor and relevant regulatory authorities, stakeholders and key ocean users throughout the operational life of the Project, including:

- On-going information gathering on key fishing areas and times and continued monitoring of fishing and fish survey activity;

- The presence, active participation and advice of the FLO on board the seismic ship, and a shore-based SPOC;

- The issuance of Notices to Mariners/Shipping and other notifications and direct industry communications throughout the periods of Project operations, and regular communication of planned survey activities with key industry representatives;

- The use of a standby or guard vessel to scout for hazards and for communicating with active fishers in the area (if any); and

- Establishment and implementation of a Fishing Gear Damage or Loss Compensation Program.

As noted in Section 5.3, the proposed survey activities will also be planned and implemented to avoid negative interactions with fisheries research surveys in the Study Area, through active and on-going communication and coordination with DFO and industry representatives.

The area of interest for the planned geophysical surveys is offshore, and the limited amount of vessel activity that will or may take place in coastal locations (such as crew changes or re-supply) will occur at existing and established commercial ports. The Project is therefore not expected to interact with, or otherwise adversely affect, other human activities that occur on land or near shore, including relevant recreational activities such as hunting, fishing and other pursuits.

5.9.3.2 Seismic Sound and Other Potential Emissions (Routine or Accidental)

As described for the various preceding biophysical VECs, offshore seismic activities may, to varying degrees, result in a degree of localized and temporary avoidance or other disturbances to certain marine species, including commercially important fish species or other biota. A considerable amount of research has been conducted on the effects of offshore seismic surveys (of various types and intensities) on marine species. This has included scientific research, monitoring studies and anecdotal reports of observed reactions, which range from no change, to behavioural effects (such as avoidance, other changes in vertical or horizontal distribution or other activities) to possible injury to or mortality of individual fish (DFO 2004). With regard to any resulting implications for commercial fisheries, as summarized in Table 5.2, a number of studies cite seismic activity as the cause of decreased fish abundance and catches, with such effects at times being evident within several kilometres of the sound source and continuing for a day or more after the cessation of seismic activity. Other studies have shown that catches for some species/gear types have increased during seismic activity whereas others have been observed to decrease. Still other studies have suggested, however, that seismic airguns have had little or no such apparent behavioural effects on fish or fish catches (Table 5.2).

Any such biophysical effects to marine resources could potentially result in a subsequent change in the nature, quality and/or value of one or more of the marine activities that utilize or depend upon them (economic or otherwise). As described throughout this Chapter, the proposed Project is not expected to result in detectable (and certainly, not significant) adverse effects upon marine fish, birds, mammals, reptiles or their habitats. Although the underwater noise and other potential interactions that will be associated with the Project have the potential to interact with marine biota, these activities will be undertaken in strict compliance with relevant standards and guidelines that pertain to vessel traffic, waste management, and other potential environmental discharges and emissions. This includes the mitigation measures that are typically required and implemented for such programs in the Canada-NL Offshore Area as conditions of regulatory approvals and which have been committed to by Nexen in this EA, in addition to the other measures described in Section 5.3. Any disturbance to marine biota will be localized and of very short-term duration at any one location. It is therefore unlikely that any individuals will be displaced from key habitats or usage (harvesting) areas for extended periods, or be otherwise affected or disrupted in a manner that causes effects on the overall availability or quality of a marine resource.

Similarly, because the proposed Project will not result in the recovery of petroleum from the seabed, the potential for, and possible size and magnitude of, an accidental spill is much lower than for other types of offshore oil and gas activities - about the same potential as for a fishing ship. As discussed in Chapter 2, however, adequate and appropriate spill prevention and response measures will be in place for the duration of Project operations.

A summary of the predicted (residual) environmental effects of the Project on marine fisheries and other activities is provided in Table 5.17 below.

Table 5.17 Marine Fisheries and Other Activities: Residual Environmental Effects Assessment Summary

Project Activity and Potential Effect(s)	Environmental Effect Descriptors						
	Nature	**Magnitude**	**Extent**	**Duration**	**Frequency**	**Reversibility**	**Certainty**
Presence and Use of Vessels/Aircraft and Equipment • Disturbance	A	L	2	1	1	R	H
Seismic Sound • Disturbance	A	N	2	1	1	R	H
Seabed and Environmental Sampling Activities • Disturbance	A	N	1	1	1	R	H
Air Emissions • Contamination	N	-	-	-	-	-	H
Lighting • Disturbance	N	-	-	-	-	-	H
Solid Waste • Contamination	N	-	-	-	-	-	H
Liquid Waste • Contamination	A	N	2	1	1	R	H
Potential Accidental Events • Potential injury • Contamination	A	L	2	1	1	R	H
Onshore Supply and Servicing	N	-	-	-	-	-	H

Overall, Resulting Effect(s) of Project on the VEC	**Evaluation of Significance**
• The Project is not anticipated to affect the overall intensity, distribution (spatial or temporal) or value of marine fisheries or other marine activities in the Study Area.	• The proposed Project is not likely to result in significant adverse environmental effects on marine fisheries and other activities.

Nature/Direction:	**Magnitude**:	**Geographic Extent**:	**Duration**:	**Frequency**:
A = Adverse N = Neutral or No Effect P = Positive	N = Negligible or No Effect L = Low M = Medium H = High	1 = < 1 km^2 2 = 1-10 km^2 3 = 11-100 km^2 4 = 101-1,000 km^2 5 = 1,001-10,000 km^2 6 = >10,000 km^2	1 = < 1 month 2 = 1-12 months 3 = 13-36 months 4 = 37-72 months 5 = > 72 months	1 = <11 events/year 2 = 11- 50 events/year 3 = 51-100 events/year 4 = 101-200 events/year 5 = >200 events/year 6 = Continuous

Project Activity and Potential Effect(s)	Environmental Effect Descriptors						
	Nature	**Magnitude**	**Extent**	**Duration**	**Frequency**	**Reversibility**	**Certainty**
Reversibility: R = Reversible I = Irreversible	**Certainty in Prediction:** L Low M Moderate H High						

NOTES

- In all cases, the above referenced effect descriptors refer to the resulting potential environmental effect to a particular environmental receptor, not to the Project activity or associated disturbance that creates the effect.
- The residual environmental effects predictions that are summarized above include integral consideration of the mitigation measures described in the preceding sections and in detail in Section 5.3

As described above, and with the implementation of the mitigation measures identified in this EA Report, the proposed Project is not likely to result in significant adverse environmental effects on marine fisheries and other activities.

5.9.4 Cumulative Environmental Effects

Fisheries and other human activities in the marine environment may be affected both individually and collectively by offshore oil and gas exploration and production activities, general marine traffic and other activities and associated disturbances. Each of these may result in, for example, direct disturbance to such activity, damage to equipment, effects on marine resources and/or other disturbances, and these effects may accumulate or interact on a regional scale to result in cumulative environmental effects. The rather dynamic nature of fishing and other marine based activity throughout the region (in terms of locations, seasons, gear types and key species) makes it difficult to predict specific areas and times from year to year for both domestic and foreign fleets, and thus, the potential for interactions between separate projects, activities and their effects.

The often spatially extensive nature of seismic surveys, along with the somewhat widespread nature of some other marine uses (both geographically and seasonally), increases the potential for fishing enterprises and other pursuits to be affected by multiple projects and activities in a region. The potential for interference by offshore oil and gas installations and vessels as well as general marine traffic can, however, be mitigated through good communication and cooperation between industries and the various mitigation measures outlined above and detailed in Section 5.3. These include the planning and mitigation measures and procedures outlined in this EA, through which the proposed seismic survey will be planned and implemented to reduce the potential for adverse interactions with other human activities. Although an unlikely and relatively infrequent occurrence, damage to gear, vessels or other marine assets would also be managed through applicable compensation policies and procedures.

As a result, the proposed Project is not likely to result in significant adverse cumulative environmental effects on this VEC in combination with other projects and activities that have been or will be carried out. Moreover, the relative contribution of this Project and its potential effects to any overall, cumulative effects on this VEC will be very low, and will not likely be perceptible.

5.9.5 Environmental Monitoring and Follow-up

As documented previously in this Chapter, Nexen has committed to a number of measures and on-going processes to avoid or reduce the potential for adverse interactions with, and effects upon, fisheries and other marine activities and users. This includes on-going communication and cooperation mechanisms throughout the operational life of this Project (Section 5.3). These are intended to allow for an on-going discussion of Project related activities and any issues as they may arise during Project implementation, and to cooperatively and collaboratively plan and implement any required (adaptive) management measures throughout the life of the Project.