Environmental Assessment Update (2019) of Multiklient Invest Newfoundland Offshore Seismic Program, 2018–2023

Prepared by

LGL LIMITED
environmental research associates

Prepared for

Multiklient Invest AS

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TGS-NOPEC Geophysical Company ASA

April 2019
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1.0 Introduction

This document is an Update of the Environmental Assessment (EA) of the Multiklient Invest AS (MKI) Newfoundland Offshore Seismic Program, 2018–2023 (LGL 2018a) and the associated Addendum (LGL 2018b). In 2019, MKI is proposing to conduct 2D and 3D seismic surveying in the Newfoundland Offshore Project Area (Figure 1.1). The EA Update document addresses the validity of the EA (Table 1.1) as it pertains to MKI's proposed seismic survey activities in 2019. The EA Update is intended to assist the Canada-Newfoundland and Labrador Offshore Petroleum Board (C-NLOPB) in its regulatory review process by demonstrating that both the scope of the assessment and the mitigation measures to which MKI previously committed remain technically valid for proposed seismic survey operations in 2019. A previous EA Update associated with this program was prepared in 2018 (LGL 2018c).

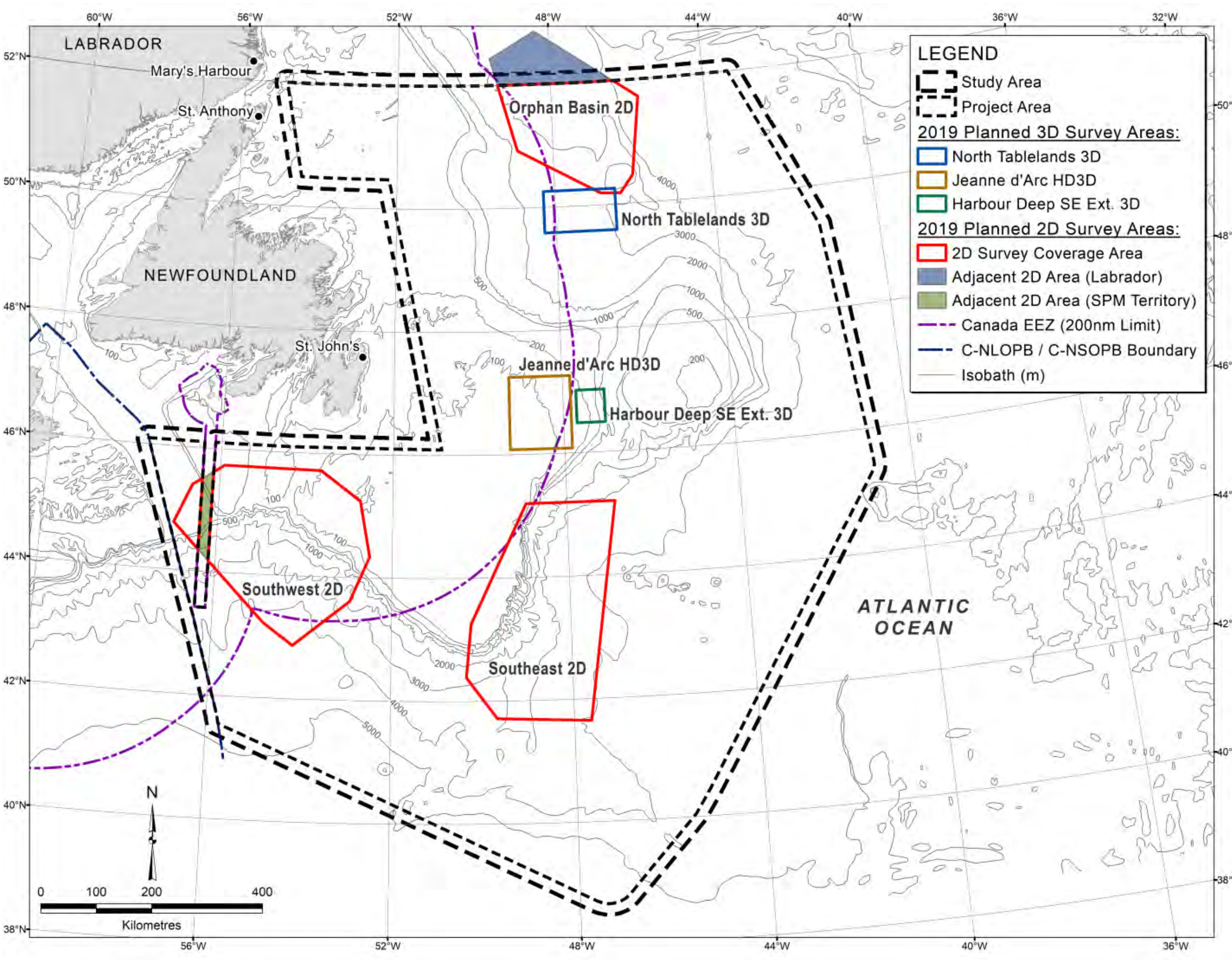


FIGURE 1.1. Locations of the Project Area, Study Area and 2019 Planned 2D and 3D Survey Areas for MKI's Newfoundland Offshore Seismic Program.

TABLE 1.1. Environmental Assessment documents for the MKI Newfoundland Offshore Seismic Program, 2018–2023. Screening determination reference number C-NLOPB File No. 45006-020-005.

Temporal Scope	EA Document
May 1 to November 30, 2018–2023	Environmental Assessment of Multiklient Invest Newfoundland Offshore Seismic Program, 2018–2023 and EA Addendum (LGL 2018a,b)[a]
May 1 to November 30, 2018	Environmental Assessment Update (2018) of the Multiklient Invest Newfoundland Offshore Seismic Program, 2018–2023 (LGL 2018c)

[a] On 15 May 2018, the C-NLOPB made a positive determination on this EA and EA Addendum.

The following sections provide the information necessary to confirm the validity of the EA and its associated documents (see Table 1.1), including assessment of the potential effects of 2D and 3D seismic survey activities within the defined Project Area (see Figure 1.1) on the following Valued Environmental Components (VECs): Fish and Fish Habitat; Fisheries; Marine-Associated Birds; Marine Mammals and Sea Turtles; Species at Risk; and Sensitive Areas. This Update includes new and relevant information not included in the EA and its associated documents.

2.0 Project Description

2.1 Vessels and Equipment

The EA assessed a project that included a maximum of four simultaneous seismic surveys within a given year: three 3D surveys and one 2D survey. For 2019, MKI will conduct three simultaneous surveys; 2D surveys with the MV *Sanco Atlantic* and 3D surveys with the MV *Ramform Atlas* and MV *Ramform Titan*. All project description parameters described in the EA are applicable to MKI's 2019 activities. However, specific details for 2019 are provided in Section 2.4.

2.2 Spatial Scope

The Project and Study areas defined in the EA (LGL 2018a) remain unchanged (see Figure 1.1).

2.3 Temporal Scope

The temporal scope defined in the EA (LGL 2018a) as 1 May–30 November during each year of the 2018–2023 period remains unchanged.

2.4 Seismic Survey Activities Planned for 2019

In 2019, MKI plans to conduct 2D and 3D seismic surveying in the Project Area. A maximum of three seismic survey vessels will be used in 2019. MKI is proposing to conduct approximately 11,705 km^2 of 3D and 12,150 km of 2D seismic surveying in the Project Area in 2019 (see Figure 1.1). There are three 3D survey areas and three 2D survey areas identified in the Project Area for 2019 (see Figure 1.1).

In 2019, MKI will use the MV *Ramform Atlas* and MV *Ramform Titan* for the 3D seismic surveying and the MV *Sanco Atlantic* for the 2D seismic surveying. The *Ramform Atlas* and *Ramform Titan* are sister ships, both built in 2013 and flagged in the Bahamas (Figure 2.1 and Figure 2.2). Both the *Atlas* and *Titan* are 104.2 m long, with a beam of 70 m and a draft of 6.4 m. The vessels will travel at a speed of ~9 km/h (4.9 knots) while conducting the 3D seismic surveying. The MV *Sanco Atlantic* (Figure 2.3) (formerly called the *Atlantic Explorer*) is 91.3 m in length, 17.4 m wide, and has a draft of 8.4 m. The vessel will travel at a speed of ~8.3 km/h (4.5 knots) while conducting the 2D seismic surveying.

All other project details presented in Section 2.0 of the EA remain applicable to MKI's seismic survey activities in 2019.

Figure 2.1. MV *Ramform Atlas.*

Figure 2.2. MV *Ramform Titan.*

FIGURE 2.3. MV *Sanco Atlantic.*

2.4.1 Seismic Energy Source Parameters

For 3D seismic surveying MKI will use a 4130 in^3 array, operated at a pressure of 2000 psi, towed at either 7 m or 9 m depth. The shotpoint interval will be one array pulse every 18.75 m or 25 m. For 2D seismic surveying MKI will use a 4880 in^3 array, operated at a pressure of 2000 psi, towed at 9 m depth. The shotpoint interval will be one array pulse every 31.25 m.

2.4.2 Seismic Streamers

The *Ramform Atlas* will tow 12 or 14 streamers each 9 km in length. The streamers will be spaced 75 m apart for a total maximum spread of ~8.8 km^2. The *Ramform Titan* will tow 16 streamers each 8.1 km in length. The streamers will be spaced 100 m apart for a total spread of 12.2 km^2. The *Sanco Atlantic*'s streamer will be 10.05 km in length. Streamers will be towed at depths ranging from 9–25 m.

2.4.3 Support Vessels

Five vessels will be used to support the 3D and 2D seismic surveys in 2019. The MV *Thor Magni* and MV *Thor Freyja* will be used as support vessels. The MV *Coriolis II*, *Strait Hunter*, and *Blain M* will perform escort vessel duties. The operational objective is to have one of these vessels available with each seismic vessel and the two support vessels will be used to fill in for escort duties when required.

2.4.4 Survey Locations and Timing

The planned timing of MKI's 3D and 2D surveys in the Project Area is summarized in Table 2.1. The maximum number of MKI seismic vessels acquiring data within the Project Area as part of the Project at any given time would be three; this is planned to occur during June–July. The *Ramform Atlas* will survey the Jeanne d'Arc HD3D survey area and the *Ramform Titan* will survey the North Tablelands survey area. The Harbour Deep SE Extension is considered an optional 3D survey area and if surveying occurs there it would be conducted by the *Ramform Atlas*, which would move from the Jeanne d'Arc HD3D survey area. Note that a portion of the Orphan Basin 2D survey area falls outside of the Project Area boundary but the two-week duration shown in Table 2.1 encompasses the entire survey period.

TABLE 2.1. Planned timing of MKI's 2019 seismic survey activities in the Project Area.

	May (week)		June (week)				July (week)				Aug (week)				Sep (week)			
3D Survey Area	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4
North Tablelands																		
Jeanne d'Arc HD3D																		
Harbour Deep SE Ext.																?	?	?
	May (week)		June (week)				July (week)				Aug (week)				Sep (week)			
2D Survey Area	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4
2D Southwest																		
2D Southeast																		
2D Orphan Basin																		

2.5 Mitigation Measures

Mitigation measures to be implemented during seismic surveys carried out for this Project will follow those described in the EA (LGL 2018a,) and its Addendum (LGL 2018b), and defined in Appendix 2 of *Geophysical, Geological, Environmental and Geotechnical Program Guidelines* (C-NLOPB 2018). These include ramp-up (i.e., soft start) of the airgun arrays, the use of qualified and experienced, dedicated Marine Mammal Observer(s) (MMOs) to monitor marine mammals and sea turtles and implement shut downs/ramp up delays of the airgun array when appropriate, and the use of a Fisheries Liaison Officer (FLO) and communication procedures to avoid conflicts with fisheries. Seabird observations and monitoring/mitigation for stranded birds will also be carried out by qualified experienced personnel (Seabird Observers, SBOs) according to established Canadian Wildlife Service (CWS) protocols aboard each of the seismic vessels.

As was done during the 2018 MKI 3D surveys, Passive Acoustic Monitoring (PAM) will be used during the pre-ramp up watch and during periods when visibility is <500 m in order to detect cetacean vocalizations. Further details are provided in Table 6.1.

3.0 Physical Environment

A summary of the physical environment was provided in Section 3.0 of the EA (LGL 2018a). There is no new relevant information available on the physical environment in the Study Area.

4.0 Biological Environment and Fisheries

The EA and associated Addendum (LGL 2018a,b) were submitted in March and April 2018, respectively. The Addendum addressed comments and data gaps identified by reviewers of the EA. The following subsections present new information on each of the VECs: Fish and Fish Habitat, Fisheries, Sea-Associated Birds, Marine Mammals and Sea Turtles, Species at Risk, and Sensitive Areas.

4.1 Fish and Fish Habitat

New information is included for key points regarding plankton, oceanic conditions, benthic invertebrates, and fish species within the Study Area. The new information presented here does not change the effects predictions made in the EA (LGL 2018a).

4.1.1 Plankton

The Atlantic Zone Monitoring Program (AZMP) was implemented by DFO in 1998 in order to better understand, describe and forecast the state of the marine ecosystem. A critical element of the AZMP is an observation program designed to assess the variability in nutrients, phytoplankton and zooplankton (DFO 2018a). The AZMP findings in relation to oceanographic conditions in the Study Area for 2017 are summarized below.

- Winter sea surface temperatures were below normal on the Southeast Grand Banks (Northwest Atlantic Fisheries Organization [NAFO] Division [Div.] 3N) throughout ice-free months and there was a record low in June 2017;
- Summer cold intermediate layer conditions were above normal on the Flemish Cap;
- Nitrate inventories across the Newfoundland Shelf were mostly below normal, except for the Grand Banks, but have shown signs of recovery from the record lows detected in 2013;
- Annual chlorophyll *a* inventories were below normal on the Grand Banks;
- The onset of the spring phytoplankton bloom was delayed on the Newfoundland Shelf and once it was established, the bloom continued for an extended period of time;
- Biomass of zooplankton was generally below normal, and the strongest negative anomalies were on the Newfoundland Shelf;
- Higher than average abundances of *Calanus finmarchicus* (a copepod species) were observed on the southern Grand Banks;
- *Pseudocalanus* sp. were more abundant than average between the Newfoundland and Labrador shelf and were observed at record highs on the southern Grand Banks; and
- Higher than average abundances of non-copepods (e.g., larval stages of benthic invertebrates and carnivorous groups that feed on other zooplankton) were observed on the Newfoundland and Labrador Shelf.

4.1.2 Benthic Invertebrates

There have been no further updates on benthic invertebrates, including corals and sponges, since the information presented in subsection 4.2.1.2 of LGL (2018a).

4.1.3 Fish

As in the EA, 'fish' includes macro-invertebrates that are targeted in the commercial fisheries and all fishes, either targeted in the commercial fisheries or otherwise. The focus is on key commercially- and ecologically-important fishes.

4.1.3.1 Principal Macro-invertebrates and Fishes Commercially Harvested

Macroinvertebrates

Snow Crab

Snow crab landings in NAFO Div. 3K declined by 66% since 2009 to 5,450 t in 2017, a time-series low; however, recruitment increased from 2016–2017 in post-season trap and trawl surveys and was expected to further increase in 2018. The exploitable biomass primarily consisted of incoming recruits (50–75%) and there were few old-shelled crabs (DFO 2018b). Offshore Div. 3LNO landings were the lowest on record for 20 years as they decreased by 26% from 2016 to 18,050 t in 2017. Recruitment and exploitable biomass have both been at or near time-series lows and there was no expectation of increased levels in 2018 (DFO 2018b). In 2017, inshore Div. 3L landings declined by 29% to 6,000 t from 2015, which was a historical high, and the exploitable biomass index decreased by 73% since 2012, resulting in a time-series low in 2017 (DFO 2018b). Landings in Div. 3Ps decreased to a time-series low of 1,200 t from a peak of 6,700 t recorded in 2011. The Total Allowable Catch (TAC) has not been reached in eight years and effort declined by 44% since 2014. The exploitable biomass index in 2016 was a time-series low but recovered slightly in 2017 and recruitment was expected to improve in 2018 (DFO 2018b). In 2019, the TAC for Newfoundland and Labrador region is 26,894 t which includes a 1% decrease in 3K, a 26% decrease in offshore 3LNO and a 15% decrease inshore 3LNO, and a 48% in 3Ps (DFO 2019a).

Northern Shrimp

Bottom trawl surveys conducted in NAFO Div. 3M on the Flemish Cap showed that total biomass indexes increased from 2016–2017 by 14% and by 52% from 2017–2018. The total biomass for 2018 was estimated at 4,394 t and the total female biomass was 4,051 t (Casas 2018). Trawl surveys conducted by the Spanish Institute of Oceanography estimated total biomass to be 3.02 t in 2017 in NAFO Div. 3NO and 12,893 t in 3L, a decrease of 36% since 2016 (Casas et al. 2017). The TAC for SFA (Shrimp Fishing Area) 6 was reduced for the 2018/19 season by 16.06% to 8,730 t to achieve a 10% exploitation rate (DFO 2019b). SFA 7 (NAFO Div. 3L) was closed in 2018 and is to remain closed for the 2019 season as per a NAFO decision (DFO 2019c).

Cockles

There have been no further updates since the information presented in subsections 4.2.2.1 and 4.3.3.2 of LGL (2015b) and 4.2.2.1 of LGL (2018a).

Stimpson's Surf Clam

On the Grand Bank (NAFO Div. 3NO) there is one vessel fishing for Stimpson's surf clam (Arctic surf clam) and two other licenses issued to vessels on the Banquereau Bank Fishing Area (Div. 4Vs). The fishery is mainly managed by limited entry licenses and the TAC is divided by allocation between enterprises, i.e., dockside monitoring, mandatory logbooks, and the VMS coverage is 100% industry-funded (DFO 2014, 2018c). In 2017, the TAC on the Grand Bank was 14,756 t; however, only 13,738 t were landed and there were no at-sea Fisheries Observer trips during this season (DFO 2018c). In 2019, the TAC remains at 14,576 t (DFO 2019d). Transfers of quotas are permitted between license holders within a fishing season (DFO 2018c).

Recent bycatch data for the species are not available; however, in 2009 catch data showed that surf clam made up 24.7% of total catch but Greenland cockle *(Serripes groenlandicus)* and northern propeller clam *(Cyrtodaria siliqua)* made up significant portions of the catch (21.1% and 18.3%, respectively). The Greenland cockle and the northern propeller clam qualify as minor retained species in this fishery (DFO 2010; Knapman et al. 2017).

Atlantic Halibut

Landings from 2016 within NAFO Div. 3NOPs were 1,071 t and preliminary landings from 2017 show that 370 t were caught within these divisions. The total landings within 3NOPs4VWX5Zc were 2,324 t compared to the TAC of 3,621 t (DFO 2018d).

Atlantic Cod

The population of the Northern cod stocks in NAFO Div. 2J3KL has remained low after the collapse and moratorium in 1992 but has shown signs of increasing in the last 10 years from an estimated population of 227 million in 2005 to 795 million in 2017 (DFO 2018e). The spawning stock biomass did initially increase from 26 kt in 2005 to 441 kt in 2017; however, it decreased in 2018 to 315 kt (DFO 2018e). In NAFO Div. 3Ps, 4,862 t was taken by Canada and 169 t was landed by France during the 2017–18 season (DFO 2019e). The spawning stock biomass for 2018 is estimated to be in the Cautious Zone due to very old fish in the population (8+ years) and the presence of strong recruitment cohorts in 2011 and 2012. Of the fish currently in the spawning stock, >70% is made up of ages 6–7 years. Spawning stock biomasses for 2020 and 2021 in 3PS are expected to be lower than those observed in 2018 (DFO 2019f). The TAC for Atlantic cod in NAFO Div. 3Ps was set at 6,500 t for the 2017–18 season and 5,980 t for 2018/19 (DFO 2019f).

American Plaice

There has been a moratorium on American plaice in NAFO Div. 3Ps (DFO 2019f) and 3LNO since 1995 and the last TAC set was 8,400 t in 1994 (Wheeland et al. 2018). Bycatch of American plaice within 3LNO is mainly from skate, redfish, and Greenland halibut fisheries and the yellowtail flounder fishery within the Canadian EEZ (Wheeland et al. 2018).

Yellowtail Flounder

The TAC for yellowtail flounder has been set at 17,000 t since 2009 in NAFO Div. 3LNO (Parsons et al. 2015; NAFO 2018, 2019).

White Hake

The TAC for white hake in NAFO Div. 3Ps for 2018/19–2020/21 is 500 t. This is the first time a TAC for white hake has been implemented (DFO 2019g).

Redfishes

The TAC for redfish in Unit 2 (NAFO Div. 3Ps, 4Va, a portion of 4W, and 3Pn + 4Pn) for the 2018–19 season is 8,500 t and the fishing season is open from 1 June–31 December. Of the Canadian commercial quota, 1,500 t is set aside for an industry-led biennial scientific survey that is implemented under Section 10 of the *Fisheries Act* (DFO 2019h).

4.1.3.2 Other Fishes of Note

Capelin

Landings in NAFO Div. 3KL and Sub-Area 2 in 2017 were 19,917 t, a decrease from 2016 and 2015 (27,708 t and 23,065 t, respectively) (DFO 2018f). In 2018, landings from 3KL were approximately 18,976 t (DFO 2019i). Since 2015, spawning times have been delayed, which has been associated with poor cohort strength. Larval index is expected to be low in 2019, which will negatively affect recruitment (DFO 2018f; Murphy et al. 2018).

Wolffishes

A proposed Recovery Strategy has been prepared for the northern *(Anarhichas denticulatus)* and spotted wolffish *(A. minor)*, and a Management Plan has been proposed for the Atlantic wolfish *(A. lupus)* (DFO 2018g). The proposed critical habitat for northern wolfish is located within NAFO Div. 2HJ3KLPsPn4RS and within 2J3KLPsPn4RS for spotted wolffish (DFO 2018g; see Section 4.6 for additional details).

Swordfish

The total landings for swordfish in Newfoundland were 23 t in 2017, which was the first record of landings for this species since 2008 (DFO 2017).

Anadromous Fishes

The estimated number of Atlantic salmon retained by the recreational fishery throughout Newfoundland and Labrador in 2017 was 19,396 fish, down from 30,056 in 2016. In 2017, the estimated number of Atlantic salmon taken during Indigenous fisheries was 13,572 fish, a small increase from 13,240 fish taken in 2016 (DFO 2018h).

4.2 Fisheries

The new information presented in this subsection does not change the effects predictions made in the EA (LGL 2018a) or its associated addendum (LGL 2018b).

4.2.1 Commercial Fisheries

Results of analyses of the May–November 2016 and 2017 domestic commercial fisheries landings data did not indicate any major differences in distribution of harvest locations as compared to May–November 2005–2010, 2014, and 2015 (see Figures 4.5–4.8 of LGL 2015a,b, Figure 4.1 of LGL 2016, Figure 4.5 of LGL 2018a, and Figure 4.1 below). The distribution of May–November 2016 and 2017 harvest locations for snow crab, northern shrimp, Atlantic halibut, Greenland halibut, and Atlantic cod is shown in Figures 4.2–4.12. Most of the harvesting in the Study Area was conducted in the western portion of the Study Area, in areas where water depths were <1,000 m, including the northeastern and southeastern portions of the planned Jeanne d'Arc HD3D 2019 survey area, northern and western portions of the Harbour Deep SE Ext. 3D survey area, the northern portion of the Southwest 2D survey area, and the western portion of the Southeast 2D survey area. There were no catches within the North Tablelands 3D or Orphan Basin 2D survey areas during May–November 2016 or 2017, or within the adjacent 2D area within Saint Pierre and Miquelon Territory during May–November 2016.

Catch weight and value quartile counts by vessel length classes and species harvested in the Study Area and planned 2019 3D and 2D survey areas during May–November 2016 and 2017 are presented in Tables 4.1–4.6. Commercial harvests within the Study Area during May–November 2016 and 2017 were caught by fishers from NL (~80%) and Nova Scotia (NS) (~20%). During 2017, fishers from New Brunswick caught 0.03% of the total harvest. Harvests within the Jeanne d'Arc HD3D, Harbour Deep SE Ext. 3D, and Saint Pierre and Miquelon Adjacent 2D 2019 survey area were only taken by fishers from NL. Fishers from NL and NS caught ~60% and ~40%, respectively, of the harvest in the Southwest 2D 2019 survey area. Harvest within the Southeast 2D 2019 survey area was taken only by fishers from NL during May–November 2016, and by fishers from NL (~80%) and NS (~20%) during May–November 2017.

As in recent years, snow crab (32% of total catch in the Study Area in terms of total catch weight quartile codes during May–November 2016 and 2017 combined), northern shrimp (12%), and Atlantic halibut (9%) dominated the commercial catches in the Study Area, followed by Greenland halibut (7%) and Atlantic cod (6%). Other notable species caught commercially in 2016/2017 included redfish (5%), yellowtail flounder (5%), white hake (4%), and American plaice (4%). Northern shrimp harvest decreased within the Study Area during May–November 2017 relative to recent years, to nearly half of the annual total quartile code counts reported since 2014 (see Tables 4.7–4.8 *in* LGL 2018a and Table 4.1 below).

Snow crab, Stimpson's surf clam, propeller clam and cockle were harvested during May–November 2016 in the Jeanne d'Arc HD3D 2019 survey area, while only snow crab were harvested during 2017 (Table 4.2). Only snow crab were harvested within the Harbour Deep SE Ext. 3D 2019 survey area during May–November 2016 and 2017 (Table 4.3). Harvests mainly consisted of white hake, Atlantic halibut, and Atlantic cod within the Southwest 2D 2019 survey area during May–November 2016 and 2017 (Table 4.4). Commercial harvests within the Saint Pierre and Miquelon Adjacent 2D 2019 survey area included redfish, Atlantic halibut and pollock during May–November 2017 (Table 4.5). Harvests within the Southeast 2D 2019 survey area mainly included snow crab, clams and cockle during May–November 2016 and 2017 (Table 4.6).

In the Study Area during May–November 2016 and 2017, snow crab and northern shrimp were mainly harvested by vessels of the length class 45–64.9'. Atlantic halibut, Atlantic cod, and Greenland halibut were mainly caught by 35–44.9', 45–64.9', and ≥125' vessels. Redfish were mostly harvested by 45–64.9' and ≥125' vessels, while yellowtail flounder and American plaice were mainly caught by vessels ≥125'. White hake were primarily harvested by vessels 35–44.9' and 45–64.9' in length (Table 4.1). Commercial harvests within the Jeanne d'Arc HD3D 2019 survey area were mainly conducted by vessels 45–64.9', followed by vessels 65–99.9' and ≥125' (Table 4.2). Most of the harvest in the Harbour Deep SE Ext. 3D 2019 survey areas was caught by vessels 45–64.9', with lesser amount of the catch taken by vessels 65–99.9' (Table 4.3). Commercial catches within the Southwest 2D 2019 survey area were mainly taken by vessels between 35' and 64.9', followed by vessels ≥125' and 65–99.9' (Table 4.4). All commercial harvests within the Saint Pierre and Miquelon Adjacent 2D 2019 survey area were caught by vessels 45–64.9' (Table 4.5). Harvests within the Southeast 2D 2019 survey areas were mainly caught by vessels ≥125' and 45–64.9', followed by vessels 100–124.9' and 65–99.9' (Table 4.6).

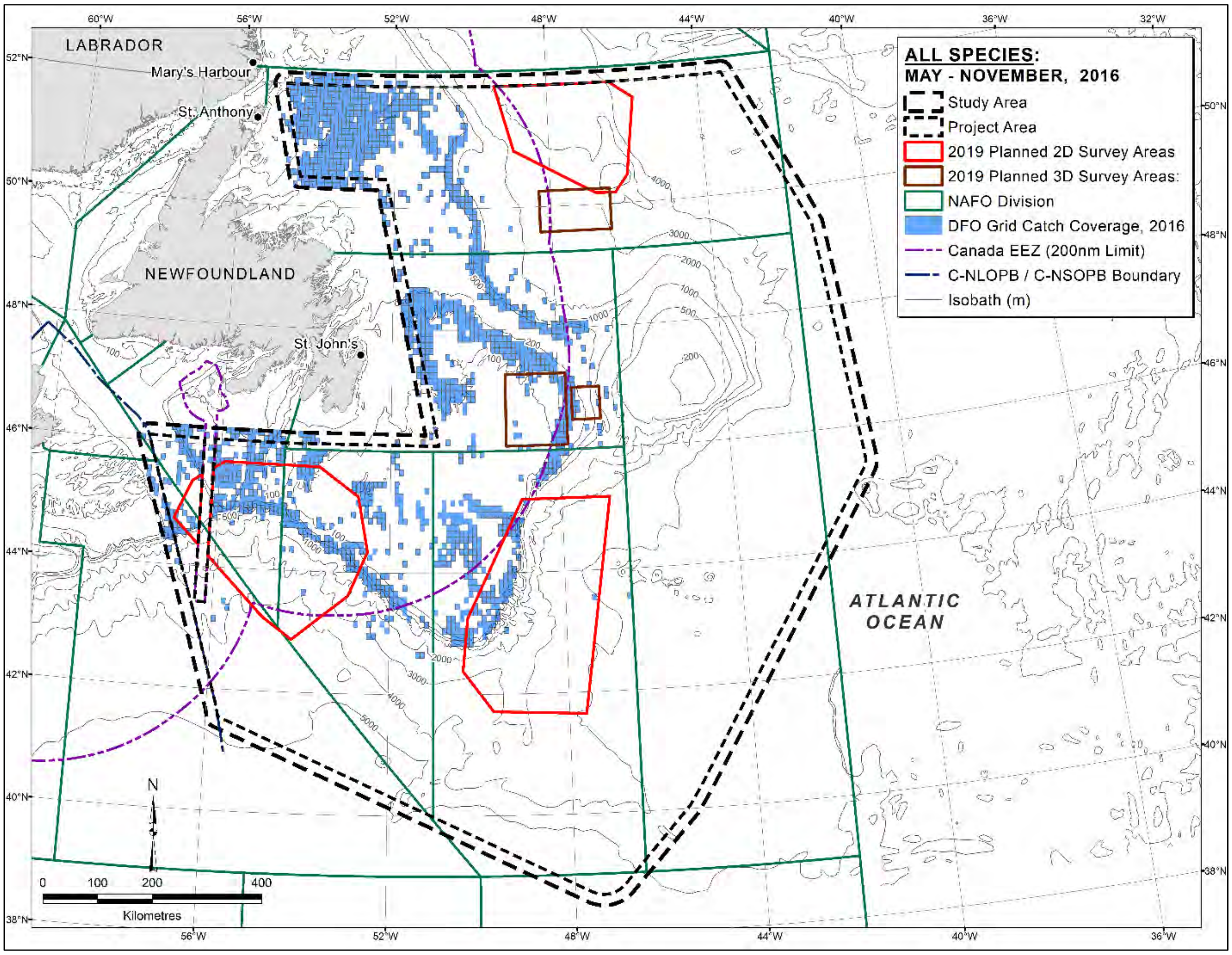


FIGURE 4.1. Distribution of commercial fishery harvest locations, all species, May–November 2016 (derived from DFO commercial landings database, 2016).

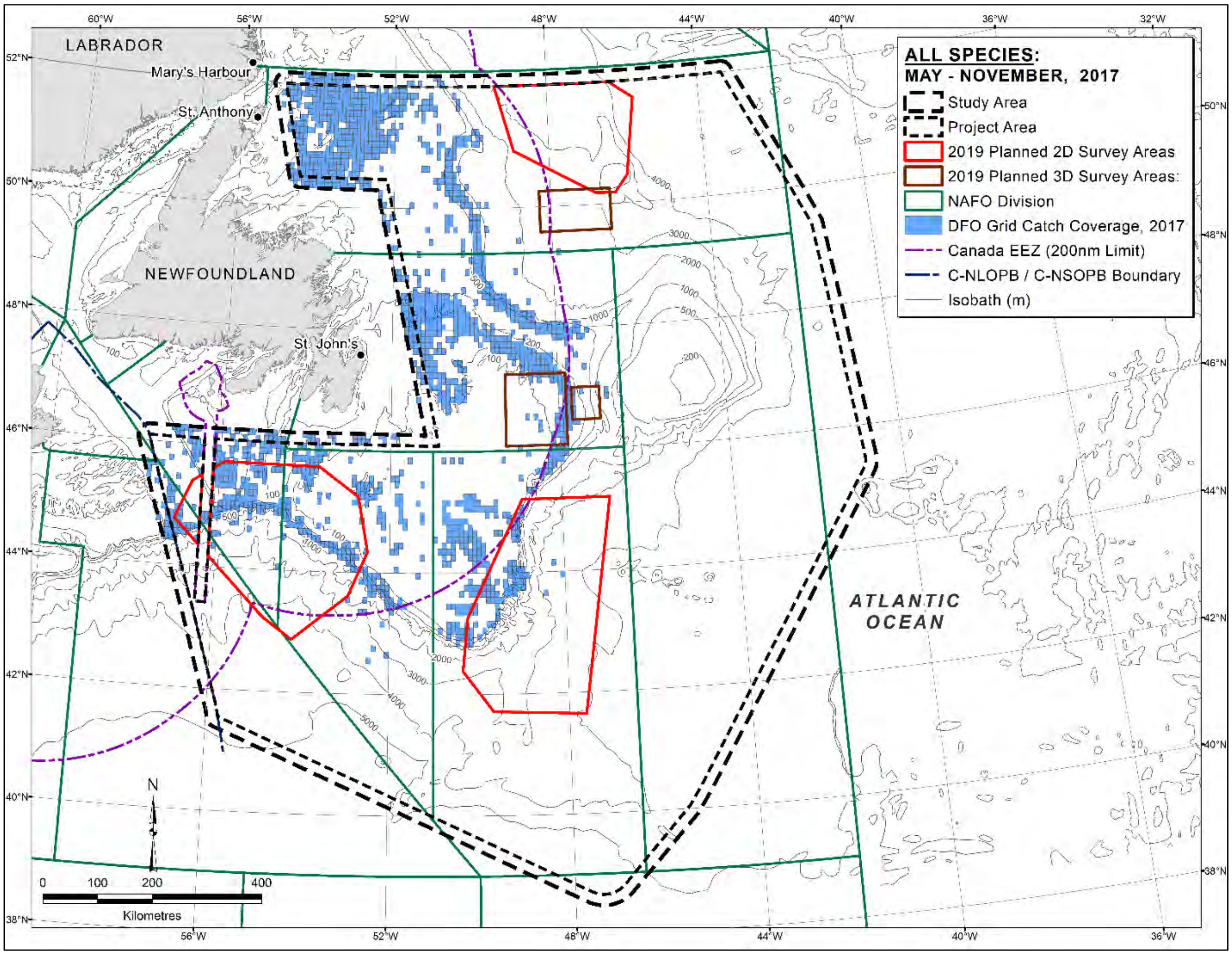


FIGURE 4.2. Distribution of commercial fishery harvest locations, all species, May–November 2017 (derived from DFO commercial landings database, 2017).

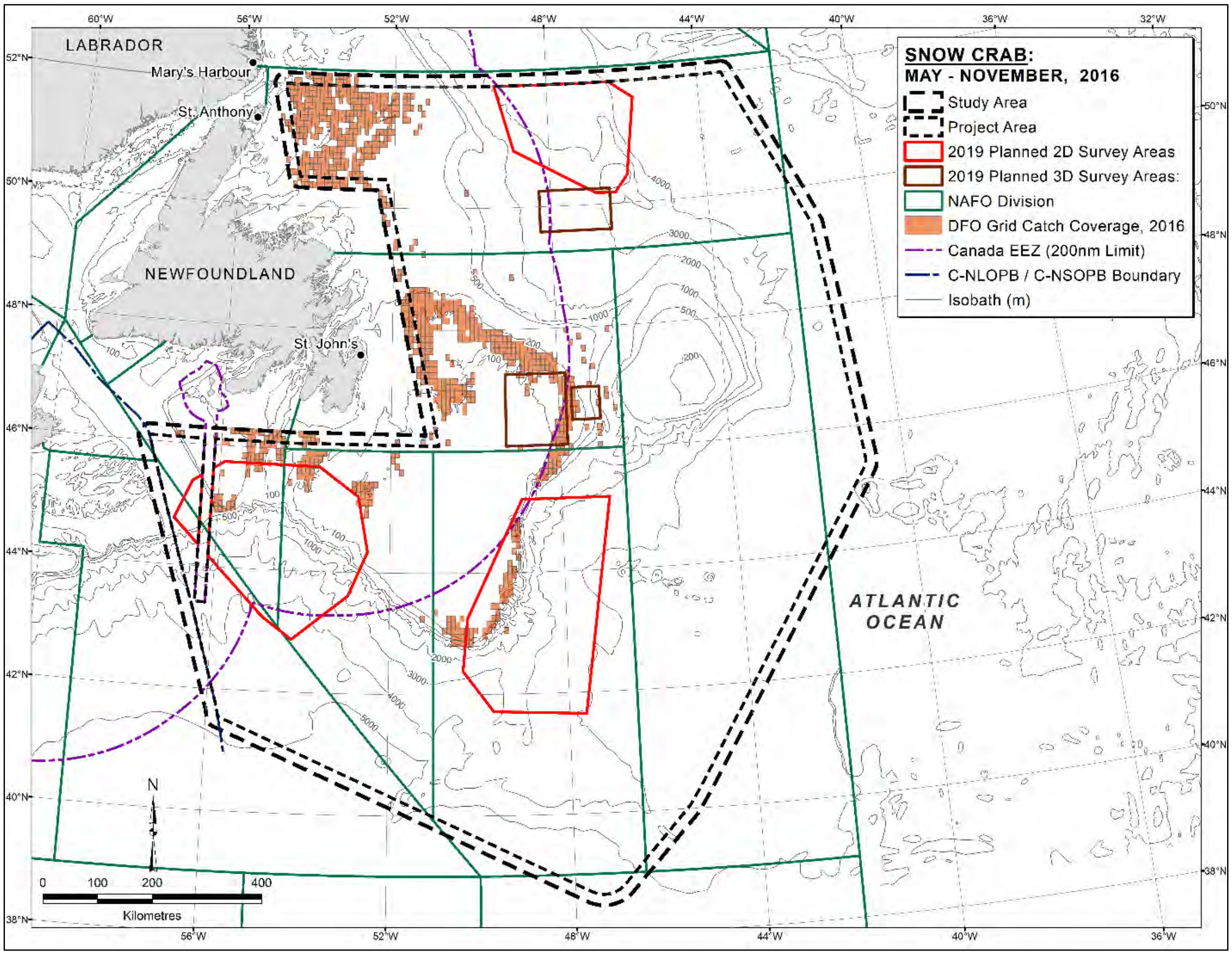


FIGURE 4.3. Distribution of commercial fishery harvest locations, snow crab, May–November 2016 (derived from DFO commercial landings database, 2016).

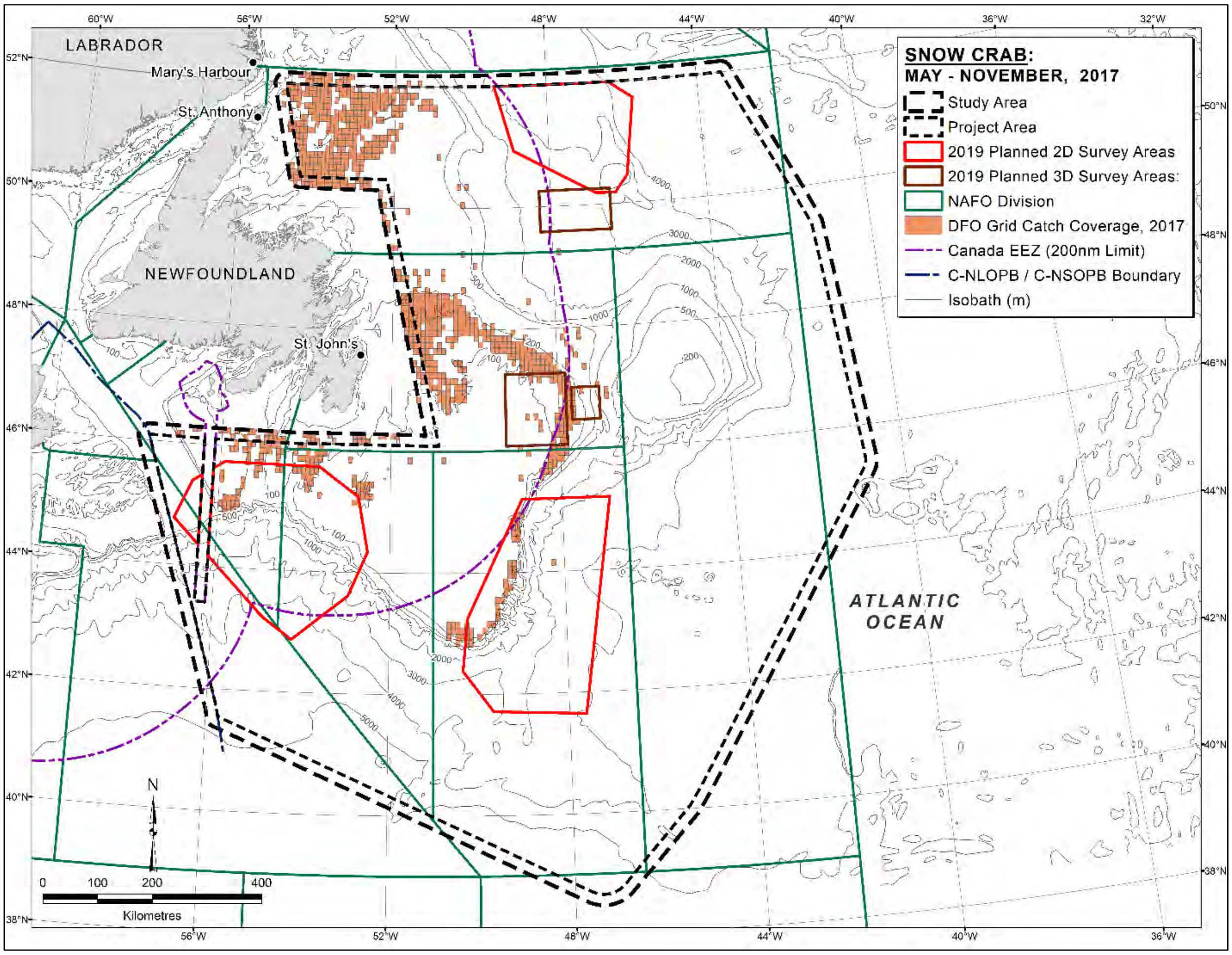


FIGURE 4.4. Distribution of commercial fishery harvest locations, snow crab, May–November 2017 (derived from DFO commercial landings database, 2017).

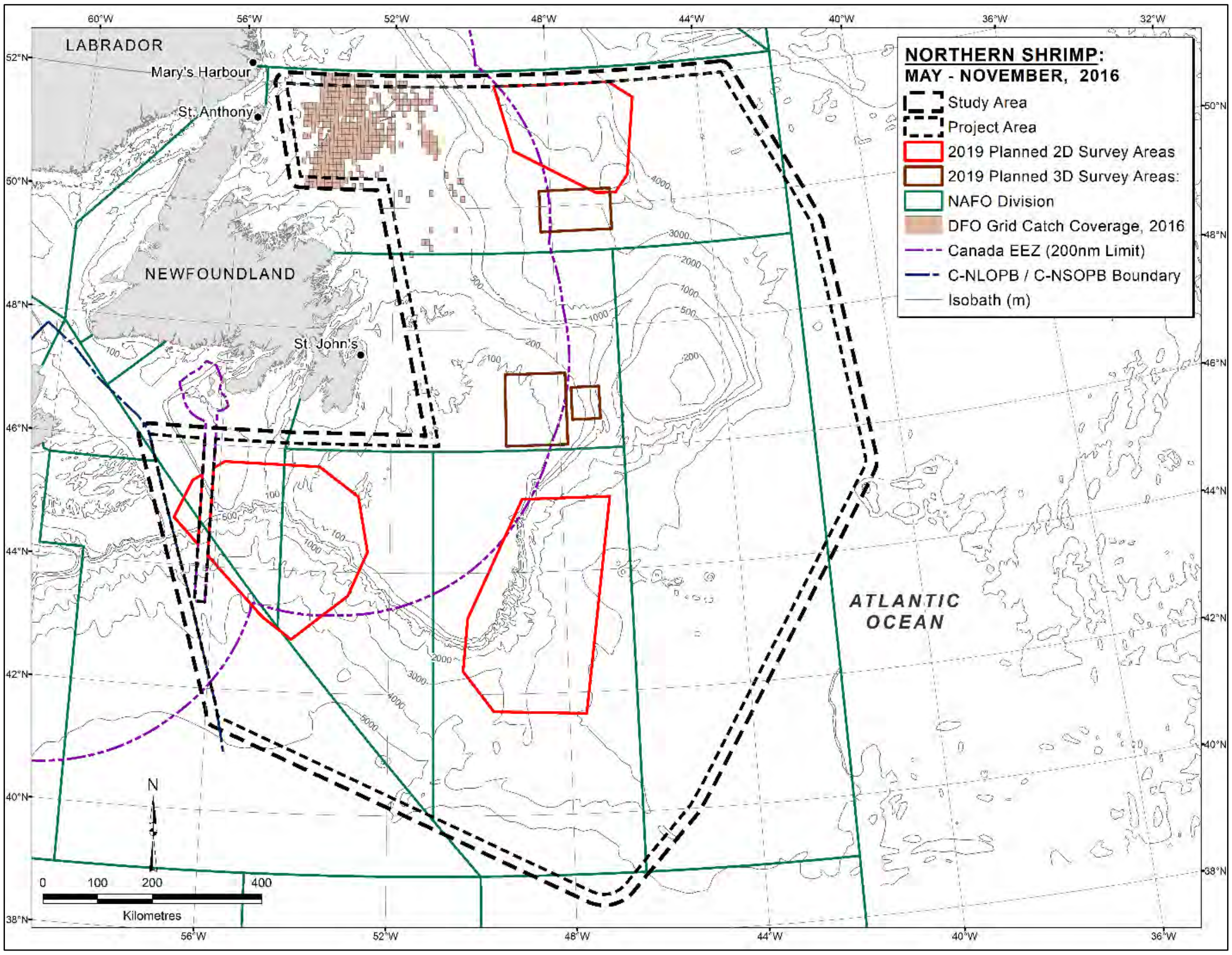


FIGURE 4.5. Distribution of commercial fishery harvest locations, northern shrimp, May–November 2016 (derived from DFO commercial landings database, 2016).

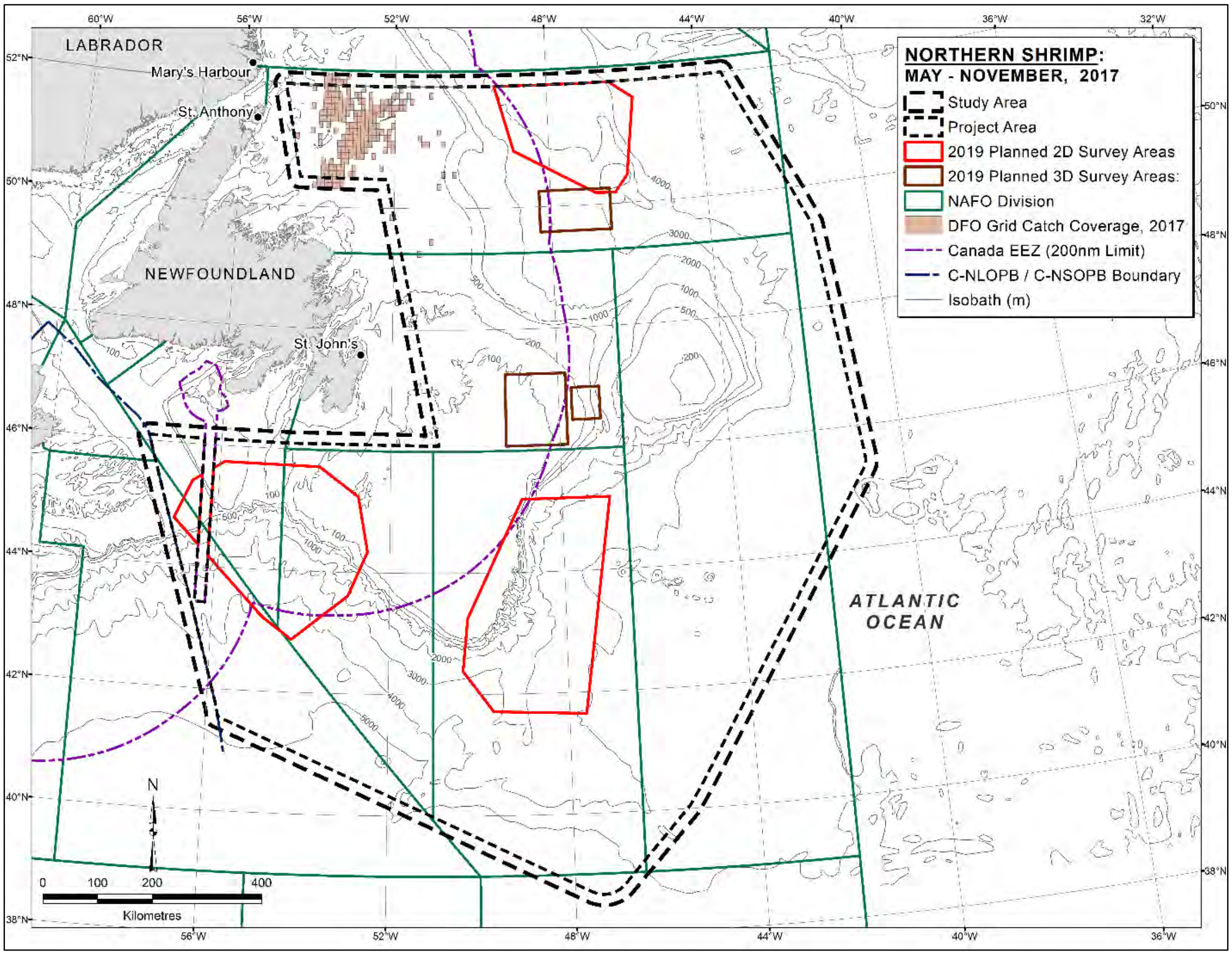


FIGURE 4.6. Distribution of commercial fishery harvest locations, northern shrimp, May–November 2017 (derived from DFO commercial landings database, 2017).

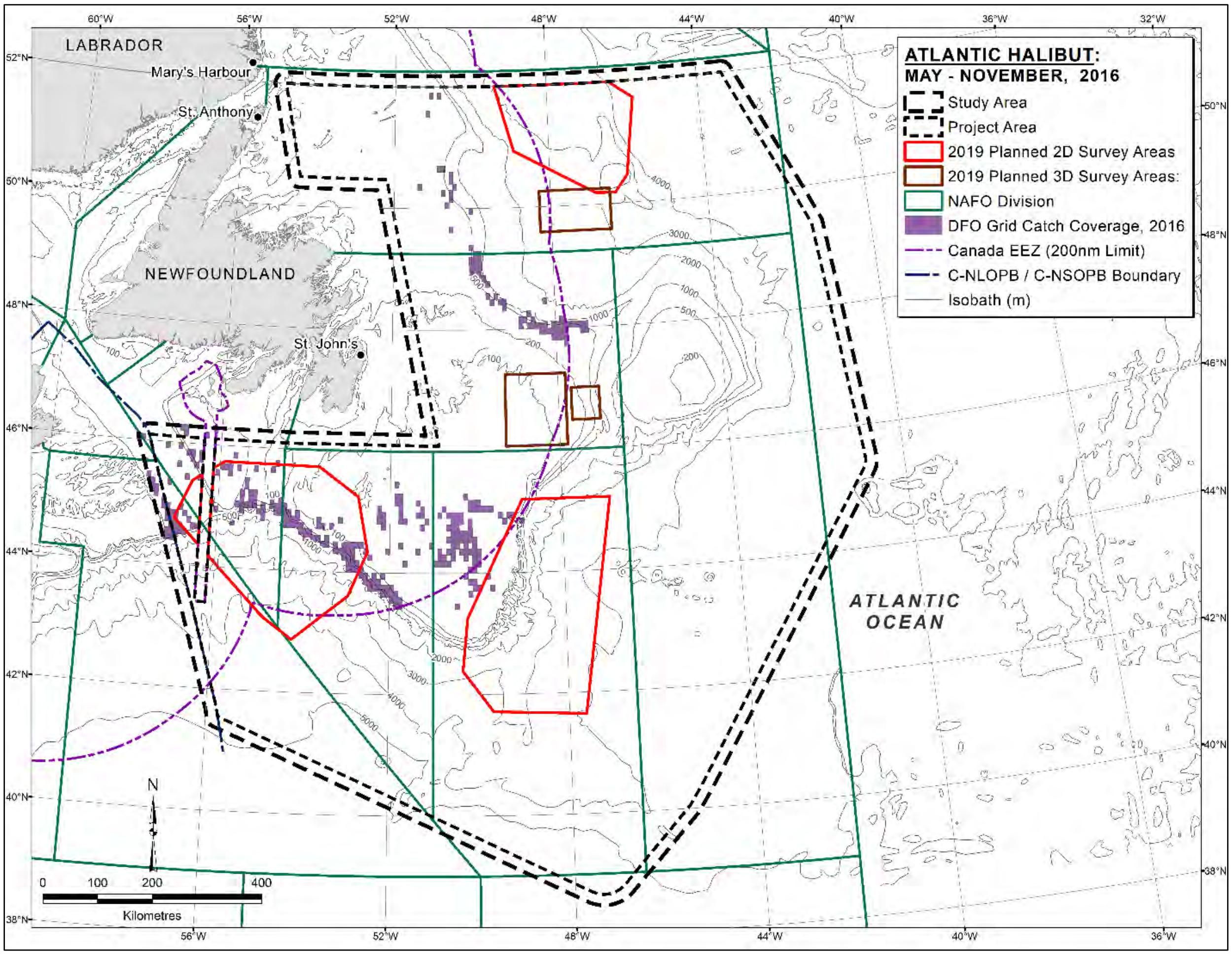


FIGURE 4.7. Distribution of commercial fishery harvest locations, Atlantic halibut, May–November 2016 (derived from DFO commercial landings database, 2016).

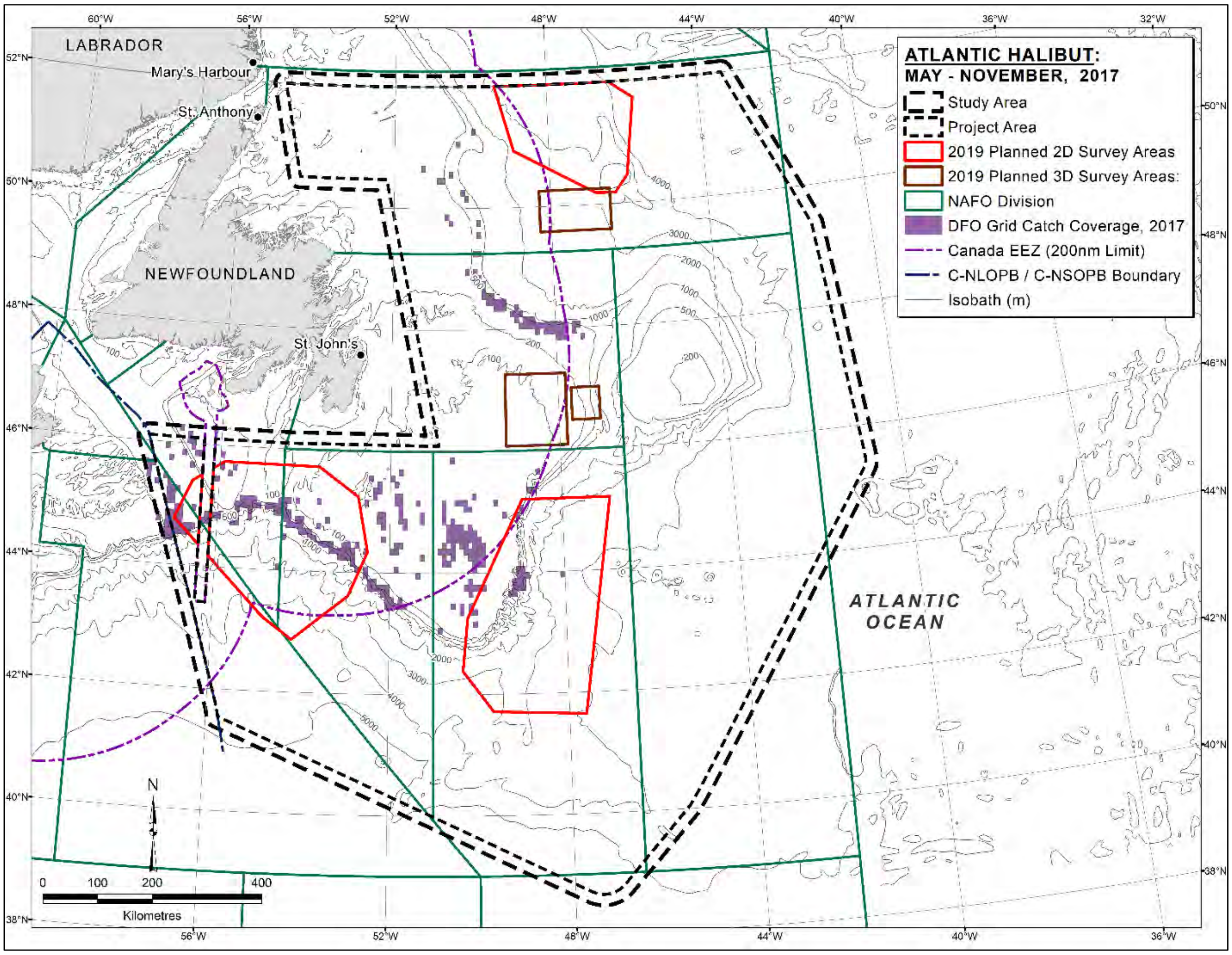


FIGURE 4.8. Distribution of commercial fishery harvest locations, Atlantic halibut, May–November 2017 (derived from DFO commercial landings database, 2017).

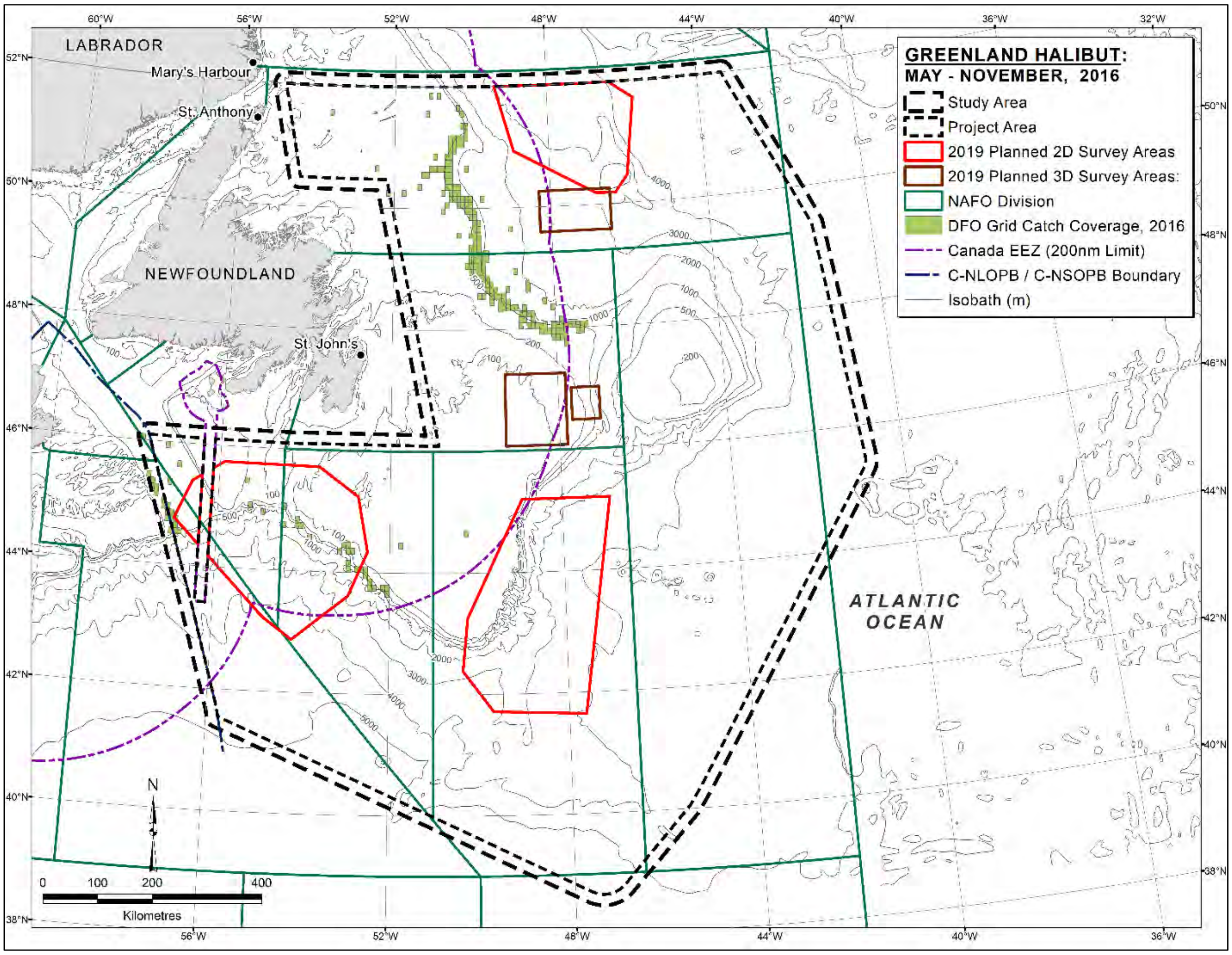


FIGURE 4.9. Distribution of commercial fishery harvest locations, Greenland halibut, May–November 2016 (derived from DFO commercial landings database, 2016).

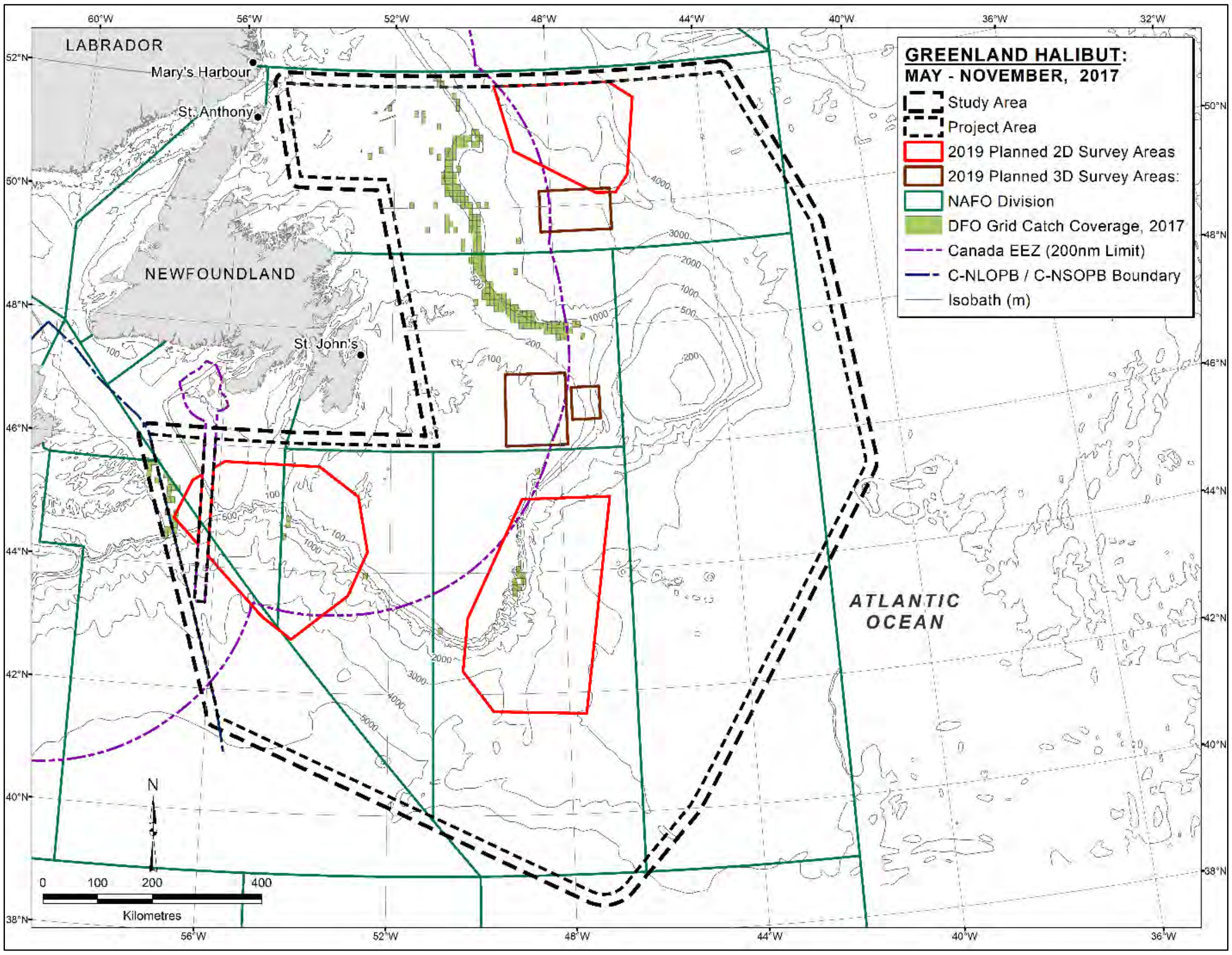


FIGURE 4.10. Distribution of commercial fishery harvest locations, Greenland halibut, May–November 2017 (derived from DFO commercial landings database, 2017).

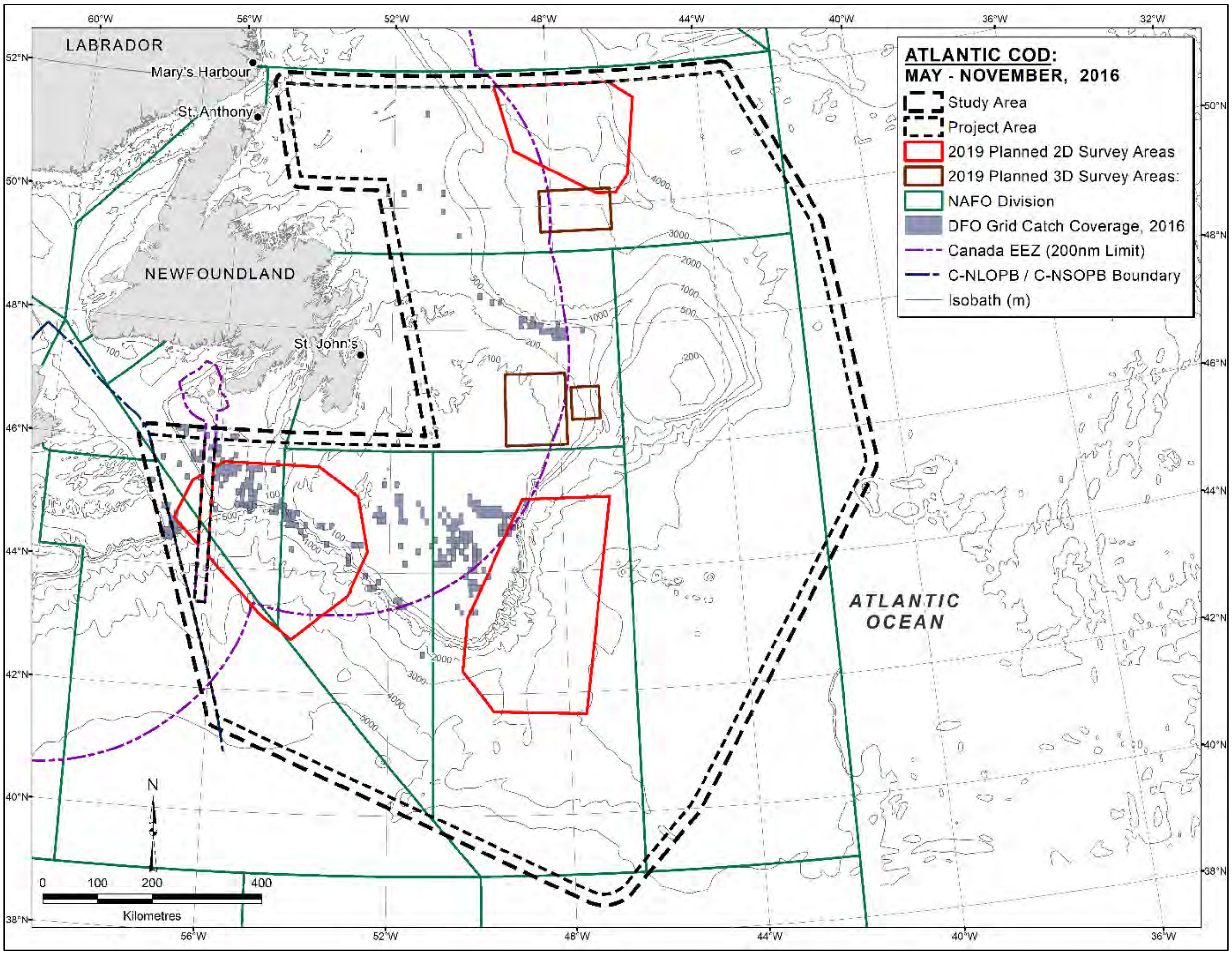


FIGURE 4.11. Distribution of commercial fishery harvest locations, Atlantic cod, May–November 2016 (derived from DFO commercial landings database, 2016).

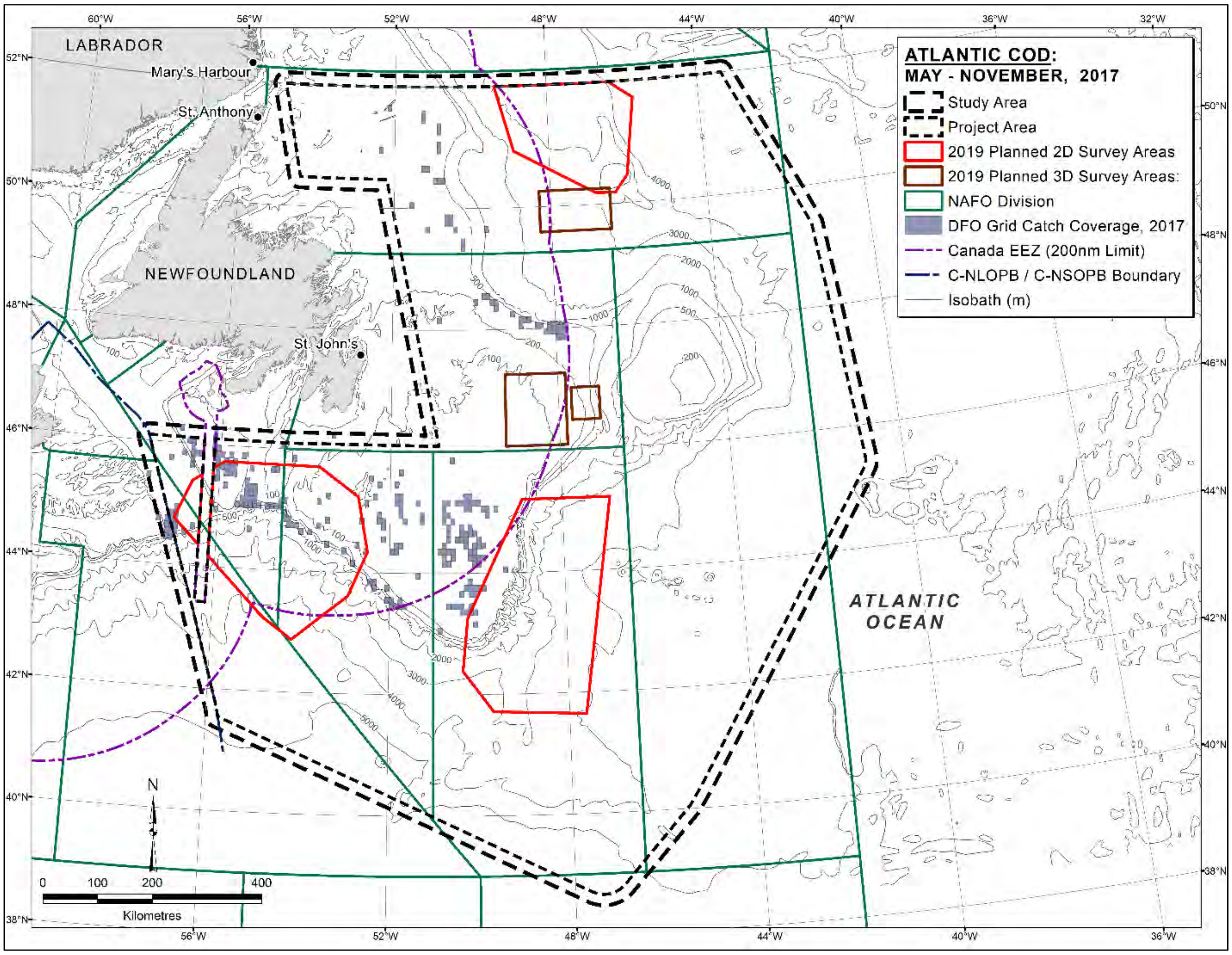


FIGURE 4.12. Distribution of commercial fishery harvest locations, Atlantic cod, May–November 2017 (derived from DFO commercial landings database, 2017).

TABLE 4.1. Commercial catch weights and values in the Study Area, May–November 2016 and 2017 (values indicate the frequency of catch weight quartile codes [i.e., 1–4] or vessel length classes attributed to each species; derived from DFO commercial landings database, 2016/2017).

Species	Catch Weight Quartile Code Counts [a]				Catch Value Quartile Code Counts [b]				Vessel Length Class Total Quartile Code Counts [c]						Total Counts [d]
	1	2	3	4	1	2	3	4	1-34.9’	35-44.9’	45-64.9’	65-99.9’	100-124.9’	≥125’	
2016															
Snow Crab	675	728	611	186	532	679	597	392	44	555	1,419	135	47	0	2,200
Northern Shrimp	255	330	233	197	330	302	205	178	0	21	716	165	0	113	1,015
Atlantic Halibut	180	181	183	79	198	255	139	31	0	160	155	23	0	285	623
Atlantic Cod	100	152	165	63	150	213	105	12	0	131	131	6	0	212	480
Greenland Halibut	92	182	154	44	125	184	133	30	7	99	226	1	0	139	472
Redfish	89	113	117	44	139	131	72	21	0	13	140	12	0	198	363
Yellowtail Flounder	57	117	117	45	140	130	61	5	0	9	15	0	0	312	336
American Plaice	29	99	121	52	95	130	66	10	0	17	30	0	0	254	301
White Hake	111	94	68	13	139	114	33	0	0	134	112	14	0	26	286
Witch Flounder	38	67	58	22	67	75	36	7	0	0	19	0	0	166	185
Haddock	48	48	53	13	69	67	25	1	0	61	68	2	0	31	162
Monkfish	31	46	54	18	65	52	30	2	0	16	83	2	0	48	149
Whelk	26	40	46	12	52	44	28	0	0	87	37	0	0	0	124
Swordfish	46	34	18	4	23	44	29	6	0	36	28	38	0	0	102
Pollock	10	32	39	11	36	43	13	0	0	25	58	6	0	3	92
Cusk	40	25	19	3	22	51	14	0	0	58	27	2	0	0	87
Skate	26	23	16	5	28	31	11	0	0	38	32	0	0	0	70
Mako Shark	28	23	13	3	12	31	20	4	0	22	19	26	0	0	67
Stimpson's Surf Clam	5	12	16	19	8	13	14	17	0	0	0	0	0	52	52
Cockle	1	6	9	16	2	7	8	15	0	0	0	0	0	32	32
Bluefin Tuna	12	6	10	2	9	13	8	0	0	8	16	6	0	0	30
Bigeye Tuna	11	12	4	2	7	12	7	3	0	13	4	12	0	0	29
Sea Scallop	1	12	7	7	7	7	8	5	0	1	8	0	0	18	27
Propeller Clam	3	5	10	7	5	5	8	7	0	0	0	0	0	25	25
Iceland Scallop	1	6	8	1	6	7	3	0	0	0	16	0	0	0	16
Albacore Tuna	4	8	1	1	1	10	2	1	0	8	0	6	0	0	14
Sea	0	0	3	7	0	2	4	4	0	3	7	0	0	0	10

Species	Catch Weight Quartile Code Counts [a]				Catch Value Quartile Code Counts [b]				Vessel Length Class Total Quartile Code Counts [c]						Total Counts [d]
	1	2	3	4	1	2	3	4	1-34.9’	35-44.9’	45-64.9’	65-99.9’	100-124.9’	≥125’	
Cucumber															
Roughhead Grenadier	1	5	3	1	1	5	3	1	0	2	8	0	0	0	10
Atlantic (striped) Wolffish	2	2	1	0	0	4	1	0	0	0	5	0	0	0	5
Shark	0	0	1	1	0	1	1	0	0	0	2	0	0	0	2
Mahi Mahi (dolphinfish)	2	0	0	0	1	1	0	0	0	1	0	1	0	0	2
Sculpin	0	1	0	0	0	1	0	0	0	1	0	0	0	0	1
Mackerel	0	1	0	0	1	0	0	0	0	0	1	0	0	0	1
Total	**1,924**	**2,410**	**2,158**	**878**	**2,270**	**2,664**	**1,684**	**752**	**51**	**1,519**	**3,382**	**457**	**47**	**1,914**	**7,370**
2017															
Snow Crab	631	792	596	158	438	625	693	421	62	517	1,413	150	35	0	2,177
Atlantic Halibut	156	207	166	90	232	224	136	27	0	127	149	60	0	283	619
Northern Shrimp	158	166	146	99	226	149	126	68	0	13	408	54	0	94	569
Greenland Halibut	67	161	153	61	105	165	142	30	1	58	232	23	0	128	442
Atlantic Cod	90	125	112	65	157	141	82	12	2	97	136	17	0	140	392
Redfish	78	123	112	63	151	126	79	20	0	9	146	42	0	179	376
White Hake	79	90	65	22	148	77	28	3	0	107	108	25	0	16	256
American Plaice	21	82	75	53	81	80	58	12	0	9	18	0	0	204	231
Yellowtail Flounder	24	90	70	42	96	73	50	7	0	4	3	0	0	219	226
Witch Flounder	22	63	50	32	56	57	43	11	0	0	28	0	0	139	167
Haddock	33	45	35	15	69	38	18	3	0	48	56	8	0	16	128
Pollock	19	27	39	18	51	33	17	2	0	19	73	11	0	0	103
Swordfish	39	25	27	0	30	30	31	0	0	35	22	34	0	0	91
Cusk	29	28	20	8	29	43	10	3	0	44	30	11	0	0	85
Monkfish	10	31	25	9	36	29	8	2	0	13	41	6	0	15	75
Whelk	15	21	29	1	29	24	13	0	0	46	20	0	0	0	66
Mako Shark	23	18	19	0	18	19	23	0	0	25	10	25	0	0	60
Skate	20	6	6	2	18	11	5	0	0	9	25	0	0	0	34
Stimpson's Surf Clam	0	3	6	24	2	4	7	20	0	0	0	0	0	33	33
Sea Cucumber	0	1	12	18	1	13	12	5	4	20	7	0	0	0	31

Species	Catch Weight Quartile Code Counts [a]				Catch Value Quartile Code Counts [b]				Vessel Length Class Total Quartile Code Counts [c]						Total Counts [d]
	1	**2**	**3**	**4**	**1**	**2**	**3**	**4**	**1-34.9'**	**35-44.9'**	**45-64.9'**	**65-99.9'**	**100-124.9'**	**≥125'**	
Bluefin Tuna	9	7	9	3	8	10	10	0	0	5	11	12	0	0	28
Cockle	0	2	5	17	2	3	2	17	0	0	0	0	0	24	24
Albacore Tuna	10	7	7	0	7	11	6	0	0	10	9	5	0	0	24
Sea Scallop	5	4	10	4	5	8	8	2	0	0	14	4	5	0	23
Iceland Scallop	4	4	10	2	5	12	2	1	0	4	16	0	0	0	20
Bigeye Tuna	5	5	7	0	4	6	7	0	0	6	5	6	0	0	17
Pink Glass Shrimp	1	2	4	3	1	2	4	3	0	0	0	0	0	10	10
Roughhead Grenadier	1	3	2	2	1	4	1	2	0	3	1	4	0	0	8
Mahi Mahi (dolphinfish)	2	2	3	0	1	2	4	0	0	5	0	2	0	0	7
Toad Crab	1	2	3	0	2	2	2	0	0	3	3	0	0	0	6
Atlantic (striped) Wolffish	4	1	0	0	1	4	0	0	0	0	5	0	0	0	5
Atlantic Herring	0	0	2	0	1	1	0	0	0	1	1	0	0	0	2
Propeller Clam	0	0	0	2	0	0	1	1	0	0	0	0	0	2	2
Lobster	0	1	1	0	0	0	2	0	0	0	2	0	0	0	2
Mackerel	0	0	2	0	0	2	0	0	2	0	0	0	0	0	2
White Marlin	0	0	1	0	0	1	0	0	0	1	0	0	0	0	1
Hagfish	0	0	1	0	0	1	0	0	0	1	0	0	0	0	1
Sculpin	0	0	1	0	0	0	1	0	0	1	0	0	0	0	1
Capelin	0	1	0	0	1	0	0	0	0	1	0	0	0	0	1
Unspecific Pelagics	1	0	0	0	1	0	0	0	0	0	0	1	0	0	1
Yellowfin Tuna	0	0	1	0	0	1	0	0	0	1	0	0	0	0	1
Total	**1,557**	**2,145**	**1,832**	**813**	**2,013**	**2,031**	**1,631**	**672**	**71**	**1,242**	**2,992**	**500**	**40**	**1,502**	**6,347**

[a] Quartile ranges provided by DFO (quartile ranges calculated annually by DFO based on total catch weights in a given year, all species combined). 2016 quartile ranges: 1 = 0 – 2,136 kg; 2 = 2,137 – 9,436 kg; 3 = 9,437 – 39,810 kg; 4 = ≥39,811 kg. 2017 quartile ranges: 1 = 0 – 1,912 kg; 2 = 1,913 – 8,828 kg; 3 = 8,829 – 35,206 kg; 4 = ≥35,207 kg.

[b] Quartile ranges provided by DFO (quartile ranges calculated annually by DFO based on total catch value in a given year, all species combined). 2016 quartile ranges: 1 = $0 – $9,428; 2 = $9,429 – $41,474; 3 = $41,475 – $154,669; 4 = ≥$154,670. 2017 quartile ranges: 1 = $0 – $9,811; 2 = $9,812 – $43,514; 3 = $43,515 – $166,502; 4 = ≥$166,503.

[c] Includes the total quartile code count for ranges 1–4, combined; total counts for catch weight and catch value are equal.

[d] Total counts of the number of catch records per species; the total quartile range counts for catch weight and catch value are equal.

TABLE 4.2. Commercial catch weights and values in the Jeanne d'Arc HD3D survey area, May–November 2016 and 2017 (values indicate the frequency of catch weight quartile codes [i.e., 1–4] or vessel length classes attributed to each species; derived from DFO commercial landings database, 2016/2017).

Species	Catch Weight Quartile Code Counts [a]				Catch Value Quartile Code Counts [b]				Vessel Length Class Total Quartile Code Counts [c]						Total Counts [d]
	1	2	3	4	1	2	3	4	1-34.9'	35-44.9'	45-64.9'	65-99.9'	100-124.9'	≥125'	
2016															
Snow Crab	16	27	56	4	11	23	38	31	0	0	75	28	0	0	103
Stimpson's Surf Clam	1	0	1	1	1	0	1	1	0	0	0	0	0	3	3
Propeller Clam	0	0	1	1	0	0	1	1	0	0	0	0	0	2	2
Cockle	0	0	1	1	0	0	1	1	0	0	0	0	0	2	2
Total	**17**	**27**	**59**	**7**	**12**	**23**	**41**	**34**	**0**	**0**	**75**	**28**	**0**	**7**	**110**
2017															
Snow Crab	21	47	47	2	12	25	56	24	0	0	80	37	0	0	117
Total	**21**	**47**	**47**	**2**	**12**	**25**	**56**	**24**	**0**	**0**	**80**	**37**	**0**	**0**	**117**

[a] Quartile ranges provided by DFO (quartile ranges calculated annually by DFO based on total catch weights in a given year, all species combined). 2016 quartile ranges: 1 = 0 – 2,136 kg; 2 = 2,137 – 9,436 kg; 3 = 9,437 – 39,810 kg; 4 = ≥39,811 kg. 2017 quartile ranges: 1 = 0 – 1,912 kg; 2 = 1,913 – 8,828 kg; 3 = 8,829 – 35,206 kg; 4 = ≥35,207 kg.

[b] Quartile ranges provided by DFO (quartile ranges calculated annually by DFO based on total catch value in a given year, all species combined). 2016 quartile ranges: 1 = $0 – $9,428; 2 = $9,429 – $41,474; 3 = $41,475 – $154,669; 4 = ≥$154,670. 2017 quartile ranges: 1 = $0 – $9,811; 2 = $9,812 – $43,514; 3 = $43,515 – $166,502; 4 = ≥$166,503.

[c] Includes the total quartile code count for ranges 1–4, combined; total counts for catch weight and catch value are equal.

[d] Total counts of the number of catch records per species; the total quartile range counts for catch weight and catch value are equal.

TABLE 4.3. Commercial catch weights and values in the Harbour Deep SE Ext. 3D survey area, May–November 2016 and 2017 (values indicate the frequency of catch weight quartile codes [i.e., 1–4] or vessel length classes attributed to each species; derived from DFO commercial landings database, 2016/2017).

Species	Catch Weight Quartile Code Counts [a]				Catch Value Quartile Code Counts [b]				Vessel Length Class Total Quartile Code Counts [c]						Total Counts [d]
	1	2	3	4	1	2	3	4	1-34.9’	35-44.9’	45-64.9’	65-99.9’	100-124.9’	≥125’	
2016															
Snow Crab	4	7	3	0	4	7	3	0	0	0	12	2	0	0	14
Total	**4**	**7**	**3**	**0**	**4**	**7**	**3**	**0**	**0**	**0**	**12**	**2**	**0**	**0**	**14**
2017															
Snow Crab	6	5	1	0	3	5	4	0	0	0	10	2	0	0	12
Total	**6**	**5**	**1**	**0**	**3**	**5**	**4**	**0**	**0**	**0**	**10**	**2**	**0**	**0**	**12**

[a] Quartile ranges provided by DFO (quartile ranges calculated annually by DFO based on total catch weights in a given year, all species combined). 2016 quartile ranges: 1 = 0 – 2,136 kg; 2 = 2,137 – 9,436 kg; 3 = 9,437 – 39,810 kg; 4 = ≥39,811 kg. 2017 quartile ranges: 1 = 0 – 1,912 kg; 2 = 1,913 – 8,828 kg; 3 = 8,829 – 35,206 kg; 4 = ≥35,207 kg.

[b] Quartile ranges provided by DFO (quartile ranges calculated annually by DFO based on total catch value in a given year, all species combined). 2016 quartile ranges: 1 = $0 – $9,428; 2 = $9,429 – $41,474; 3 = $41,475 – $154,669; 4 = ≥$154,670. 2017 quartile ranges: 1 = $0 – $9,811; 2 = $9,812 – $43,514; 3 = $43,515 – $166,502; 4 = ≥$166,503.

[c] Includes the total quartile code count for ranges 1–4, combined; total counts for catch weight and catch value are equal.

[d] Total counts of the number of catch records per species; the total quartile range counts for catch weight and catch value are equal.

TABLE 4.4. Commercial catch weights and values in the Southwest 2D survey area, May–November 2016 and 2017 (values indicate the frequency of catch weight quartile codes [i.e., 1–4] or vessel length classes attributed to each species; derived from DFO commercial landings database, 2016/2017).

Species	Catch Weight Quartile Code Counts [a]				Catch Value Quartile Code Counts [b]				Vessel Length Class Total Quartile Code Counts [c]						Total Counts [d]
	1	2	3	4	1	2	3	4	1-34.9’	35-44.9’	45-64.9’	65-99.9’	100-124.9’	≥125’	
2016															
White Hake	68	59	50	7	83	80	21	0	0	102	63	5	0	14	184
Atlantic Halibut	70	40	38	9	55	72	30	0	0	76	59	12	0	10	157
Atlantic Cod	36	46	53	13	59	64	25	0	0	66	76	2	0	4	148
Haddock	27	29	39	6	41	48	12	0	0	43	46	0	0	12	101
Whelk	22	32	35	12	42	35	24	0	0	75	26	0	0	0	101
Monkfish	15	19	35	6	26	36	13	0	0	16	50	1	0	8	75
Snow Crab	21	27	13	4	16	23	18	8	0	38	27	0	0	0	65
Pollock	6	18	29	6	22	31	6	0	0	25	31	1	0	2	59

Species	Catch Weight Quartile Code Counts [a]				Catch Value Quartile Code Counts [b]				Vessel Length Class Total Quartile Code Counts [c]						Total Counts [d]
	1	2	3	4	1	2	3	4	1-34.9'	35-44.9'	45-64.9'	65-99.9'	100-124.9'	≥125'	
Cusk	20	20	11	0	13	30	8	0	0	38	13	0	0	0	51
Redfish	13	12	24	1	16	26	8	0	0	5	42	2	0	1	50
Swordfish	17	11	8	3	7	16	11	5	0	17	13	9	0	0	39
Skate	13	8	9	5	9	18	8	0	0	23	12	0	0	0	35
American Plaice	6	7	11	5	11	11	7	0	0	13	11	0	0	5	29
Mako Shark	11	8	6	2	4	12	8	3	0	10	11	6	0	0	27
Bluefin Tuna	8	3	9	2	5	11	6	0	0	6	15	1	0	0	22
Greenland Halibut	12	5	4	1	9	11	2	0	0	17	4	1	0	0	22
Yellowtail Flounder	5	4	6	3	9	5	4	0	0	3	13	0	0	2	18
Witch Flounder	10	1	2	0	10	3	0	0	0	0	1	0	0	12	13
Bigeye Tuna	1	3	3	1	1	0	5	2	0	4	1	3	0	0	8
Sea Scallop	0	2	2	2	0	2	3	1	0	0	0	0	0	6	6
Iceland Scallop	0	3	1	0	2	1	1	0	0	0	4	0	0	0	4
Albacore Tuna	0	2	1	1	0	1	2	1	0	4	0	0	0	0	4
Atlantic (striped) Wolffish	1	1	0	0	0	2	0	0	0	0	2	0	0	0	2
Shark	0	0	0	1	0	0	1	0	0	0	1	0	0	0	1
Stimpson's Surf Clam	1	0	0	0	1	0	0	0	0	0	0	0	0	1	1
Propeller Clam	1	0	0	0	1	0	0	0	0	0	0	0	0	1	1
Cockle	1	0	0	0	1	0	0	0	0	0	0	0	0	1	1
Total	**385**	**360**	**389**	**90**	**443**	**538**	**223**	**20**	**0**	**581**	**521**	**43**	**0**	**79**	**1,224**
2017															
White Hake	48	51	37	13	85	52	12	0	0	75	60	7	0	7	149
Atlantic Halibut	57	52	27	5	74	51	15	1	0	64	52	19	0	6	141
Atlantic Cod	23	38	35	14	50	41	19	0	0	38	64	4	0	4	110
Snow Crab	22	29	24	4	10	24	30	15	0	39	40	0	0	0	79
Haddock	19	25	19	8	42	24	5	0	0	22	39	3	0	7	71

Species	Catch Weight Quartile Code Counts [a]				Catch Value Quartile Code Counts [b]				Vessel Length Class Total Quartile Code Counts [c]						Total Counts [d]
	1	2	3	4	1	2	3	4	1-34.9’	35-44.9’	45-64.9’	65-99.9’	100-124.9’	≥125’	
Pollock	11	15	26	11	31	25	7	0	0	16	45	2	0	0	63
Monkfish	4	21	21	5	20	25	6	0	0	12	33	0	0	6	51
Redfish	11	17	16	5	25	18	6	0	0	3	38	7	0	1	49
Whelk	11	17	21	0	21	17	11	0	0	31	18	0	0	0	49
Cusk	17	20	11	1	22	23	4	0	0	34	14	1	0	0	49
Swordfish	19	11	3	0	15	14	4	0	0	10	13	10	0	0	33
Mako Shark	12	7	2	0	10	8	3	0	0	5	9	7	0	0	21
Bluefin Tuna	1	5	7	3	2	6	8	0	0	4	11	1	0	0	16
American Plaice	1	4	9	1	3	8	4	0	0	4	11	0	0	0	15
Skate	5	1	6	2	6	5	3	0	0	4	10	0	0	0	14
Sea Cucumber	0	1	6	3	1	6	3	0	2	7	1	0	0	0	10
Albacore Tuna	4	4	1	0	3	5	1	0	0	2	4	3	0	0	9
Bigeye Tuna	4	3	2	0	3	4	2	0	0	1	5	3	0	0	9
Witch Flounder	3	5	0	0	6	2	0	0	0	0	0	0	0	8	8
Sea Scallop	0	1	5	2	0	2	4	2	0	0	1	3	4	0	8
Yellowtail Flounder	2	1	3	0	3	0	3	0	0	3	2	0	0	1	6
Toad Crab	1	2	3	0	2	2	2	0	0	3	3	0	0	0	6
Iceland Scallop	1	0	4	1	1	4	0	1	0	1	5	0	0	0	6
Greenland Halibut	0	2	2	1	1	3	1	0	0	0	5	0	0	0	5
Mahi Mahi (dolphinfish)	1	0	0	0	1	0	0	0	0	0	0	1	0	0	1
Atlantic (striped) Wolffish	0	1	0	0	0	1	0	0	0	0	1	0	0	0	1
Total	**277**	**333**	**290**	**79**	**437**	**370**	**153**	**19**	**2**	**378**	**484**	**71**	**4**	**40**	**979**

[a] Quartile ranges provided by DFO (quartile ranges calculated annually by DFO based on total catch weights in a given year, all species combined). 2016 quartile ranges: 1 = 0 – 2,136 kg; 2 = 2,137 – 9,436 kg; 3 = 9,437 – 39,810 kg; 4 = ≥39,811 kg. 2017 quartile ranges: 1 = 0 – 1,912 kg; 2 = 1,913 – 8,828 kg; 3 = 8,829 – 35,206 kg; 4 = ≥35,207 kg.

[b] Quartile ranges provided by DFO (quartile ranges calculated annually by DFO based on total catch value in a given year, all species combined). 2016 quartile ranges: 1 = $0 – $9,428; 2 = $9,429 – $41,474; 3 = $41,475 – $154,669; 4 = ≥$154,670. 2017 quartile ranges: 1 = $0 – $9,811; 2 = $9,812 – $43,514; 3 = $43,515 – $166,502; 4 = ≥$166,503.

[c] Includes the total quartile code count for ranges 1–4, combined; total counts for catch weight and catch value are equal.

[d] Total counts of the number of catch records per species; the total quartile range counts for catch weight and catch value are equal.

TABLE 4.5. Commercial catch weights and values in the Saint Pierre and Miquelon Territory Adjacent 2D survey area, May–November 2017 (values indicate the frequency of catch weight quartile codes [i.e., 1–4] or vessel length classes attributed to each species; derived from DFO commercial landings database, 2017).

Species	Catch Weight Quartile Code Counts [a]				Catch Value Quartile Code Counts [b]				Vessel Length Class Total Quartile Code Counts [c]						Total Counts [d]
	1	2	3	4	1	2	3	4	1-34.9'	35-44.9'	45-64.9'	65-99.9'	100-124.9'	≥125'	
Redfish	4	2	1	0	6	1	0	0	0	0	7	0	0	0	7
Atlantic Halibut	3	2	1	0	5	1	0	0	0	0	6	0	0	0	6
Pollock	1	1	1	0	2	1	0	0	0	0	3	0	0	0	3
Total	**8**	**5**	**3**	**0**	**13**	**3**	**0**	**0**	**0**	**0**	**16**	**0**	**0**	**0**	**16**

[a] Quartile ranges provided by DFO (quartile ranges calculated annually by DFO based on total catch weights in a given year, all species combined). 2016 quartile ranges: 1 = 0 – 2,136 kg; 2 = 2,137 – 9,436 kg; 3 = 9,437 – 39,810 kg; 4 = ≥39,811 kg. 2017 quartile ranges: 1 = 0 – 1,912 kg; 2 = 1,913 – 8,828 kg; 3 = 8,829 – 35,206 kg; 4 = ≥35,207 kg.

[b] Quartile ranges provided by DFO (quartile ranges calculated annually by DFO based on total catch value in a given year, all species combined). 2016 quartile ranges: 1 = $0 – $9,428; 2 = $9,429 – $41,474; 3 = $41,475 – $154,669; 4 = ≥$154,670. 2017 quartile ranges: 1 = $0 – $9,811; 2 = $9,812 – $43,514; 3 = $43,515 – $166,502; 4 = ≥$166,503.

[c] Includes the total quartile code count for ranges 1–4, combined; total counts for catch weight and catch value are equal.

[d] Total counts of the number of catch records per species; the total quartile range counts for catch weight and catch value are equal.

TABLE 4.6. Commercial catch weights and values in the Southeast 2D survey area, May–November 2016 and 2017 (values indicate the frequency of catch weight quartile codes [i.e., 1–4] or vessel length classes attributed to each species; derived from DFO commercial landings database, 2016/2017).

Species	Catch Weight Quartile Code Counts [a]				Catch Value Quartile Code Counts [b]				Vessel Length Class Total Quartile Code Counts [c]						Total Counts [d]
	1	2	3	4	1	2	3	4	1-34.9'	35-44.9'	45-64.9'	65-99.9'	100-124.9'	≥125'	
2016															
Snow Crab	47	59	20	0	35	52	38	1	0	0	71	8	47	0	126
Stimpson's Surf Clam	3	7	12	18	5	8	11	16	0	0	0	0	0	40	40
Cockle	0	2	6	15	0	4	5	14	0	0	0	0	0	23	23
Propeller Clam	2	1	6	6	3	1	5	6	0	0	0	0	0	15	15
Yellowtail Flounder	2	4	5	0	3	6	2	0	0	0	0	0	0	11	11
American Plaice	0	5	5	0	1	7	2	0	0	0	0	0	0	10	10
Atlantic Cod	0	4	4	0	1	6	1	0	0	0	0	0	0	8	8

Species	Catch Weight Quartile Code Counts [a]				Catch Value Quartile Code Counts [b]				Vessel Length Class Total Quartile Code Counts [c]						Total Counts [d]
	1	**2**	**3**	**4**	**1**	**2**	**3**	**4**	**1-34.9’**	**35-44.9’**	**45-64.9’**	**65-99.9’**	**100-124.9’**	**≥125’**	
Witch Flounder	0	2	3	0	0	3	2	0	0	0	0	0	0	5	5
Atlantic Halibut	1	0	2	0	1	1	1	0	0	0	1	0	0	2	3
Haddock	1	0	0	0	1	0	0	0	0	0	1	0	0	0	1
Skate	1	0	0	0	1	0	0	0	0	0	1	0	0	0	1
Total	**57**	**84**	**63**	**39**	**51**	**88**	**67**	**37**	**0**	**0**	**74**	**8**	**47**	**114**	**243**
2017															
Snow Crab	37	25	4	0	28	23	15	0	0	0	47	3	16	0	66
Stimpson's Surf Clam	0	1	6	21	1	3	6	18	0	0	0	0	0	28	28
Cockle	0	1	5	17	1	3	2	17	0	0	0	0	0	23	23
Atlantic Halibut	11	7	0	2	6	9	5	0	0	0	4	14	0	2	20
Greenland Halibut	2	6	0	0	0	5	3	0	0	0	0	8	0	0	8
American Plaice	1	1	1	3	2	1	2	1	0	0	0	0	0	6	6
Atlantic Cod	2	1	1	2	3	1	1	1	0	0	3	0	0	3	6
Yellowtail Flounder	0	1	1	3	1	1	2	1	0	0	0	0	0	5	5
Skate	2	0	0	0	1	1	0	0	0	0	2	0	0	0	2
Haddock	1	0	0	0	0	1	0	0	0	0	0	1	0	0	1
White Hake	0	1	0	0	1	0	0	0	0	0	1	0	0	0	1
Witch Flounder	1	0	0	0	1	0	0	0	0	0	0	0	0	1	1
Total	**57**	**44**	**18**	**48**	**45**	**48**	**36**	**38**	**0**	**0**	**57**	**26**	**16**	**68**	**167**

[a] Quartile ranges provided by DFO (quartile ranges calculated annually by DFO based on total catch weights in a given year, all species combined). 2016 quartile ranges: 1 = 0 – 2,136 kg; 2 = 2,137 – 9,436 kg; 3 = 9,437 – 39,810 kg; 4 = ≥39,811 kg. 2017 quartile ranges: 1 = 0 – 1,912 kg; 2 = 1,913 – 8,828 kg; 3 = 8,829 – 35,206 kg; 4 = ≥35,207 kg.

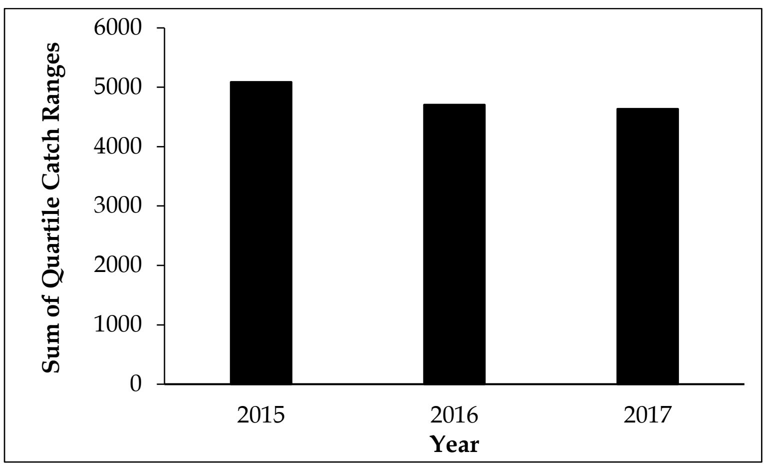
[b] Quartile ranges provided by DFO (quartile ranges calculated annually by DFO based on total catch value in a given year, all species combined). 2016 quartile ranges: 1 = $0 – $9,428; 2 = $9,429 – $41,474; 3 = $41,475 – $154,669; 4 = ≥$154,670. 2017 quartile ranges: 1 = $0 – $9,811; 2 = $9,812 – $43,514; 3 = $43,515 – $166,502; 4 = ≥$166,503.

[c] Includes the total quartile code count for ranges 1–4, combined; total counts for catch weight and catch value are equal.

[d] Total counts of the number of catch records per species; the total quartile range counts for catch weight and catch value are equal.

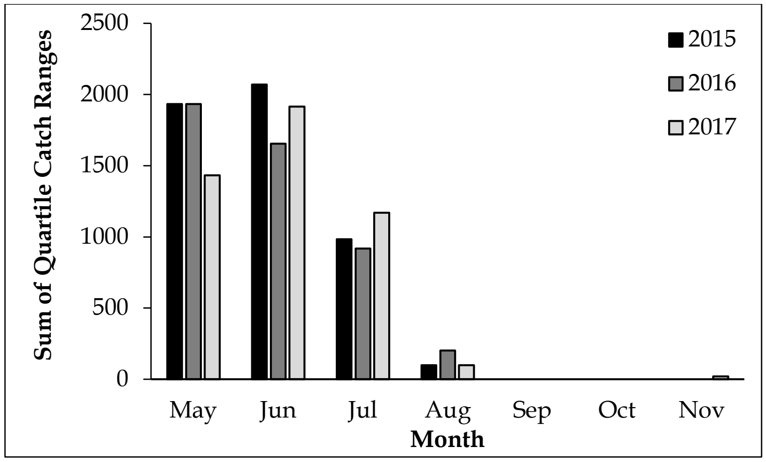
4.2.1.1 Snow Crab

During May–November 2016 and 2017, the distribution of harvest locations for snow crab in the Study Area was consistent with that observed during May–November 2005–2015 (see Figures 4.21–4.24 *in* LGL 2015a, Figures 4.15–4.18 *in* LGL 2015b, Figure 4.2 *in* LGL 2016, Figure 4.12 *in* LGL 2018a, and Figures 4.3–4.4 above). Catches primarily occurred in northwestern and central-western portions of the of the Study Area, including the Jeanne d'Arc HD3D, Harbour Deep SE Ext. 3D, Southwest 2D and Southeast 2D 2019 survey areas, principally in water depths <200 m. The TAC values for snow crab in NAFO Division (Div.) 3K (including the North Tablelands 3D and Orphan Basin 2D 2019 survey areas) have remained relatively consistent since 2016, at 5,856 mt for 2019 (DFO 2019j). The TAC has steadily decreased in Div. 3LNO (Jeanne d'Arc HD3D, Harbour Deep SE Ext. 3D, Southeast 2D and the eastern portion of the Southwest 2D 2019 survey areas) since 2015, ranging from 35,698 mt for 2015 to 15,818 mt for 2019 (DFO 2019j). The TAC has fluctuated during recent years in Div. 3PS (western portion of the Southwest 2D 2019 survey area), from 4,299 mt in 2015 to 1,505 mt in 2017, and to 2,649 mt for 2019 (DFO 2019j). Overall, snow crab harvest within the Study Area during May–November slightly decreased from 2015–2017 (Figure 4.13), and most snow crab catches occurred during May–July (Figure 4.14).



Note: Sum of quartile catch ranges is the summation of catch weight quartile ranges (i.e., 1–4) for all catch records for all species; the greater the sum of quartile range counts, the greater the catch for a given year).

FIGURE 4.13. Total annual catch weight quartile codes, May–November 2015–2017 for snow crab in the Study Area (derived from DFO commercial landings database, 2015–2017).

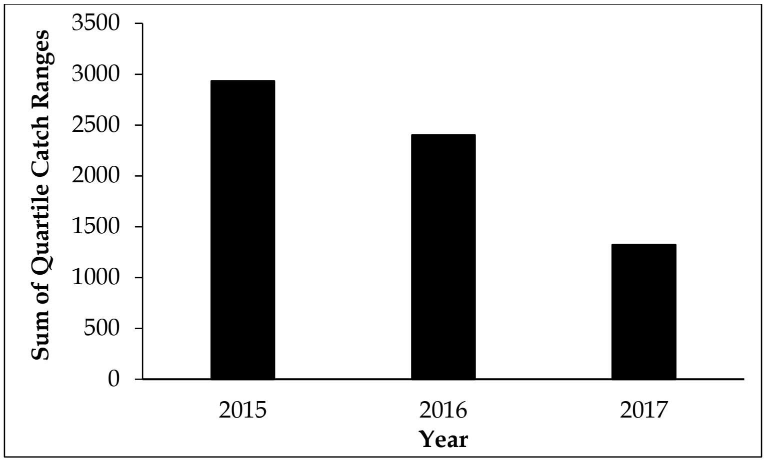


Note: Sum of quartile catch ranges is the summation of catch weight quartile ranges (i.e., 1–4) for all species; the greater the sum of quartile range counts, the greater the catch weight for a given month).

FIGURE 4.14. Total monthly catch weight quartile codes, May–November 2015–2017 for snow crab in the Study Area (derived from DFO commercial landings database, 2015–2017).

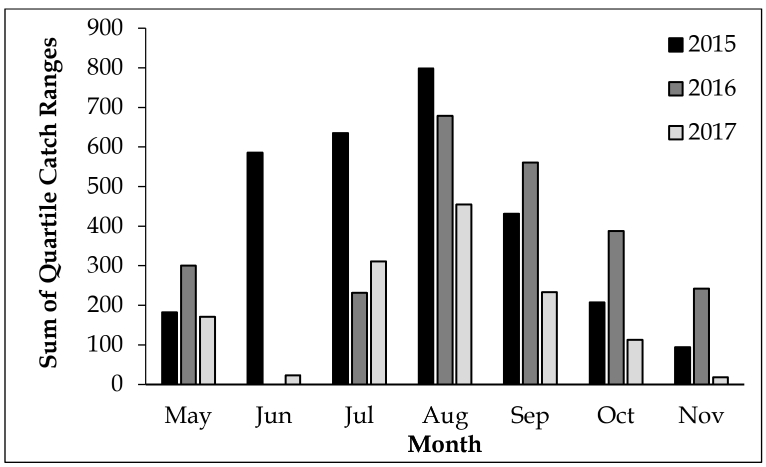
4.2.1.2 Northern Shrimp

Northern shrimp harvest locations during May–November 2016 and 2017 were similar to those reported during May–November 2015 (see Figure 4.9 *in* LGL 2018a, and Figures 4.5–4.6 above). Harvest locations were exclusively in the northwest portion of the Study Area. There were no northern shrimp catch locations within the planned 2019 3D and 2D survey areas during May–November 2016 or 2017. The shrimp fishery has remained closed in Div. 3L (includes the Jeanne d'Arc HD3D and Harbour Deep SE Ext. 3D 2019 survey areas) and SFA 7 (Jeanne d'Arc HD3D and Southwest 2D 2019 survey areas), and decreased in SFA 6 (northwest portion of Study Area) from 10,400 mt in 2017 to 8,730 mt in 2019 (DFO 2019j; NAFO 2019). Northern shrimp harvest within the Study Area decreased from 2015–2017 (Figure 4.15). Most harvest occurred during the summer (Figure 4.16).



Note: Sum of quartile catch ranges is the summation of catch weight quartile ranges (i.e., 1–4) for all catch records for all species; the greater the sum of quartile range counts, the greater the catch for a given year).

FIGURE 4.15. Total annual catch weight quartile codes, May–November 2015–2017 for northern shrimp in the Study Area (derived from DFO commercial landings database, 2015–2017).

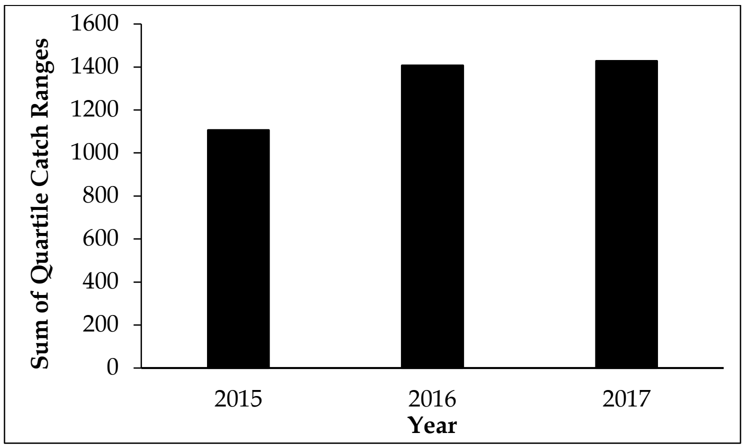


Note: Sum of quartile catch ranges is the summation of catch weight quartile ranges (i.e., 1–4) for all species; the greater the sum of quartile range counts, the greater the catch weight for a given month).

FIGURE 4.16. Total monthly catch weight quartile codes, May–November 2015–2017 for northern shrimp in the Study Area (derived from DFO commercial landings database, 2015–2017).

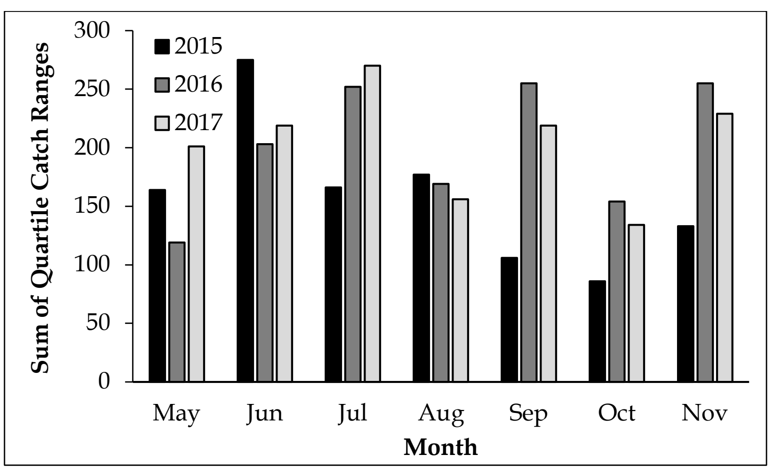
4.2.1.3 Atlantic Halibut

Harvest locations for Atlantic halibut in the Study Area were consistent during May–November 2016 and 2017 and May–November 2005–2015 (see Figures 4.48–4.51 *in* LGL 2015b, Figure 4.21 *in* LGL 2018a, and Figure 4.7–4.8 above). Atlantic halibut were primarily caught along the shelf and slope edges in the central-western and southwestern portions of the Study Area, including the northern portion of the Southwest 2D survey area and western portion of the Southeastern 2D survey area. No TACs have been posted on the DFO website for the Study Area since the 2014/2015 limit of 2,738 mt in Div. 3NOPs4VWX+5 (includes Southwest 2D and Southeast 2D 2019 survey areas) (DFO 2019j). Commercial harvests increased within the Study Area during May–November 2015 and 2016 and remained relatively steady during 2017 (Figure 4.17). Catches occurred throughout all months between May and November 2015–2017, with slightly increased harvests during June, July, September, and November (Figure 4.18).



Note: Sum of quartile catch ranges is the summation of catch weight quartile ranges (i.e., 1–4) for all catch records for all species; the greater the sum of quartile range counts, the greater the catch for a given year).

FIGURE 4.17. Total annual catch weight quartile codes, May–November 2015–2017 for Atlantic halibut in the Study Area (derived from DFO commercial landings database, 2015–2017).

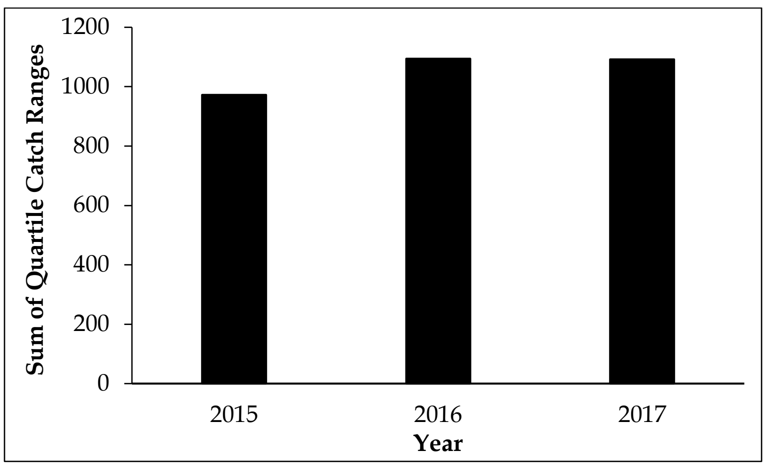


Note: Sum of quartile catch ranges is the summation of catch weight quartile ranges (i.e., 1–4) for all species; the greater the sum of quartile range counts, the greater the catch weight for a given month).

FIGURE 4.18. Total monthly catch weight quartile codes, May–November 2015–2017 for Atlantic halibut in the Study Area (derived from DFO commercial landings database, 2015–2017).

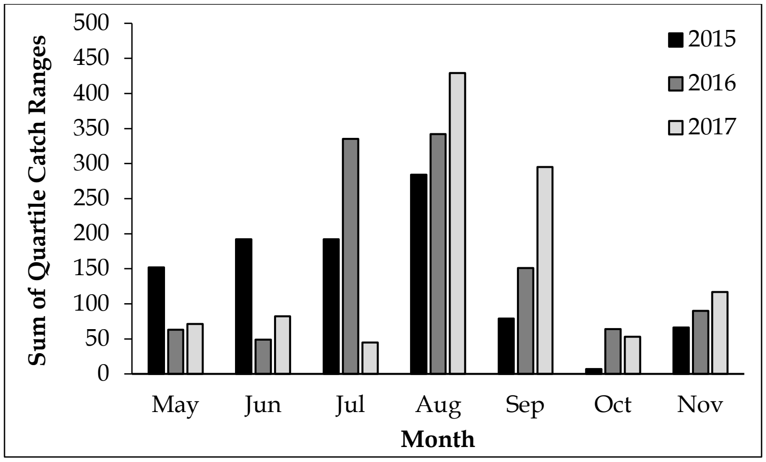
4.2.1.4 Greenland Halibut

During May–November 2016 and 2017, the distribution of harvest locations for Greenland halibut in the Study Area was consistent with locations observed during May–November 2005–2015 (see Figures 4.27–4.30 *in* LGL 2015a, Figure 4 *in* LGL 2016, Figure 4.15 *in* LGL 2018a, and Figures 4.9–4.10 above), although there have been fewer catch locations within the central portion of the Study Area since 2014. Greenland halibut were mainly caught in the northwestern portion of the Study Area, and the central and western portions of the Southwest and Southeast 2D survey areas, respectively during May–November 2016 and 2017. The TAC for Greenland halibut in Div. 3LMNO (includes the Jeanne d'Arc HD3D, Harbour Deep SE Ext. 3D, Southwest 2D, and Southeast 2D 2019 survey areas) decreased from 11,543 mt in 2015 to 10,966 mt in 2017, and increased thereafter to 12,227 mt and 12,242 mt during 2018 and 2019, respectively (NAFO 2019). Catches increased between 2015 and 2016 and remained relatively steady into 2017 (Figure 4.19). Most Greenland halibut are harvested during the summer (Figure 4.20).



Note: Sum of quartile catch ranges is the summation of catch weight quartile ranges (i.e., 1–4) for all catch records for all species; the greater the sum of quartile range counts, the greater the catch for a given year).

FIGURE 4.19. Total annual catch weight quartile codes, May–November 2015–2017 for Greenland halibut in the Study Area (derived from DFO commercial landings database, 2015–2017).

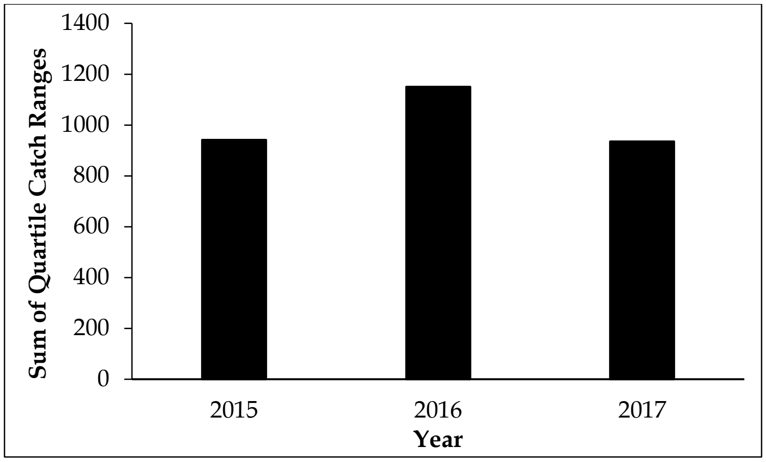


Note: Sum of quartile catch ranges is the summation of catch weight quartile ranges (i.e., 1–4) for all species; the greater the sum of quartile range counts, the greater the catch weight for a given month).

FIGURE 4.20. Total monthly catch weight quartile codes, May–November 2015–2017 for Greenland halibut in the Study Area (derived from DFO commercial landings database, 2015–2017).

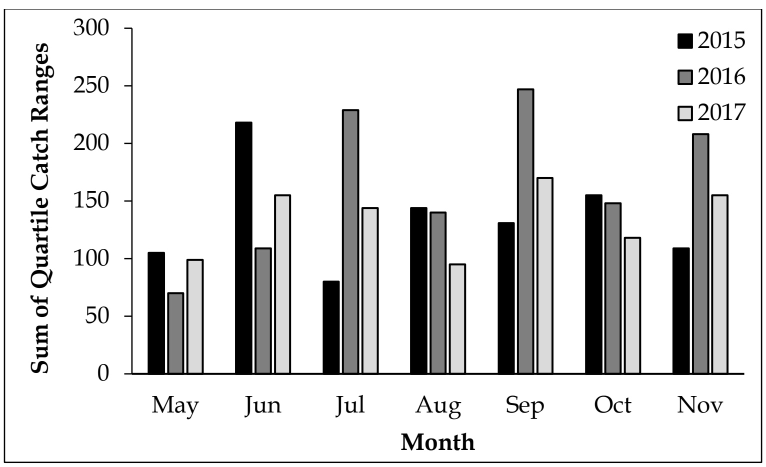
4.2.1.5 Atlantic Cod

Atlantic cod catch locations were similar during May–November 2016 and 2017 relative to those observed during May–November 2005–2015 (see Figures 4.42–4.45 *in* LGL 2015b, Figure 4.19 *in* LGL 2018a, and Figures 4.11–4.12 above). Atlantic cod were mainly harvested in the southwestern and northwestern portions of the Study Area, including within the northern portion of the Southwest 2D survey area and the western portion of the Southeast 2D survey area. The fishing ban for Atlantic cod has remained in place for Div. 3NOPs (DFO 2019j; NAFO 2019). The TAC for Div. 3Ps decreased from 13,490 mt in 2015 to 5,980 mt for 2018 and 2019 (NAFO 2019). The TAC for Atlantic cod in Div. 3M remained steady near 14,000 mt during 2015–2017, decreased to 11,145 mt in 2018 and increased to 17,500 mt in 2019 (NAFO 2019). Overall, Atlantic cod harvest remained relatively consistent during May–November 2015–2017 (Figure 4.21), and were slightly elevated during June, July, September and November (Figure 4.22).



Note: Sum of quartile catch ranges is the summation of catch weight quartile ranges (i.e., 1–4) for all catch records for all species; the greater the sum of quartile range counts, the greater the catch for a given year).

FIGURE 4.21. Total annual catch weight quartile codes, May–November 2015–2017 for Atlantic cod in the Study Area (derived from DFO commercial landings database, 2015–2017).



Note: Sum of quartile catch ranges is the summation of catch weight quartile ranges (i.e., 1–4) for all species; the greater the sum of quartile range counts, the greater the catch weight for a given month).

FIGURE 4.22. Total monthly catch weight quartile codes, May–November 2015–2017 for Atlantic cod in the Study Area (derived from DFO commercial landings database, 2015–2017).

4.2.1.6 Other Notable Commercial Species

As noted in the EA (see Tables 4.3–4.8 *in* LGL 2018a), redfish, yellowtail flounder, white hake and American plaice are also important commercial species in the Study Area (see also Table 4.1 above). Redfish, yellowtail flounder, and American plaice are primarily harvested in areas where water depths are <500 m (see Figure 4.18, 4.20, and 4.22 *in* LGL 2018a) and white hake in water depths <1,000 m (see Figure 3.33 *in* C-NLOPB 2010) (i.e., within the western portion of the

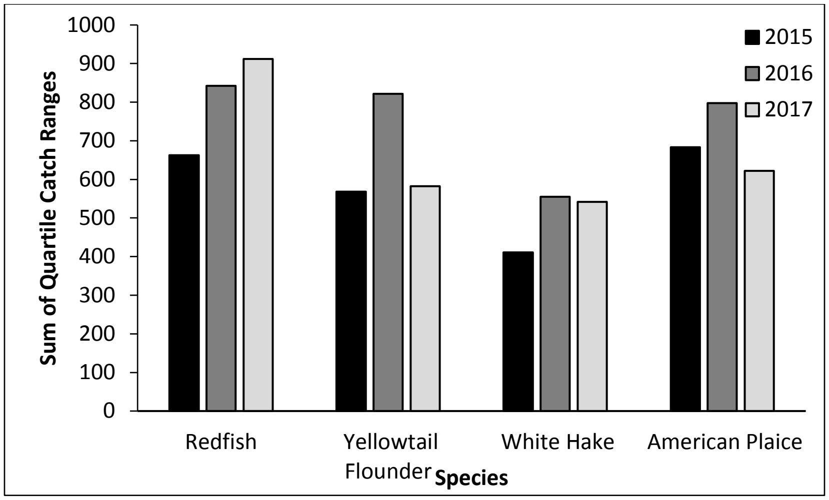
Study Area, including within and/or near the Jeanne d'Arc HD3D, Harbour Deep SE Ext. 3D, Southwest 2D and Southeast 2D 2019 survey areas). NAFO sets annual TAC limits for yellowtail flounder, while both DFO and NAFO manage the fisheries for redfish, white hake, and American plaice.

The TAC for redfish in DFO Unit 2 (i.e., Div. 3Ps, 4Vs, a portion of 4W, and 3Pn+4Vn, during 1 June–31 December; includes the western portion of the Southwest 2D 2019 survey area) has remained at 8,500 mt, with 1,500 mt of the 2018 and 2019 Canadian quota designated for an industry-led biennial scientific redfish survey, as per Section 10 of the *Fisheries Act* (DFO 2019j). The redfish TAC in Div. 3LN (Jeanne d'Arc HD3D, Harbour Deep SE Ext. 3D, and Southeast 2D 2019 survey areas) increased from 10,400 mt in 2015/2016 to 18,100 mt in 2019 (NAFO 2019). The TAC also increased in Div. 3M, from 6,700 mt in 2015 to 10,500 mt in 2019 (NAFO 2019). There have been no changes in TAC in Div. 3O (eastern portion of the Southwest 2D 2019 survey area) or Sub-Area 2 and Div. 1F+3K (North Tablelands 3D and Orphan Basin 2D 2019 survey areas) since the EA (LGL 2018a), with a limit of 20,000 mt in 3O and a fishing ban in place for Sub-Area 2/1F+3K (NAFO 2019). Redfish commercial harvests in the Study Area during May–November increased from 2015–2017 (Figure 4.23), with the highest catches generally occurring during the summer and early-fall (Figure 4.24).

The TAC for yellowtail flounder in Div. 3LNO (includes the Jeanne d'Arc HD3D, Harbour Deep SE Ext. 3D, Southeast 2D, and the eastern portion of the Southwest 2D 2019 survey areas) has remained unchanged since the EA (LGL 2018a), set at 17,000 mt (NAFO 2019). Commercial harvests for yellowtail flounder in the Study Area during May–November increased from 2015–2016 but returned to near the 2015 level by 2017 (Figure 4.23). Yellowtail flounder is mainly harvested during May–July and September–November (Figure 4.24), with the fewest catches during August.

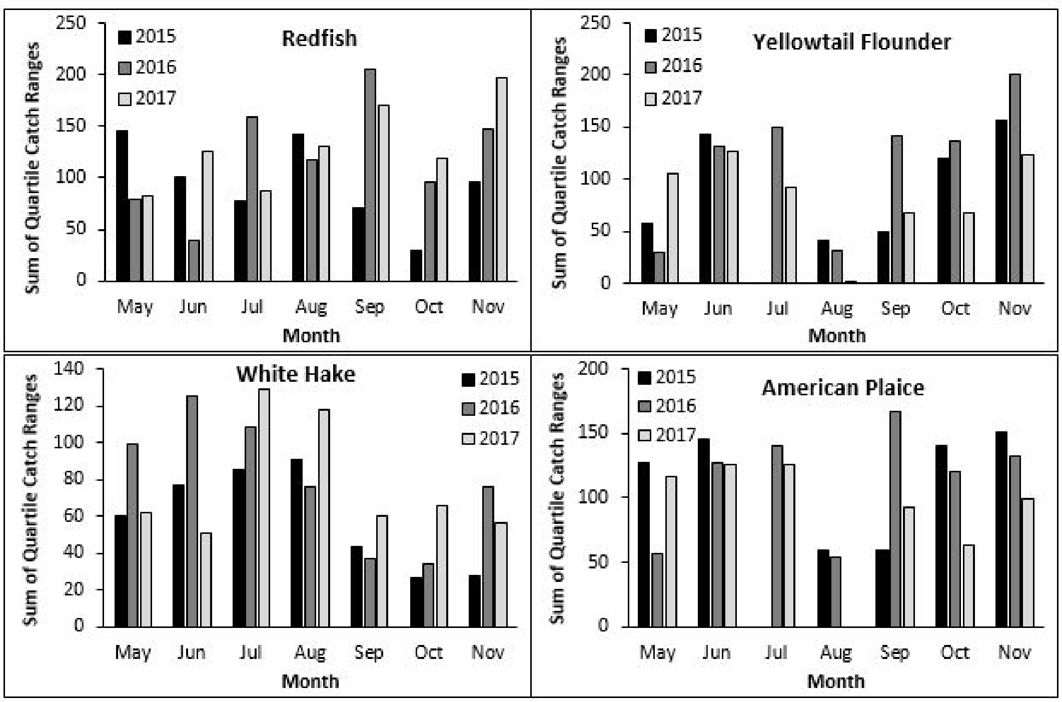
A TAC was set by DFO for white hake in Div. 3Ps (includes the western portion of the Southwest 2D 2019 survey area) for the first time during 2018, at 500 mt until at least 2020/2021 (DFO 2019j). The TAC in Div. 3NO (Southwest 2D and the eastern portion of the Southwest 2D 2019 survey areas) has remained at 1,000 mt (NAFO 2019). Commercial white hake harvests during May–November in the Study Area increased from 2015–2016 and remained relatively steady into 2017 (Figure 4.23). White hake are mainly caught from May–August (Figure 4.24).

A fishing moratorium has remained in effect for American plaice in Div. 3Ps (includes the western portion of the Southwest 2D 2019 survey area), 3LNO (Jeanne d'Arc HD3D, Harbour Deep Se Ext. 3D, Southeast 2D, and the eastern portion of the Southwest 2D 2019 survey areas) and 3M (DFO 2019j; NAFO 2019). American plaice commercial catches during May–November in the Study Area increased from 2015–2016 and decreased in 2017 to slightly below the 2015 harvest level (Figure 4.23). Like yellowtail flounder, American plaice are mainly caught during May–July and September–November, with relatively few catches during August (Figure 4.24).



Note: Sum of quartile catch ranges is the summation of catch weight quartile ranges (i.e., 1–4) for all catch records for all species; the greater the sum of quartile range counts, the greater the catch for a given year).

FIGURE 4.23. Total annual catch weight quartile codes, May–November 2015–2017 for redfish, yellowtail flounder, white hake, and American plaice (derived from DFO commercial landings database, 2015–2017).

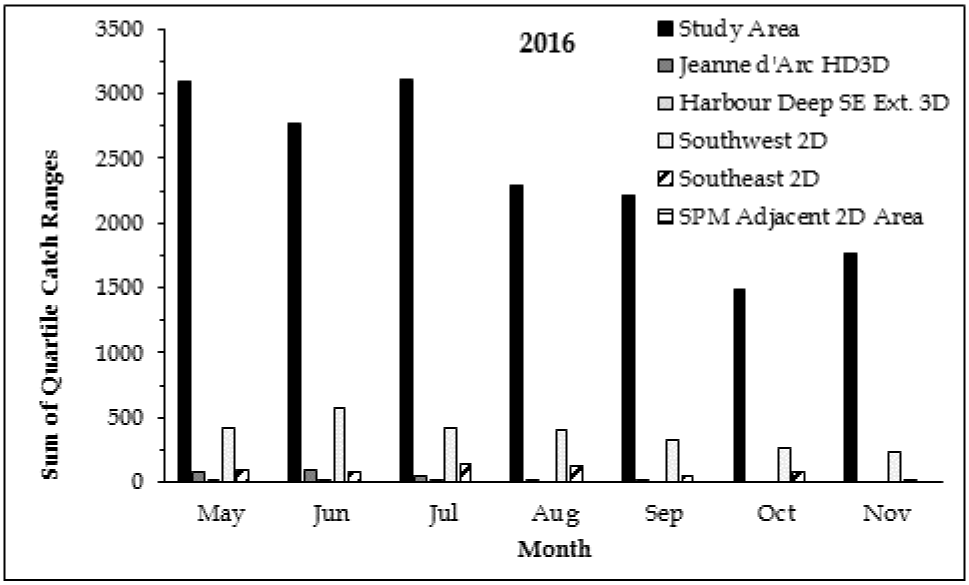


Note: Sum of quartile catch ranges is the summation of catch weight quartile ranges (i.e., 1–4) for all species; the greater the sum of quartile range counts, the greater the catch weight for a given month).

FIGURE 4.24. Total monthly catch weight quartile codes, May–November 2015–2017 for redfish, yellowtail flounder, white hake, and American plaice (derived from DFO commercial landings database, 2015–2017).

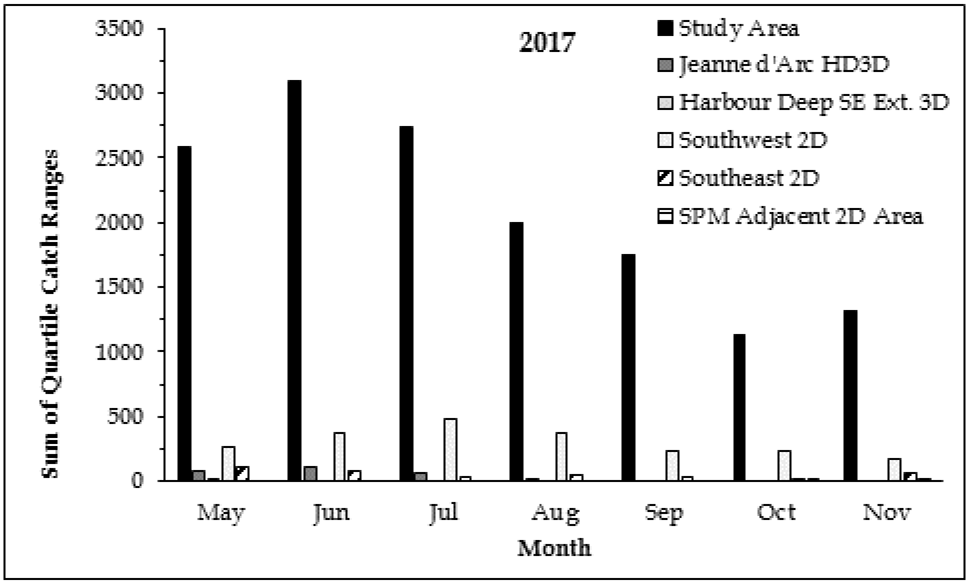
4.2.1.7 Timing and Gear Types

Consistent with previous years, most of the May–November 2016 and 2017 harvesting in the Study Area and planned 2019 3D and 2D survey areas occurred during the May–August period (see Figure 4.5 *in* LGL 2016, Figure 4.7 *in* LGL 2018a and Figures 4.25–4.26 below). Gear types used in the Study Area during 2016 and 2017 were typical of those used during previous years (see Table 4.1 *in* LGL 2016, Table 4.10 *in* LGL 2018a, and Table 4.7 below). The May–November 2016 and 2017 harvest locations for fixed and mobile gears are shown in Figures 4.27–4.30.



Note: Sum of quartile catch ranges is the summation of catch weight quartile ranges (i.e., 1–4) for all species; the greater the sum of quartile range counts, the greater the catch weight for a given month).

FIGURE 4.25. Total monthly catch weight quartile codes in the Study Area and planned 2019 3D and 2D survey areas, for all species combined during May–November 2016 (derived from DFO commercial landings database, 2016).



Note: Sum of quartile catch ranges is the summation of catch weight quartile ranges (i.e., 1–4) for all species; the greater the sum of quartile range counts, the greater the catch weight for a given month).

FIGURE 4.26. Total monthly catch weight quartile codes in the Study Area and planned 2019 3D and 2D survey areas, for all species combined during May–November 2017 (derived from DFO commercial landings database, 2017).

TABLE 4.7. Summary of gear type used and timing of the commercial fishery in the Study Area, and 2D and 3D survey areas, May–November 2016 and 2017 (derived from DFO commercial landings database, 2016/2017).

Species	Harvest Month														Gear Type	
	2016							2017							Fixed	Mobile
	M	J	J	A	S	O	N	M	J	J	A	S	O	N		
Study Area																
Snow Crab	■	■	■	■				■	■	■	■			■	Pot	
Northern Shrimp	■		■	■	■	■	■	■	■	■	■	■	■	■		Trawl
Atlantic Halibut	■	■	■	■	■	■	■	■	■	■	■	■	■	■	Gillnet; Longline	Trawl
Atlantic Cod	■	■	■	■	■	■	■	■	■	■	■	■	■	■	Gillnet; Longline; Pot	Trawl
Greenland Halibut	■	■	■	■	■	■	■	■	■	■	■	■	■	■	Gillnet; Longline	Trawl
Redfish	■	■	■	■	■	■	■	■	■	■	■	■	■	■	Gillnet; Longline	Trawl
Yellowtail Flounder	■	■	■	■	■	■	■	■	■	■	■	■	■	■	Gillnet; Longline	Trawl
American Plaice	■	■	■	■	■	■	■	■	■	■		■	■	■	Gillnet; Longline	Trawl
White Hake	■	■	■	■	■	■	■	■	■	■	■	■	■	■	Gillnet; Longline	Trawl
Witch Flounder	■	■	■	■	■	■	■	■	■	■	■	■	■	■	Gillnet	Trawl
Haddock	■	■	■	■	■	■	■	■	■	■	■	■	■	■	Gillnet; Longline	Trawl
Monkfish	■	■	■	■	■	■	■	■	■	■	■	■	■	■	Gillnet; Longline	Trawl
Whelk	■	■	■	■	■	■	■	■	■	■	■				Pot	
Swordfish			■	■	■	■				■	■	■	■		Longline	
Pollock	■	■	■	■	■	■	■	■	■	■	■	■	■	■	Gillnet; Longline	Trawl
Cusk	■	■	■	■	■	■	■	■	■	■	■	■	■	■	Longline	Trawl
Skate	■	■	■	■	■	■	■		■	■	■	■			Gillnet; Longline	Trawl
Mako Shark			■	■	■	■				■	■	■	■		Longline	
Stimpson's Surf Clam	■		■	■	■	■	■	■	■		■	■	■	■		Dredge (boat)
Cockle	■			■	■	■	■	■	■		■	■	■	■		Dredge (boat)
Bluefin Tuna				■	■	■	■					■	■		Longline	Troller Lines; Rod and Reel (trolling); Electric Harpoon
Bigeye Tuna			■	■	■	■				■	■	■	■		Longline	
Sea Scallop	■	■	■	■				■	■	■	■	■	■			Dredge (boat)
Propeller Clam	■		■	■	■	■							■			Dredge (boat)
Iceland Scallop	■	■		■	■	■	■	■	■	■	■	■	■			Dredge (boat)
Albacore Tuna			■		■	■				■		■	■		Longline	
Sea Cucumber	■	■	■	■	■				■	■	■	■	■	■		Sea Cucumber Drag
Roughhead Grenadier	■		■	■					■		■	■			Gillnet	Trawl
Atlantic (striped) Wolffish		■							■	■					Longline	
Shark					■										Gillnet	
Mahi Mahi (dolphinfish)			■							■	■	■			Longline	
Sculpin							■							■		Trawl

Species	Harvest Month														Gear Type	
	2016							2017							Fixed	Mobile
	M	J	J	A	S	O	N	M	J	J	A	S	O	N		
Mackerel						■							■			Seine
Pink Glass Shrimp											■					Trawl
Toad Crab										■					Pot	
Atlantic Herring													■			Seine
Lobster													■	■	Pot	
White Marlin													■		Longline	
Hagfish													■		Trap Net	
Capelin										■						Seine
Unspecified Pelagics										■					Longline	
Yellowfin Tuna													■		Longline	
Jeanne d'Arc HD3D Survey Area																
Snow Crab	■	■	■	■				■	■	■	■				Pot	
Stimpson's Surf Clam					■											Dredge (boat)
Propeller Clam					■											Dredge (boat)
Cockle					■											Dredge (boat)
Harbour Deep SE Ext. 3D Survey Area																
Snow Crab	■	■	■					■	■	■					Pot	
Southwest 2D Survey Area																
White Hake	■	■	■	■	■	■	■	■	■	■	■	■	■	■	Gillnet; Longline	Trawl
Atlantic Halibut	■	■	■	■	■	■	■	■	■	■	■	■	■	■	Gillnet; Longline	Trawl
Atlantic Cod	■	■	■	■	■	■	■	■	■	■	■	■	■	■	Gillnet; Longline; Pot	Trawl
Haddock	■	■	■	■	■	■	■	■	■	■	■	■	■	■	Gillnet; Longline	Trawl
Whelk	■	■	■	■	■	■		■	■	■	■				Pot	
Monkfish	■	■	■	■	■	■	■	■	■	■	■	■	■		Gillnet; Longline	Trawl
Snow Crab	■	■	■					■	■	■					Pot	
Pollock	■	■	■	■	■	■	■	■	■	■	■	■	■	■	Gillnet; Longline	Trawl
Cusk	■	■	■	■	■	■		■	■	■	■		■	■	Longline	Trawl
Redfish	■	■	■	■	■	■	■	■	■	■	■	■	■	■	Longline	Trawl
Swordfish			■	■	■	■				■	■	■	■		Longline	
Skate		■	■	■		■	■		■	■	■	■			Gillnet; Longline	
American Plaice		■	■	■	■	■	■	■	■			■			Gillnet; Longline	Trawl
Mako Shark				■	■	■				■	■	■	■		Longline	
Bluefin Tuna				■	■	■	■					■	■		Longline	Troller Lines; Rod and Reed (trolling); Electric Harpoon
Greenland Halibut		■	■	■	■	■	■				■		■	■	Gillnet; Longline	Trawl
Yellowtail Flounder			■	■	■	■	■		■	■	■		■		Gillnet; Longline	Trawl
Witch Flounder	■			■			■	■					■			Trawl

Species	Harvest Month														Gear Type	
	2016							2017							Fixed	Mobile
	M	J	J	A	S	O	N	M	J	J	A	S	O	N		
Bigeye Tuna				■	■					■		■	■		Longline	
Sea Scallop		■	■	■						■		■				Dredge (boat)
Iceland Scallop	■	■								■	■	■				Dredge (boat)
Albacore Tuna					■					■		■	■		Longline	
Atlantic (striped) Wolffish		■							■						Longline	
Shark					■										Gillnet	
Stimpson's Surf Clam					■											Dredge (boat)
Propeller Clam					■											Dredge (boat)
Cockle					■											Dredge (boat)
Sea Cucumber												■	■	■		Sea Cucumber Drag
Toad Crab										■					Pot	
Mahi Mahi (dolphinfish)										■					Longline	
Adjacent 2D Area (Saint Pierre and Miquelon Territory)																
Redfish													■	■		Trawl
Atlantic Halibut													■	■		Trawl
Pollock													■			Trawl
Southeast 2D Survey Area																
Snow Crab	■	■	■	■				■	■	■	■				Pot	
Stimpson's Surf Clam	■		■	■	■	■	■	■	■		■	■	■	■		Dredge (boat)
Cockle	■			■	■	■	■	■	■		■	■	■	■		Dredge (boat)
Propeller Clam	■		■	■	■	■										Dredge (boat)
Yellowtail Flounder		■	■		■	■	■	■	■							Trawl
American Plaice		■	■	■	■	■		■	■					■		Trawl
Atlantic Cod		■	■	■	■			■	■	■					Longline	Trawl
Witch Flounder			■											■		Trawl
Atlantic Halibut		■	■					■	■	■					Longline	Trawl
Haddock		■						■							Longline	
Skate		■							■						Longline	
Greenland Halibut								■							Longline	
White Hake										■					Longline	

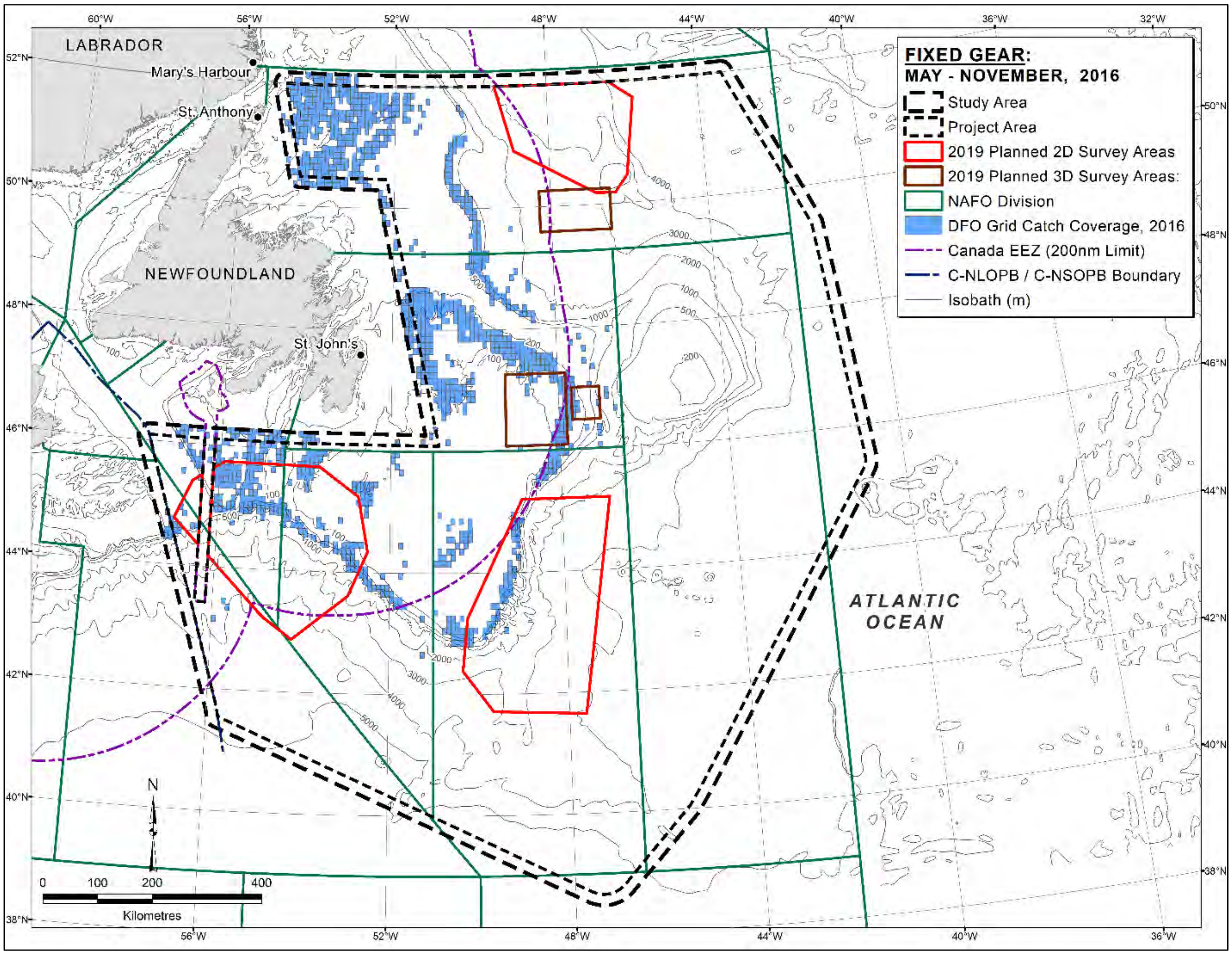


FIGURE 4.27. Harvest locations for fixed gear in the Study Area, all species, May–November 2016 (derived from DFO commercial landings database, 2016).

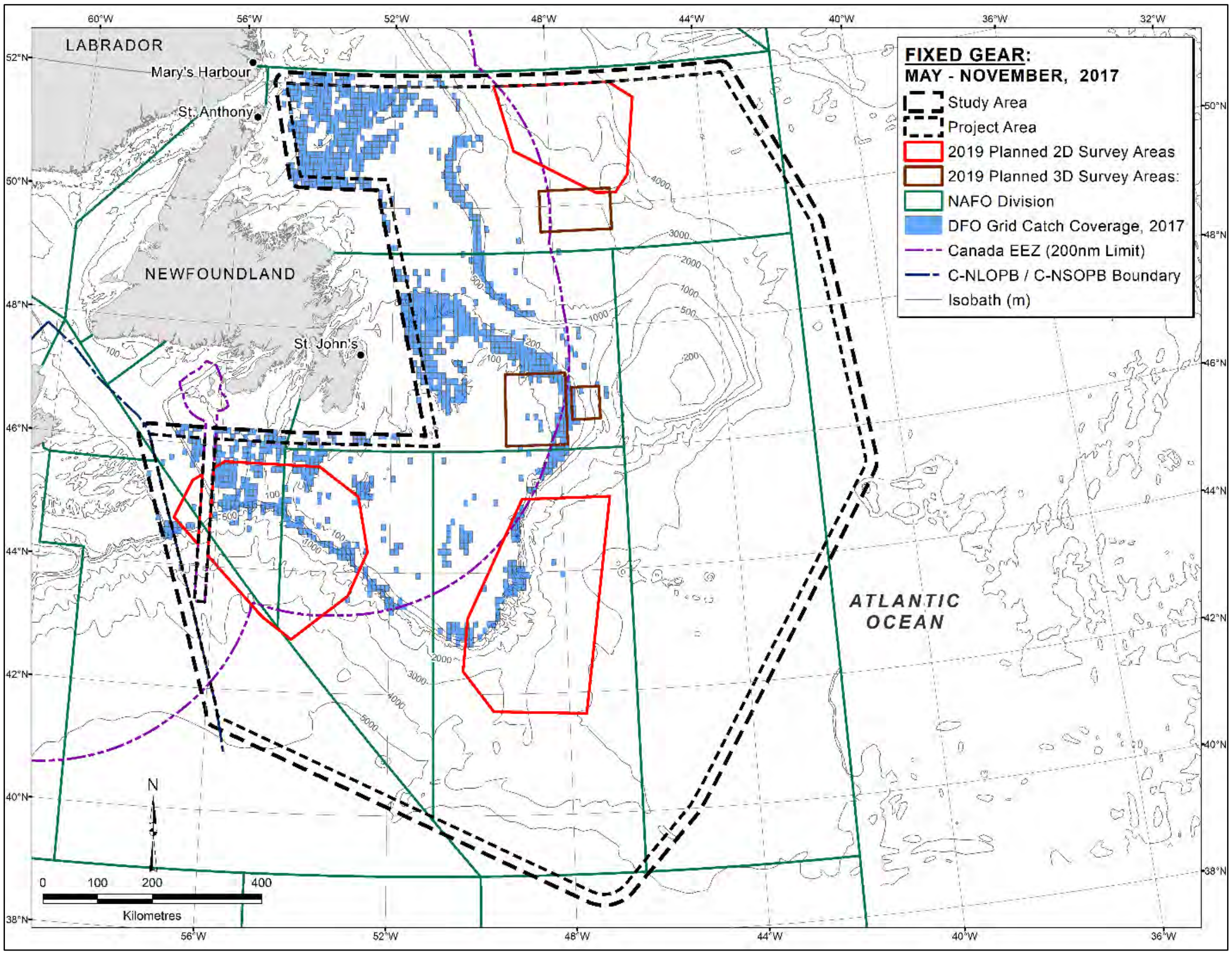


FIGURE 4.28. Harvest locations for fixed gear in the Study Area, all species, May–November 2017 (derived from DFO commercial landings database, 2017).

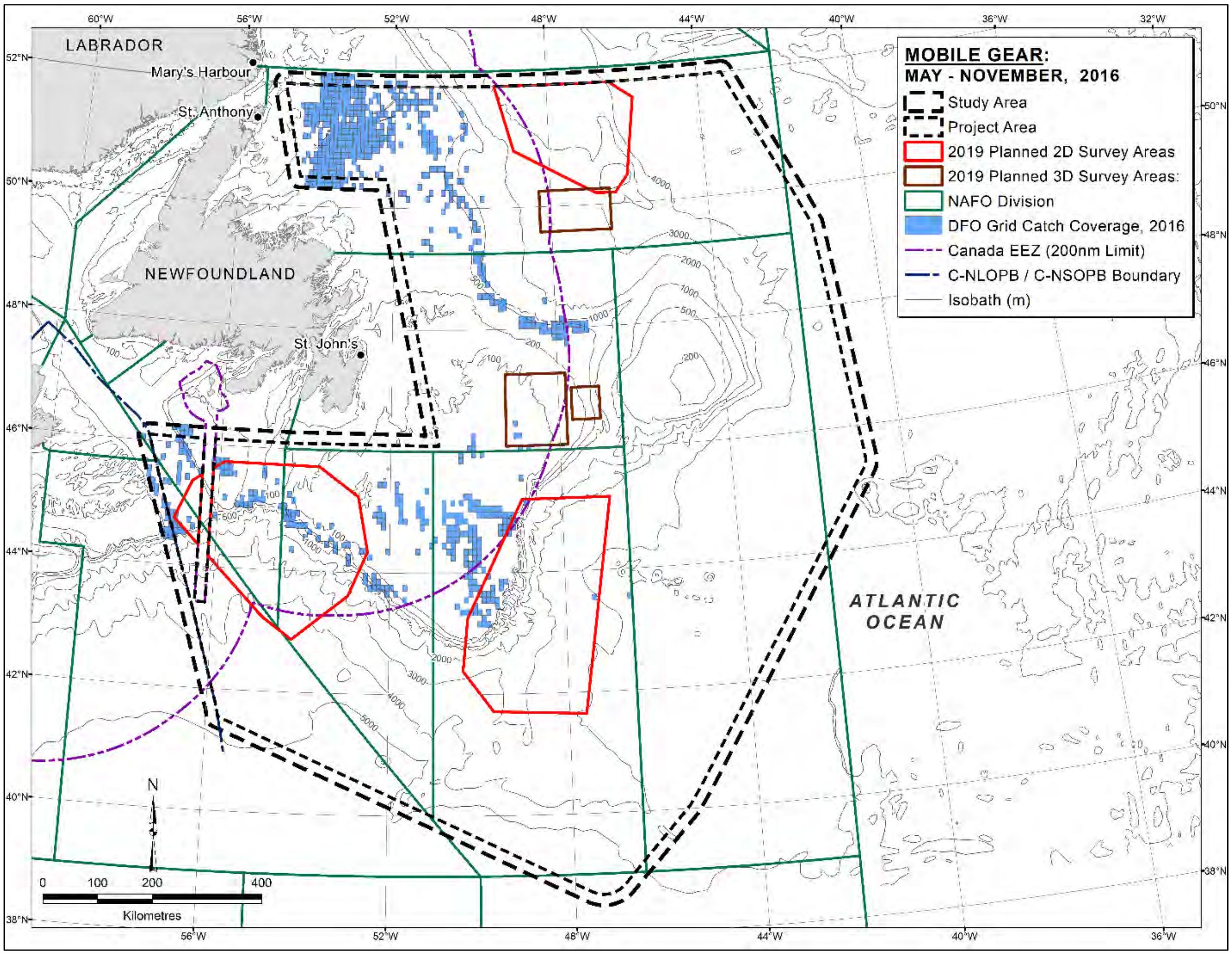


FIGURE 4.29. Harvest locations for mobile gear in the Study Area, all species, May–November 2016 (derived from DFO commercial landings database, 2016).

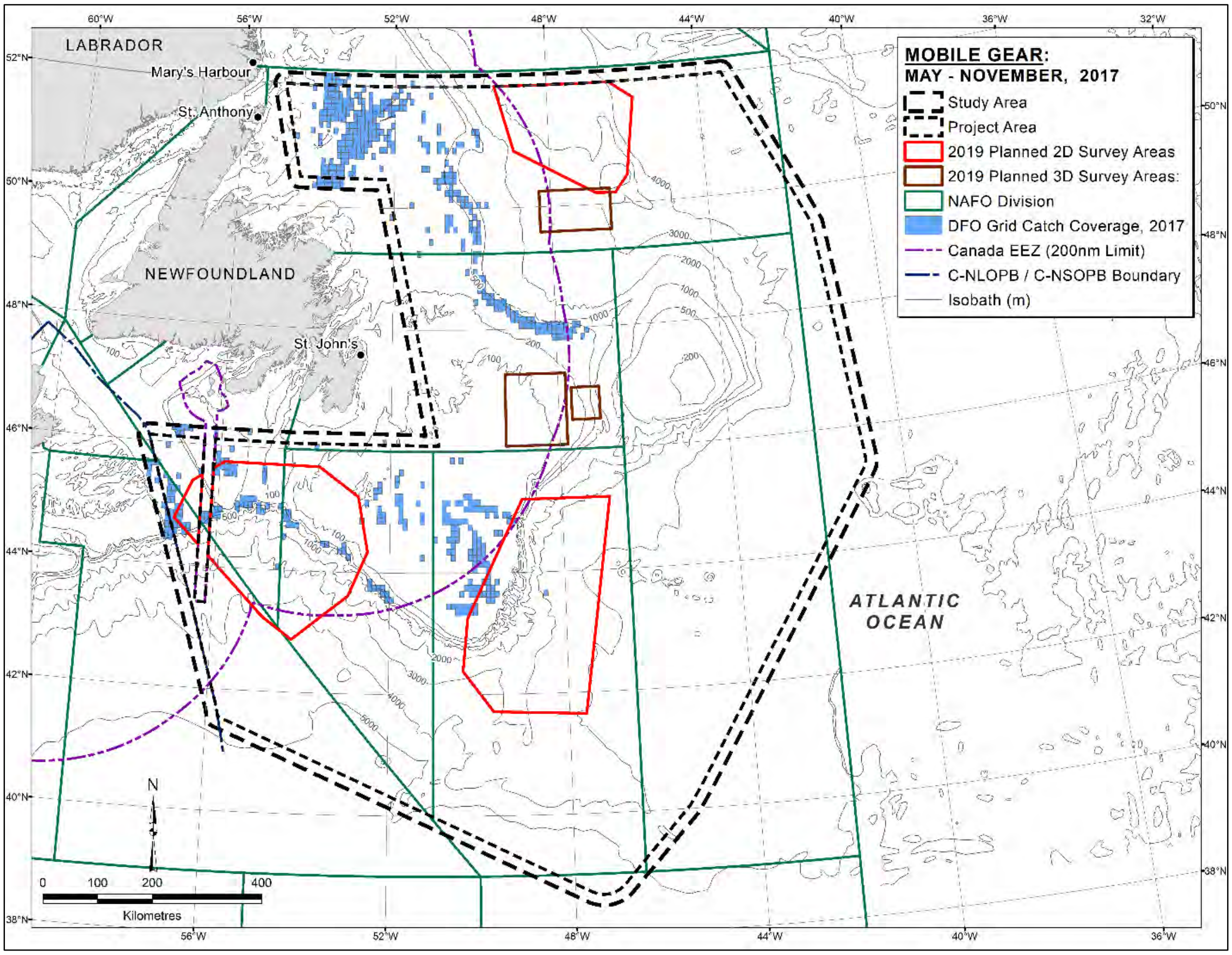


FIGURE 4.30. Harvest locations for mobile gear in the Study Area, all species, May–November 2017 (derived from DFO commercial landings database, 2017).

4.2.2 Indigenous Fisheries

The most recent (December 2018) Indigenous communal-commercial licences and allocations for NL-based groups and organizations providing commercial fisheries access within the Study Area include the following (D. Ball, Resource Management, DFO, pers. comm., 19 April 2019):

- Innu Nation
  - Capelin – Capelin Fishing Areas 3–11
  - Groundfish – 3KL
  - Groundfish (Mobile) – 3KL
  - Mid-shore Groundfish (Atlantic-wide) – 3KLMNOPs and 4V
  - Mackerel – Mackerel Fishing Areas 3–11
  - Shrimp – SFA 6 & 7

- NunatuKavut Community Council (NCC)
  - Groundfish – 3KL
  - Seal – Seal Fishing Areas 5–8 & 33
  - Shrimp – SFA 6
- Nunatsiavut Government (NG)
  - Groundfish – 2KL
  - Seal – Seal Fishing Areas 5–8 & 33
  - Greenland Halibut – 3LMNO
- Miawpukek First Nation (MFN)
  - Bait – Area of Home Port of Lobster Area (Crab Fishing Areas 10 & 11)
  - Capelin – Capelin Fishing Areas 3–11
  - Groundfish – 3KLPs
  - Groundfish (Mobile) – 3KLPs
  - Herring – Herring Fishing Area 11
  - Mackerel – Mackerel Fishing Areas 3–11
  - Scallop – 3Ps
  - Sea Cucumber – 3Ps
  - Seal – Seal Fishing Areas 5–8 & 33
  - Snow Crab – Snow Crab Fishing Areas 10 & 11
  - Squid – Squid Fishing Area 10
  - Bluefin Tuna – 3LNOP-Atlantic; 3LNOP-Rotational
  - Unspecified Tuna – 3NLOP-Atlantic
  - Whelk – 3Ps
- Qalipu Mi'kmaq First Nation Band (QFNB)
  - Bait – Area of Home Port of Lobster Area 4B
  - Lobster – Lobster Fishing Area 4B
  - Capelin – Capelin Fishing Areas 3–11
  - Groundfish – 3KL
  - Herring – Herring Fishing Areas 3–8
  - Mackerel – Mackerel Fishing Areas 3–11
  - Shrimp – SFA 6
  - Snow Crab – Snow Crab Fishing Area 4
  - Squid – Squid Fishing Area 4
- Mi'kmaq Alsumk Mowimsikik Koqoey Association (MAMKA) (Aboriginal Aquatic Resource & Oceans Management [AAROM] Body – MFN and QFNB)
  - Capelin – Capelin Fishing Area 10
  - Groundfish – 3KLPs
  - Herring – Herring Fishing Area 10
  - Scallop – 3Ps
  - Snow Crab – Snow Crab Fishing Areas 10 & 11
  - Whelk – 3Ps

There are no food, social and ceremonial (FSC) fisheries within the Study Area (D. Ball, Resource Management, DFO, pers. comm., 19 April 2019).

4.2.3 Recreational Fisheries

Recreational fisheries in NL are described in Section 4.3.4.4 *in* C-NLOPB (2014), Section 3.3.3 *in* C-NLOPB (2010), Section 4.3.5 *in* LGL (2015a), Section 4.2.3 *in* LGL (2016), and Section 4.3.5 *in* LGL (2018a).

The 2018 NL recreational groundfish fishery was open for 39 days, a decrease of seven days from 2017, from 30 June–30 September (DFO 2019j). As in the 2017 season, there was still no requirement for fishing licenses or tags during 2018 (DFO 2019j). There was no change in the NAFO Div. in which the recreational fishery occurred, including 2GHJ, 3KLPsPn, and 4R but excluding the Eastport and Gilbert Bay Marine Protected Areas (MPAs), of which 3KLPs overlap with the Study Area.

Pending the results of a full science stock assessment scheduled for March 2019, the 2019 recreational Atlantic salmon fishery interim management decision currently allows for the retention of at least one salmon on all rivers that permit retention, in light of the slight improvement observed in small salmon by the end of the 2018 angling season (DFO 2019j). The season will variably be open from June–September or October, depending on the fishing zone (DFO 2019j).

It is possible that recreational fisheries may occur within the shallower portions of the Study Area. Due to their depth and distance from shore, no recreational fisheries are anticipated within the planned 2019 3D and 2D survey areas.

4.2.4 Aquaculture

Aquaculture operations in NL are described in Section 4.3.4.3 *in* C-NLOPB (2014) and Section 3.3.2 *in* C-NLOPB (2010). All aquaculture sites within NL have remained coastally-based. There are no approved aquaculture sites within the Study Area (FLR 2018; C. Laing, Registrar of Aquaculture, Aquaculture Licencing Administrator, Department of Fisheries and Land Resources, Government of Newfoundland and Labrador, Canada, pers. comm., 26 March 2019).

4.2.5 Science Surveys

4.2.5.1 DFO Research Vessel (RV) Surveys

Results of analysis of DFO RV survey data collected within the Study Area during annual spring and fall multi-species trawl surveys during May–November 2009–2014 are described in

Section 4.3.7 of the EA (LGL 2018a), and those for the May–November 2015, 2016 and 2017 datasets are summarized below for comparative purposes.

Similar to DFO RV surveys described in the EA (LGL 2018a), the following species comprised the majority of the total catch weight during RV surveys between May and November 2015–2017: deepwater redfish (45% of total catch weight), yellowtail flounder (9%), American plaice (8%), thorny skate (7%), and Atlantic cod (6%). Total catch weight across all species caught in the Study Area during DFO RV surveys during May–November 2015–2017 was 339 mt, with annual total catch weights (2015 = 133 mt; 2016 = 102 mt; 2017 = 104 mt) similar to those observed during 2013 and 2014 (LGL 2018a). Catch weights and numbers for species/groups contributing ≥0.1% of the total catch weight in the Study Area during May–November 2015–2017 are presented in Table 4.8.

TABLE 4.8. Catch weights and numbers of macroinvertebrates and fishes collected during DFO RV surveys in the Study Area, May–November 2015–2017 (derived from DFO RV survey databases, 2015–2017).

Species	Catch Weight (mt)			Total Catch Weight (mt)	Catch Number			Total Catch Number
	2015	2016	2017		2015	2016	2017	
Deepwater Redfish (*Sebastes mentella*)	69	51	32	152	407,182	221,043	152,392	780,617
Yellowtail Flounder (*Limanda ferruginea*)	11	9	11	31	35,968	32,680	39,525	108,173
American Plaice (*Hippoglossoides platessoides*)	11	7	11	28	96,676	68,840	75,164	240,680
Thorny Skate (*Raja radiata*)	8	6	10	23	3,666	3,370	6,132	13,168
Atlantic Cod (*Gadus morhua*)	9	6	6	22	11,257	8,499	8,700	28,456
Orange-footed Sea Cucumber (*Cucumaria frondosa*)	1	3	6	10	4,745	8,154	17,564	30,463
Sand Lance (*Ammodytes dubius*)	1	4	3	7	142,496	333,858	263,813	740,167
Greenland Halibut (*Reinhardtius hippoglossoides*)	3	1	2	6	9,952	4,665	9,507	24,124
Northern Shrimp (*Pandalus borealis*)	4	1	1	6	845,260	259,390	280,033	1,384,683
Silver Hake (*Merluccius bilinearis*)	2	1	3	5	8,042	4,129	14,625	26,796
Witch Flounder (*Glyptocephalus cynoglossus*)	1	1	2	4	3,118	2,672	6,791	12,581
Capelin (*Mallotus villosus*)	2	0.5	2	4	102,300	48,022	436,781	587,103
Roughhead Grenadier (*Macrourus berglax*)	1	1	1	3	2,178	2,329	3,462	7,969
Greenland Shark (*Somniosus microcephalus*)	0	2	1	3	0	1	1	2
White Hake (*Urophycis tenuis*)	1	1	1	3	730	665	921	2,316

Species	Catch Weight (mt)			Total Catch Weight (mt)	Catch Number			Total Catch Number
	2015	2016	2017		2015	2016	2017	
Sponge (Porifera)	0.5	1	1	2	n/d	n/d	n/d	n/d
Jellyfishes (Schyphozoa)	1	1	1	2	n/d	n/d	n/d	n/d
Atlantic Halibut (*Hippoglossus hippoglossus*)	1	1	1	2	41	53	62	156
Sea Anemone (Actinaria)	0.4	1	1	2	3,315	9,121	10,497	22,933
Atlantic (striped) Wolffish (*Anarhichas lupus*)	1	0.4	1	2	527	492	631	1,650
Striped Shrimp (*Pandalus montagui*)	0.5	0.5	0.5	1	142,274	136,491	136,661	415,426
Atlantic Haddock (*Melanogrammus aeglefinus*)	1	0.4	0.3	1	357	296	132	785
Snow Crab (*Chionoecetes opilio*)	0.4	0.2	0.4	1	3,923	2,700	4,170	10,793
Basket Star (*Gorgonocephalus arcticus*)	0.2	0.4	0.3	1	19	34	53	106
Longfin Hake (*Urophycis chesteri*)	0.2	0.2	0.4	1	2,275	2,334	5,308	9,917
Monkfish (*Lophius americanus*)	0.2	0.2	0.4	1	39	38	73	150
Green Sea Urchin (*Strongylocentrotus droebachiensis*)	0.2	0.2	0.4	1	18,777	14,820	27,154	60,751
Spiny Dogfish Shark (*Squalus acanthias*)	0.04	0.02	1	1	22	19	433	474
Northern Wolffish (*Anarhichas denticulatus*)	0.2	0.2	0.4	1	59	63	115	237
Black Dogfish Shark (*Centroscyllium fabricii*)	0.1	0.3	0.2	1	193	412	308	913
Arctic Argid Shrimp (*Argis dentata*)	0.3	0.2	0.1	1	45,884	37,307	21,791	104,982
Shorthorn Sculpin (*Myoxocephalus scorpius*)	0.2	0.1	0.2	1	274	144	278	696
Spinytail Skate (*Raja spinicauda*)	0.1	0.1	0.3	1	15	15	29	59
Sessile Tunicate (*Boltenia* sp.)	0.2	0.2	0.2	1	1,150	1,637	1,994	4,781
Spotted Wolffish (*Anarhichas minor*)	0.2	0.1	0.2	1	62	61	82	205
Comb Jelly (Ctenophora)	0.3	0.1	0.1	0.5	n/d	n/d	n/d	n/d
Roundnose Grenadier (*Coryphaenoides rupestris*)	0.1	0.1	0.3	0.4	781	663	2,088	3,532
Marlin Spike (*Nezumia bairdi*)	0.1	0.1	0.2	0.4	2,405	2,669	3,215	8,289
Blue Hake (*Antimora rostrata*)	0.1	0.1	0.1	0.4	1,258	1,181	847	3,286
Longhorn Sculpin (*Myoxocephalus octodecemspinosus*)	0.2	0.1	0.2	0.4	711	424	519	1,654
Sea Cucumber (Holothuroidea)	0.3	0.01	0.1	0.4	3,848	367	8,003	12,218
Golden Redfish (*Sebastes marinus*)	0.1	0.1	0.1	0.4	84	82	111	277
Sand Dollar (Clypeasteroida)	0.1	0.2	0.2	0.4	4,284	5,171	7,224	16,679

Species	Catch Weight (mt)			Total Catch Weight (mt)	Catch Number			Total Catch Number
	2015	2016	2017		2015	2016	2017	
Sand Dollar (*Echinarachnius parma*)	0.1	0.1	0.1	0.3	7,003	5,903	5,782	18,688
Sea Raven (*Hemitripterus americanus*)	0.1	0.1	0.1	0.3	67	44	75	186
Coral	0.1	0.1	0.1	0.3	2,509	1,961	5,057	9,527
Moustache Sculpin (*Triglops murrayi*)	0.1	0.1	0.1	0.3	5,854	13,957	9,289	29,100
Mud Star (*Ctenodiscus crispatus*)	0.04	0.04	0.2	0.3	5,296	4,490	27,147	36,933
Longnose Eel (*Synaphobranchus kaupii*)	0.1	0.1	0.1	0.3	1,473	1,709	2,632	5,814
Brittle Star (*Ophiura sarsi*)	0.1	0.05	0.2	0.3	8,324	1,390	1,403	11,117
Silver Hake (*Merluccius albidus*)	0	0.3	0	0.3	0	533	0	533
Atlantic Herring (*Clupea harengus*)	0.1	0.1	0.02	0.2	358	408	124	890
Total	**132**	**101**	**102**	**335**	**1,937,031**	**1,245,306**	**1,598,698**	**4,781,035**

Note: n/d denotes data unavailable.

As during May–November 2014, RV survey catch locations were in the western portion of the Study Area in 2015–2017, mainly in water depths <1,000 m, including throughout the Jeanne d'Arc HD3D and Harbour Deep SE Ext. 3D 2019 survey areas, the northern portion of the Southwest 2D survey area, and the western portion of the Southeast 2D survey area (see Figure 4.24 *in* LGL 2018a, and Figures 4.31–4.33 below). There were no catch locations within the North Tablelands 3D or Orphan Basin 2D survey areas. Mean catch depths for species/groups contributing ≥0.1% of the total catch weight and predominant species for all species caught at various mean depth ranges in the Study Area during May–November 2015–2017 are presented in Tables 4.9–4.10.

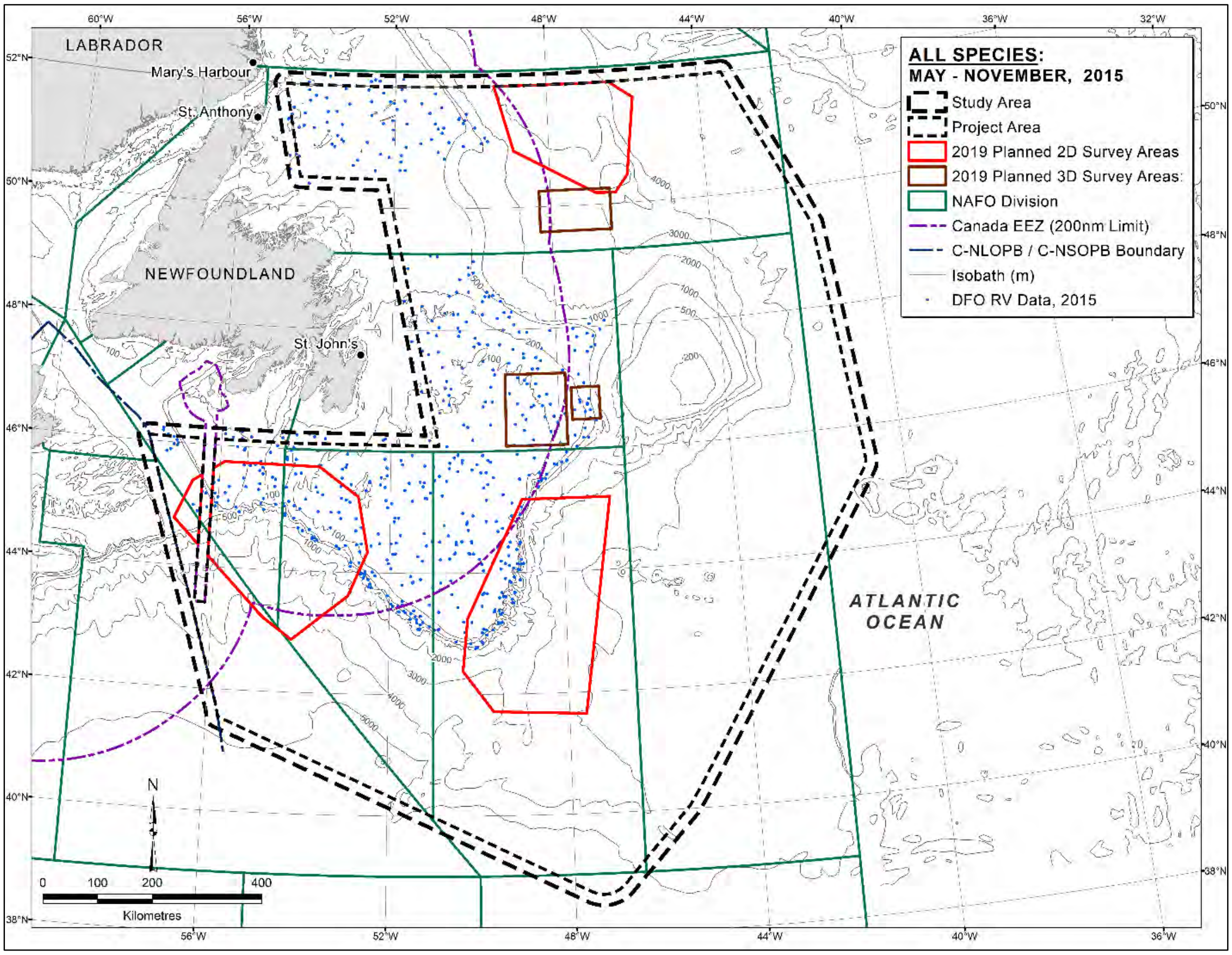


FIGURE 4.31. Distribution of DFO RV survey catch locations in the Study Area, all species, May–November 2015 (derived from DFO RV survey database, 2015).

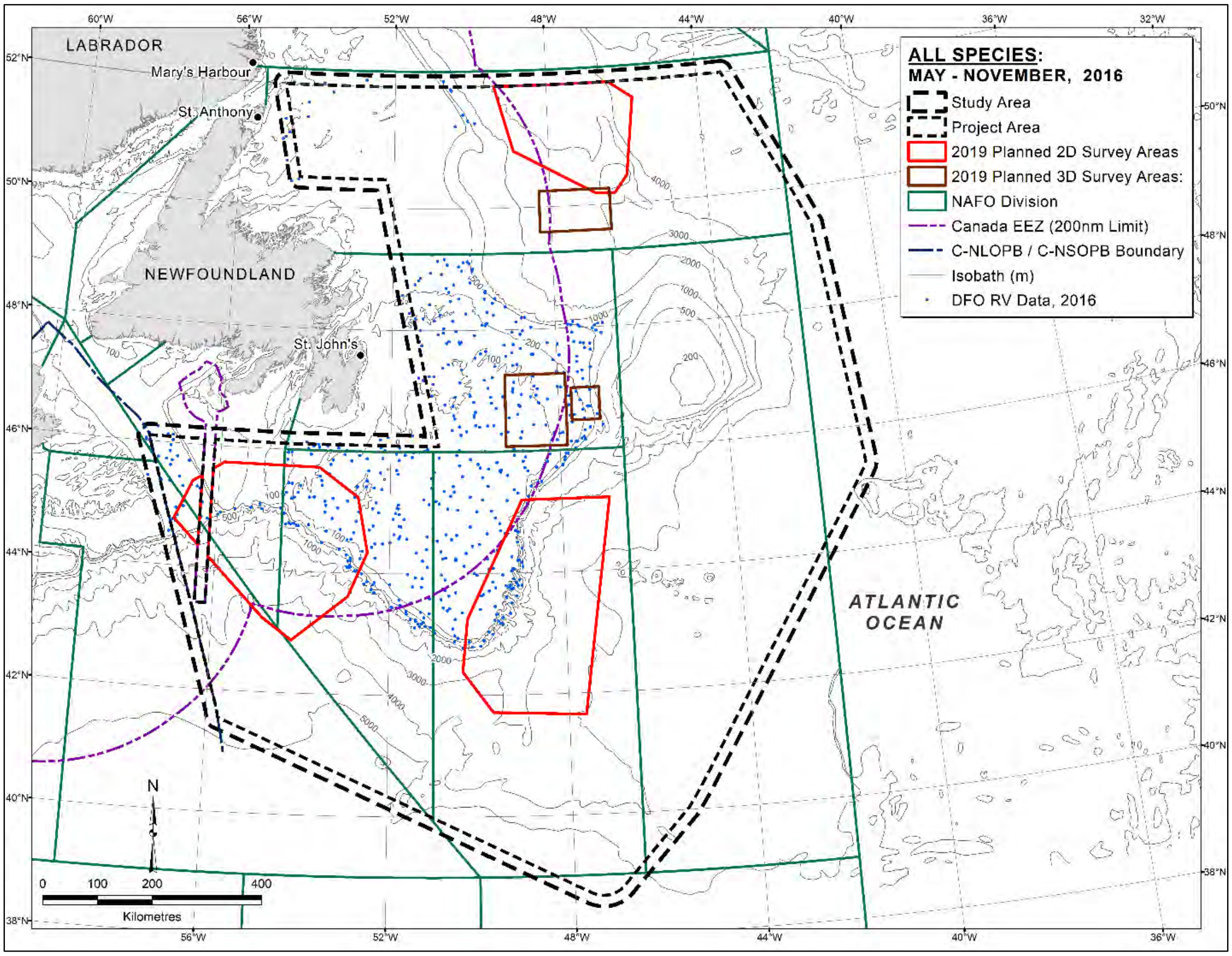


FIGURE 4.32. Distribution of DFO RV survey catch locations in the Study Area, all species, May–November 2016 (derived from DFO RV survey database, 2016).

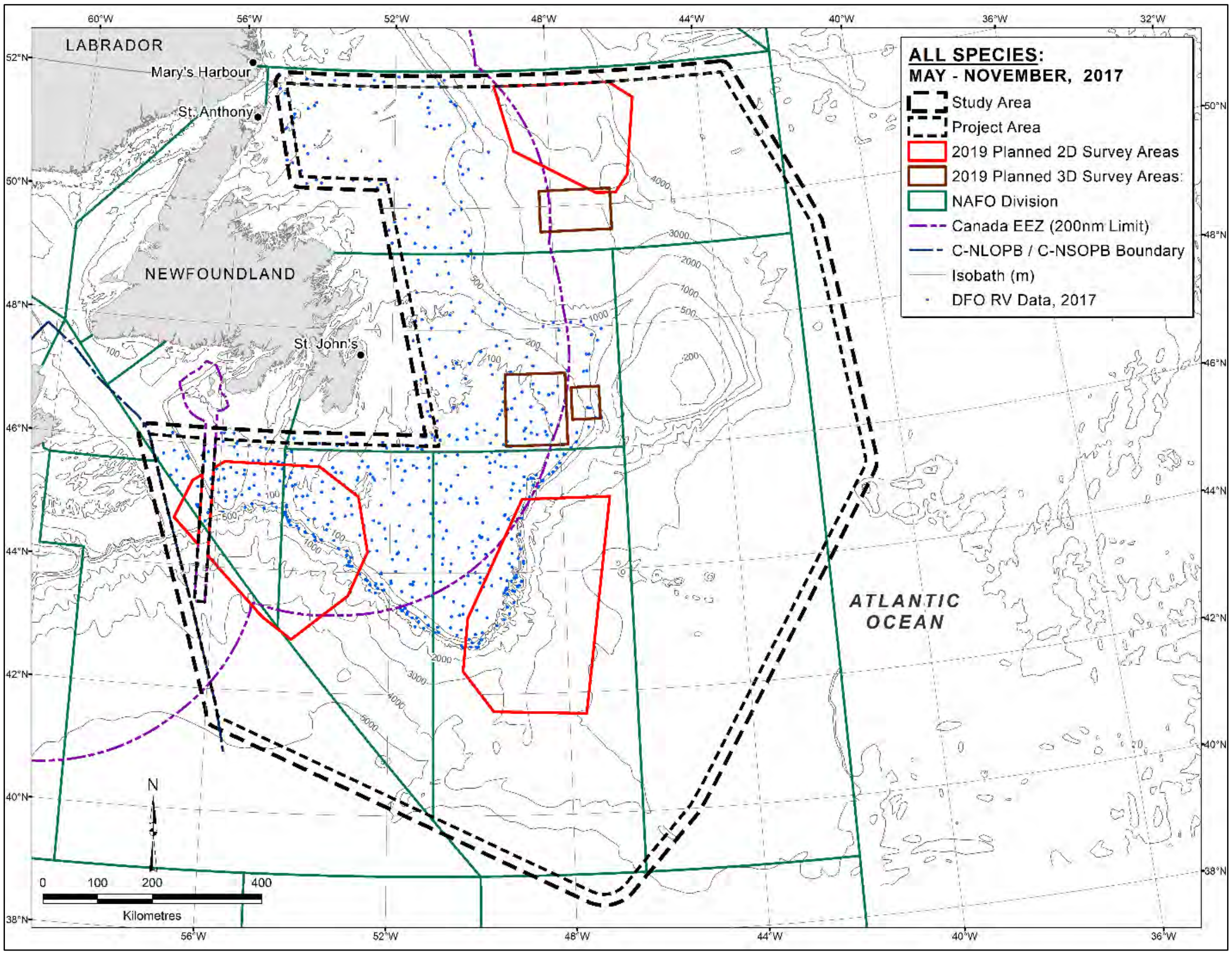


FIGURE 4.33. Distribution of DFO RV survey catch locations in the Study Area, all species, May–November 2017 (derived from DFO RV survey database, 2017).

TABLE 4.9. Mean catch depths of macroinvertebrates and fishes collected during DFO RV surveys in the Study Area, May–November 2015–2017 (derived from DFO RV survey databases, 2015–2017).

Species	Spring Mean Catch Depth (m) [a]				Fall Mean Catch Depth (m) [b]			
	2015	2016	2017	Total	2015	2016	2017	Total
Deepwater Redfish (*Sebastes mentella*)	321	354	356	345	284	312	291	296
Yellowtail Flounder (*Limanda ferruginea*)	67	79	72	73	77	70	80	75
American Plaice (*Hippoglossoides platessoides*)	137	226	123	171	158	134	166	152
Thorny Skate (*Raja radiata*)	240	308	267	277	199	170	198	189
Atlantic Cod (*Gadus morhua*)	164	244	140	192	142	126	173	147
Orange-footed Sea Cucumber (*Cucumaria frondosa*)	81	171	78	110	137	108	173	139
Sand Lance (*Ammodytes dubius*)	91	95	74	86	–	–	–	–
Greenland Halibut (*Reinhardtius hippoglossoides*)	339	334	279	320	349	330	284	321

Species	Spring Mean Catch Depth (m) [a]				Fall Mean Catch Depth (m) [b]			
	2015	**2016**	**2017**	**Total**	**2015**	**2016**	**2017**	**Total**
Northern Shrimp (*Pandalus borealis*)	265	318	207	271	348	284	243	285
Silver Hake (*Merluccius bilinearis*)	262	302	293	284	–	328	–	328
Witch Flounder (*Glyptocephalus cynoglossus*)	340	390	409	381	275	289	293	286
Capelin (*Mallotus villosus*)	124	160	95	126	–	–	–	–
Roughhead Grenadier (*Macrourus berglax*)	454	465	490	470	539	494	516	517
Greenland Shark (*Somniosus microcephalus*)	–	563	–	563	–	–	552	552
White Hake (*Urophycis tenuis*)	262	360	337	336	264	171	163	208
Sponge (Porifera)	280	294	265	282	317	300	279	299
Jellyfishes (Schyphozoa)	449	399	324	392	342	325	293	320
Atlantic Halibut (*Hippoglossus hippoglossus*)	293	425	222	347	292	322	268	294
Sea Anemone (Actinaria)	263	317	342	309	319	284	279	294
Atlantic (striped) Wolffish (*Anarhichas lupus*)	204	241	192	216	169	157	216	181
Striped Shrimp (*Pandalus montagui*)	124	144	77	115	112	98	123	111
Atlantic Haddock (*Melanogrammus aeglefinus*)	162	190	193	177	139	130	209	159
Snow Crab (*Chionoecetes opilio*)	154	205	147	174	189	160	170	173
Basket Star (*Gorgonocephalus arcticus*)	133	180	187	167	139	116	174	143
Longfin Hake (*Urophycis chesteri*)	391	415	446	417	–	380	–	380
Monkfish (*Lophius americanus*)	218	298	255	257	324	336	299	320
Green Sea Urchin (*Strongylocentrotus droebachiensis*)	107	134	86	109	98	97	119	105
Spiny Dogfish Shark (*Squalus acanthias*)	174	–	220	197	127	312	152	197
Northern Wolffish (*Anarhichas denticulatus*)	534	573	508	538	494	569	396	473
Black Dogfish Shark (*Centroscyllium fabricii*)	539	485	534	511	673	634	619	638
Arctic Argid Shrimp (*Argis dentata*)	119	130	94	115	123	106	120	117
Shorthorn Sculpin (*Myoxocephalus scorpius*)	87	98	75	87	–	–	–	–
Spinytail Skate (*Raja spinicauda*)	559	505	357	497	584	495	445	523
Sessile Tunicate (*Boltenia* sp.)	102	181	89	124	149	120	112	127
Spotted Wolffish (*Anarhichas minor*)	310	332	372	338	291	309	282	295
Comb Jelly (Ctenophora)	139	67	107	112	123	78	104	102
Roundnose Grenadier (*Coryphaenoides rupestris*)	634	500	596	566	703	680	750	715
Marlin Spike (*Nezumia bairdi*)	464	445	461	455	–	371	–	371
Blue Hake (*Antimora rostrata*)	596	587	564	583	–	590	–	590
Longhorn Sculpin (*Myoxocephalus octodecemspinosus*)	58	63	62	61	–	–	–	–
Sea Cucumber (Holothuroidea)	59	214	190	158	313	509	60	251
Golden Redfish (*Sebastes marinus*)	227	487	253	388	316	261	288	292
Sand Dollar (Clypeasteroida)	138	150	102	130	130	112	130	123
Sand Dollar (*Echinarachnius parma*)	161	136	135	144	198	239	140	192
Sea Raven (*Hemitripterus americanus*)	75	70	70	71	–	–	–	–
Coral	276	323	245	287	403	320	378	367

Species	Spring Mean Catch Depth (m) [a]				Fall Mean Catch Depth (m) [b]			
	2015	2016	2017	Total	2015	2016	2017	Total
Moustache Sculpin (*Triglops murrayi*)	115	134	82	110	–	–	–	–
Mud Star (*Ctenodiscus crispatus*)	185	175	323	228	183	154	253	196
Longnose Eel (*Synaphobranchus kaupii*)	536	524	507	523	–	524	–	524
Brittle Star (*Ophiura sarsi*)	157	187	162	169	215	152	274	214
Silver Hake (*Merluccius albidus*)	–	398	–	398	–	290	–	290
Atlantic Herring (*Clupea harengus*)	138	202	215	188	–	–	–	–
Total	**209**	**279**	**166**	**227**	**212**	**210**	**219**	**214**

[a] Spring survey months: 2015 = May–June; 2016 = May–June and August; 2017 = May–June.
[b] Fall survey months: 2015/2016/2017 = September–November.

TABLE 4.10. Total catch weights and predominant species caught at various mean catch depth ranges during DFO RV surveys, May–November 2015–2017 (derived from DFO RV survey database, 2015–2017).

Mean Catch Depth Range (m)	Total Catch Weight (mt)			Predominant Species (% of Total Catch Weight)		
	2015	2016	2017	2015	2016	2017
<100	13	13	17	Yellowtail Flounder (86%) Sand Lance (9%)	Yellowtail Flounder (68%) Sand Lance (28%)	Yellowtail Flounder (66%) Sand Lance (15%) Capelin (11%)
100 – 199	26	20	26	American Plaice (41%) Atlantic Cod (33%)	American Plaice (33%) Atlantic Cod (33%) Orange-footed Sea Cucumber (13%)	American Plaice (41%) Atlantic Cod (25%) Orange-footed Sea Cucumber (23%)
200 – 299	16	9	23	Thorny Skate (50%) Northern Shrimp (22%) Silver Hake (11%)	Thorny Skate (66%) Northern Shrimp (14%)	Thorny Skate (43%) Silver Hake (13%) Witch Flounder (9%) Greenland Halibut (9%) Northern Shrimp (6%)
300 – 399	74	57	34	Deepwater Redfish (93%) Greenland Halibut (4%)	Deepwater Redfish (90%) Greenland Halibut (2%)	Deepwater Redfish (94%) Jellyfishes (2%)
400 – 499	2	2	2	Roughhead Grenadier (59%) Northern Wolffish (13%) Marlin Spike (9%)	Roughhead Grenadier (59%) Marlin Spike (8%) Sea Star (Asteriidae) (8%)	Roughhead Grenadier (60%) Northern Wolffish (16%) Spinytail Skate (13%)
500 – 599	0.3	3	1	Blue Hake (50%) Spinytail Skate (40%)	Greenland Shark (71%) Black Dogfish Shark (12%)	Greenland Shark (66%) Black Dogfish Shark (16%) Blue Hake (11%)
600 – 699	0.2	0.1	0.02	Black Dogfish Shark (53%) Roundnose Grenadier (39%)	Roundnose Grenadier (74%) Shrimp (*Acanthephyra pelagica*) (16%)	Deepwater Skate (*Raja fyllae*) (38%) Spiny Red Crab (*Neolithodes grimaldii*) (26%) Jensen's Skate (*Raja jenseni*) (9%)
700 – 799	0.02	0	0.3	Shrimp (*A. pelagica*) (87%)	–	Roundnose Grenadier (91%) Shrimp (*A. pelagica*) (8%)
800 – 899	0.02	<0.01	<0.01	Shrimp (*Pasiphaea tarda*) (55%) Soft Deep-sea Urchin (*Phormosoma placenta*) (41%)	Mysid (*Gnathophausia* sp.) (100%)	Skate (*Raja* sp.) (100%)
900 – 999	0	0	0.02	–	–	Soft Deep-sea Urchin (100%)
≥1,000	0.03	0.03	0.03	Jensen's Skate (56%) Deep-sea Cat Shark (*Apristurus profundorum*) (43%)	Jensen's Skate (66%) Deep-sea Cat Shark (30%)	White Skate (*Raja lintea*) (51%) Deep-sea Cat Shark (45%)

The tentative schedule for the 2019 DFO multispecies RV surveys is presented in Table 4.11 (L. Mello, Stock Assessment Biologist, Marine Fish Species at Risk and Fisheries Sampling, Northwest Atlantic Fisheries Centre, DFO, pers. comm., 27 March 2019). Spring RV surveys within the Study Area are set to begin late-March and continue into early-June. Fall RV surveys within the Study Area will begin mid-September and end in late-December.

TABLE 4.11. Tentative schedule of DFO RV surveys within the Study Area during 2019.

NAFO Division	Start Date	End Date	Vessel
3L	27 Mar	18 Apr	*Teleost*
3P	28 Mar	9 Apr	*Needler*
3P	10 Apr	18 Apr	*Needler*
3P + 3O	23 Apr	7 May	*Needler*
3P + 3KLMNO	23 Apr	29 Apr	*Teleost*
3KL	30 Apr	20 May	*Teleost*
3O + 3N	8 May	21 May	*Needler*
3L + 3N	22 May	4 Jun	*Needler*
3O	11 Sep	24 Sep	*Needler*
3O + 3N	25 Sep	8 Oct	*Needler*
3N + 3L	9 Oct	22 Oct	*Needler*
3L	23 Oct	5 Nov	*Needler*
3K + 3L	6 Nov	19 Nov	*Needler*
3K	19 Nov	3 Dec	*Teleost*
3K	4 Dec	20 Dec	*Teleost*

4.2.5.2 Industry and DFO Science Surveys

The DFO-Industry collaborative post-season snow crab trap survey is described in Section 4.3.8 *in* LGL (2018a). The snow crab TAC for this survey increased from 350 mt during 2015 and 2016 to 470 mt in 2017, then decreased to 460 mt and 400 mt during 2018 and 2019, respectively (DFO 2019j). A total of 432 survey stations occur within the Study Area, including 24 and seven within the Jeanne d'Arc HD3D 2019 and Harbour Deep SE Ext. 3D survey areas, respectively, and 19 within the Southwest 2D 2019 survey area (Figure 4.34). As noted in LGL (2018a), survey stations are randomly sampled in a given year.

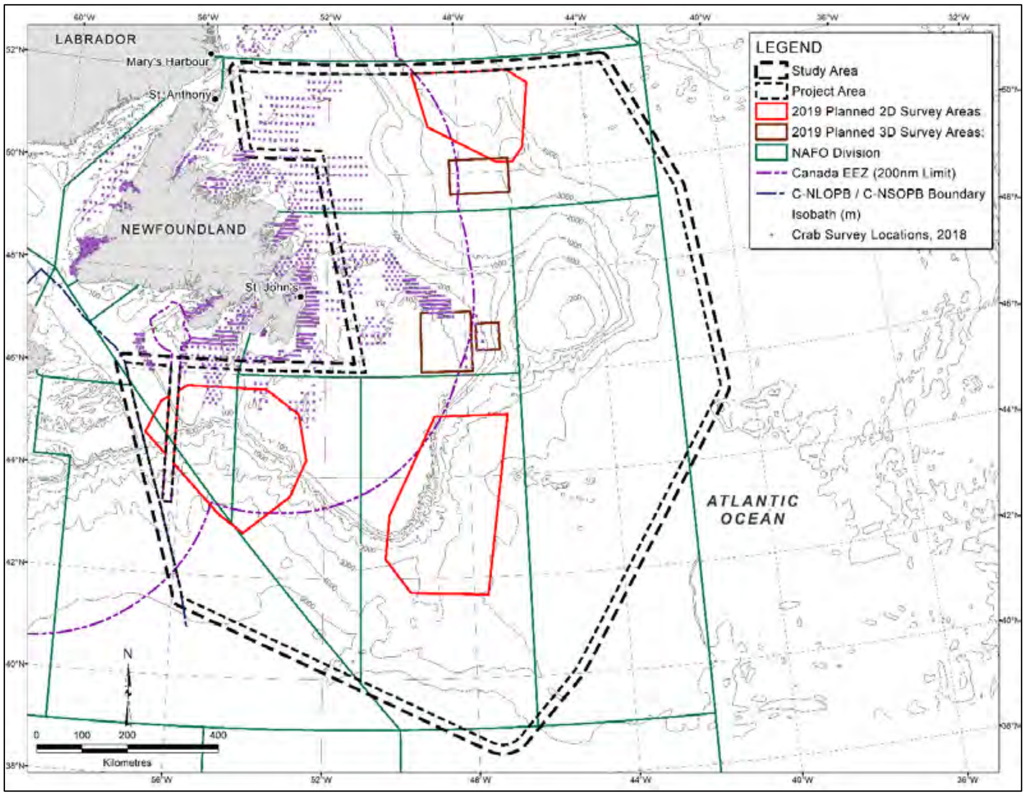


FIGURE 4.34. Locations of DFO-Industry collaborative post-season snow crab trap survey stations in relation to the Study Area and planned 2019 3D and 2D survey areas.

4.3 Marine-Associated Birds

CWS has updated Eastern Canadian Seabirds at Sea data with the addition of data collected from 2010–2016 and made the updated distribution and density summaries available at the on-line "Atlas of Seabirds at Sea in Eastern Canada 2006 - 2016" (Bolduc et al. 2018). In this Atlas database, marine bird distribution and densities are presented by three periods of the year comprising marine birds' annual cycle: 1) spring migration and nesting periods of nidifugous species (those whose young leave the nest immediately after hatching) (April–July); 2) adult moult, the chick-rearing periods of nidifugous species, and the second half of the nesting of nidicolous species (those whose young remain in the nest after hatching) (August–November); and 3) fall migration and wintering of all species (December–March).

The patterns of distribution and density in this updated summary largely confirm those presented in the summary of 2006–2009 ECSAS data (Fifield et al. 2009), and those from seabird surveys conducted from geophysical exploration vessels by LGL (LGL 2018a). However, the newly collected data include previously unsampled areas of the southwestern Grand Banks and the Tail of the Bank. These data show a high concentration of combined murre species during the April–July period at Whale Deep (96.5–137.5 birds/km^2) and on the adjacent Whale Bank during the August–November period (58.7–75.8 birds/km^2), both of which overlap the Southwest 2D survey area planned for 2019. Density is also high on the Tail of the Bank during April–July (20.0–96.5 birds/km^2), which overlaps the planned Southeast 2D survey area. These concentrations probably represent Thick-billed Murres lingering into April and May before their departure to Arctic nesting and summering areas. The newly sampled areas around the Tail of the Bank, including the Southeast 2D survey area, also show high concentrations of Leach's Storm-Petrel (11.8–29.7 birds/km^2) during August–November. This is consistent with the abandonment of storm-petrel nesting colonies during September and October, and this species' preference for foraging in the waters off the continental shelf (Hedd et al. 2018). However, these updated ECSAS data do not affect the conclusions of the original EA with its proposed mitigation measures of searching for, recovering, and releasing storm-petrels which may strand on Project vessels.

Since the EA, Environment and Climate Change Canada (ECCC)-CWS has acquired updated nesting colony information for several species of seabirds (ECCC-CWS unpubl. data). These updated data are highlighted in blue font in Table 4.12 and reflected in the text below on breeding colonies in Newfoundland. These updated data do not affect the conclusions in the original EA.

There are seabird breeding colonies of worldwide significance in eastern Newfoundland (Table 4.12). Over 4 million pairs of seabirds nest on the southeast coast of Newfoundland alone. These include 2.8 million pairs of Leach's Storm-Petrels and 756,000 pairs of Common Murres (Table 4.12). Funk Island, Baccalieu Island, and the Witless Bay are the largest seabird breeding colonies in Atlantic Canada. More than 3.4 million pairs of seabirds nest at these three locations alone (Table 4.12). These include the largest Atlantic Canadian colonies of Leach's Storm-petrel (2.02 million pairs on Baccalieu Island), Common Murre (470,000 pairs on Funk Island), Black-legged Kittiwake (11,696 pairs on Witless Bay Islands), and Atlantic Puffin (304,000) pairs on Witless Bay Islands). These birds use the Study Area during their breeding season. After the nesting season, seabirds disperse over a wider area of the Newfoundland and Labrador offshore area, including most of the Study Area. Large numbers of seabirds that did not nest in Newfoundland and Labrador also spend part of their non-breeding season within the Study Area. Several million Great Shearwater and Sooty Shearwater migrate from breeding islands in the South Atlantic and occur in the waters offshore Newfoundland and Labrador in summer. Many of the 3.8 million Thick-billed Murres breeding in the eastern Canadian Arctic as well as up to 10 million Dovekies from Greenland either winter in the Labrador Sea and Grand Banks or migrate through these areas on the way to the continental shelf waters of Nova Scotia and areas farther south. Large numbers of sub-adults of Northern Fulmar and Black-legged Kittiwake from breeding colonies in the eastern Arctic and Europe spend the early parts of their lives in the Labrador Sea.

Table 4.12. Number of pairs (p) and individual (i) seabirds at nesting colonies in northern and eastern Newfoundland (46°N to 52°N).

Species	**Northern Groais Island**	**Wadham Islands**	**Coleman Island**	**Funk Island**	**Cape Freels/Cabot Island**	**Bonavista Peninsula**	**Baccalieu Island**	**Witless Bay Islands**	**Mistaken Point**	**Cape St. Mary's**	**Middle Lawn Island**	**Corbin Island**	**Green Island**	**Grand Colombier Island**	**Miquelon Cape**
Northern Fulmar	-	-	-	40p[a]	-	-	-	52p[a]	-	Present[a]	-	-	-		
Manx Shearwater	-	-	-	-	-	-	-	-	-	-	7p[c]	-	-		
Leach's Storm-Petrel	-	200p[a] -	2,906p [a]	150p[a]	8,200p[a]	60p[a]	2,022,000p[a,b]	314,020p[a]	-	-	8,773p[a]	100,000p[b]	48,000p[a]	363,787p[e]	
Northern Gannet	-	-	-	10.964p[a]	-	-	3,488p[a]	-	-	14,598p[a]	-	-	-		
Herring Gull	-	-	5p	-	250p[a]	993i[a]	46p[a]	2,266p[a]	-	39p[b]	20p[b]	50p[b]	Present[b]	60p[f]	265p[d]
Great Black-backed Gull	-	-	-	75i[a]	14p[a]	1,000i[a]	2p[a]	15p[a]	-	Present[b]	6p[b]	25p[b]	-	10p[f]	
Black-legged Kittiwake	1,050p[g]	-	5p	95p[a]	43p[a]	1,000i[a]	5,096p[a]	11,696p[a]	4,170p[f]	10,000p[b]	-	50p[b]	-	196p[f]	2,415p[d]
Arctic and Common Terns	-	22p[g]	4p[a]	-	1,420i[a]	17i[a]	-	-	-	-	-	-	Present[b]		
Common Murre	-	-	-	472,259p[g]	9,897p[a]	-	1,440p[a]	250,000p, 14,599i[a]	84p[b]	15,484p[a]	-	-	-	7,176p[h]	
Thick-billed Murre	-	-	-	250p[a]	-	-	73p[a]	240p[a]	-	1,000p[f]	-	-	-		
Razorbill	-	273p[k]	1,346p [a]	200p[a]	35p[a]		406p[a]	380p, 231i[a]	22p[f]	100p[b]	-	-	-	1,443p[h]	
Black Guillemot	-	50p[a]	25i [a]	1p[b]	4p[a]	25i[a]	113p[a]	1p, 13i[a]	Present[b]	Present[b]	-	-	-	95p[i]	Present[d]
Atlantic Puffin	-	6,190p[k]	12,649p[a]	2,000p[a]	755p[a]	4,870p[a]	75,000p[f]	304,042p[a,j]	79p[f]	-	-	-	-	9,543p[i]	
TOTALS	**1,050p**	**6,735p**	**16,915p, 25i**	**485,959p, 75i**	**20.618p**	**4.930p, 3.035i**	**2,107,664p**	**882,712p, 14,843i**	**4,355p**	**41,221p**	**8,806p**	**100,125p**	**48,000p**	**382,310p**	**2,680p**

Sources: [a] ECCC-CWS unpublished data, [b] Wilhelm et al. submitted; [c] Fraser et al. (2013); [d] Cairns et al. (1989); [e] Lormée et al. (2012); [f] Parks and Natural Areas Division, unpublished data; [g] Thomas et al. (2014a); [h] Lormée et al. (2015); [i] Lormée (2008); [j] Wilhelm et al. (2015); [k] Robertson and Elliot 2002.

4.4 Marine Mammals and Sea Turtles

4.4.1 General Cetacean and Sea Turtle Surveys

A large database of cetacean and sea turtle sightings in Newfoundland and Labrador waters has been compiled from various sources by DFO in St. John's, and was made available during preparation of the EA for the purposes of describing species sightings within the Study Area. There have been no updates to that database since preparation of the original EA (J. Lawson, DFO Research Scientist, pers. comm., April 2019).

Opportunistic surveys of the North Atlantic Current and Evlanov Seamount candidate Marine Protected Area (cMPA) were conducted in July 2013 and July 2018 (Wakefield 2018). The western-most portion of the cMPA overlaps with the eastern-most portion of the Study Area. Sightings within or near the Study Area in 2013 included sperm whales, *Kogia* sp., pilot whales, short-beaked common dolphins, striped dolphins, unidentified beaked whales, and other unidentified cetaceans. Pilot whales and striped dolphins were also seen along the shelf edge of the Grand Banks. In 2018, other sightings inside the cMPA but to the east of the Study Area included fin whales and common minke whales. In addition, a loggerhead turtle was seen along the shelf edge of the Grand Banks in 2013, and a leatherback turtle was seen east of the cMPA in 2013 (Wakefield 2018).

Delarue et al. (2018) deployed acoustic recorders at 20 sites off Canada's East Coast ranging from Nova Scotia to Labrador from August 2015–July 2017; eight of those were located within the Study Area. Up to 23 marine mammal species were detected acoustically, some of which were only detected off Nova Scotia (e.g., right whale) or off northern Labrador (e.g., walrus, bearded seal). Species diversity was higher at the deep-water stations than over the shelf or nearshore; species richness was reduced at the northerly stations during winter and spring, whereas it stayed consistent throughout the year at more southerly stations.

Blue whales were generally detected from August–January throughout the Study Area, including all 2D survey areas, and near the Jeanne d'Arc HD3D survey area. The highest detection rates occurred in the Southwest 2D survey area. Fin whale vocalizations were detected year-round throughout the Study Area, including all 2D survey areas, and the Jeanne d'Arc HD3D survey area. The highest detection rates were reported on the Grand Banks and Scotian Shelf. Humpback whales were also detected in the northern and southern portions of the Study Area throughout the year; the highest detection rates were made on the Scotian Shelf as well as on the Grand Banks during winter 2016. Minke whales were only detected in the Southwest 2D survey area, as well as off Nova Scotia, right whale vocalizations were only recorded off Nova Scotia from August–November, and sei whale calls were detected year-round throughout the Study Area.

Sperm whale vocalizations were detected throughout the northern and southern portions of the Study Area, including all 2D survey areas and near the Jeanne d'Arc HD3D survey area. However, there was a general seasonal decline in detection rates, except at sites in and adjacent to the Flemish Pass which had high rates year-round; this suggests that this area may be important to sperm whales. Killer whale vocalizations were mostly recorded during summer and fall, with detections throughout the northern and southern portions of the Study Area, including in the Southwest 2D survey area and near the Jeanne d'Arc HD3D survey area. Pilot whale vocalizations occurred throughout the year south of the Grand Banks and off the Scotian Shelf, but were typically absent during winter and spring north of the Flemish Pass. Detections were made within the northern and southern parts of the Study Area, including in the Southwest 2D, Southeast 2D survey areas, and near the Orphan Basin 2D and Jeanne d'Arc HD3D survey areas; the highest detection rates were made on the Scotian Shelf and along the western edge of the Grand Banks. Vocalizations of dolphins were concentrated at the southern sites during winter and spring. High detection rates occurred near Flemish Pass, especially from July–November; the Grand Banks and Scotian Shelf also had high detection rates.

Harbour porpoise clicks were detected throughout the year in the southern portions of the Study Area, including on the Grand Banks and near the Jeanne d'Arc HD3D survey area; peak detection rates at the northern sites occurred during summer. The highest detection rates, however, occurred outside the Study Area on the Scotian Shelf and in the Strait of Belle Isle. Possible *Kogia* clicks were detected in the Southwest 2D survey area. Harp seal calls were mainly recorded during February and March on the northeastern edge of the Grand Banks and off Labrador.

Northern bottlenose whales, Sowerby's beaked whales, and Cuvier's beaked whales were detected throughout the year within the northern and southern portions of the Study Area. Detections of all three beaked whale species were recorded in the Southwest 2D, Southeast 2D, and near the Orphan Basin 2D survey areas. Most detections of northern bottlenose whales occurred off the east coast of Newfoundland and off Labrador. Cuvier's and Sowerby's beaked whale clicks were prominent along the edge of the Scotian Shelf; Sowerby's beaked whale clicks were also detected at high rates along the shelf edge of the Grand Banks.

Stanistreet et al. (2017) reported on acoustic detections of beaked whales in the western North Atlantic from 2011–2015. Acoustic recorders were deployed at six sites, including the Gully at the edge of the Scotian Shelf, just to the west of the Study Area. Northern bottlenose whales, Sowerby's beaked whales, and Cuvier's beaked whales were recorded year-round at that location. Gomez et al. (2017) conducted species distribution models and showed that the most suitable habitats and therefore priority areas for monitoring of northern bottlenose whales on the edges of the eastern Scotian Shelf and Newfoundland and Labrador Shelves, canyons, and deep basins overlap with anthropogenic activities.

4.4.2 Updated Species Information

4.4.2.1 North Atlantic Right Whale

Twenty mortalities were reported for the North Atlantic right whale population over the last two years - 17 individuals in 2017 and 3 individuals in 2018 (Pettis et al. 2018). The best population estimate at the end of 2017 was 411 individuals; no calves were born in 2018 (Pettis et al. 2018).

4.4.2.2 Blue Whale

In 2018, an action plan for blue whales was proposed (DFO 2018i). Lesage et al. (2018) reported that the continental shelf edge off Nova Scotia, southern Newfoundland, and the Grand Banks (including the planned Southwest and Southeast 2D survey areas) is an important blue whale foraging area (also see DFO 2018j). Similarly, Moors-Murphy et al. (2019) reported that slope waters off the Scotian Shelf, Grand Banks, and deep water of the Laurentian Channel are potentially important habitat areas. Gomez et al. (2017) conducted species distribution models and showed that the most suitable habitats and therefore priority areas for monitoring on the Scotian Shelf and the shelf break off southern Newfoundland overlap with anthropogenic activities. Year-round acoustic detections have also been made in the southern portions of the Study Area (e.g., Simard et al. 2016; Clark 1995 *in* Lesage et al. 2018; Moors-Murphy et al. 2019), and Moors-Murphy et al. (2019) reported several additional sightings of blue whales for that area.

4.4.2.3 Sei Whale

Genetic studies have shown low divergence among North Atlantic sei whales suggesting a single rather than multiple stocks, including a Nova Scotian stock; however, the data showed high uncertainty (Huijser et al. 2018).

4.4.2.4 Leatherback Turtle

In 2018, an action plan for leatherback sea turtles was proposed (DFO 2018k). Leatherback turtles tagged in Nova Scotia between 1999 and 2016 have been recorded within the southern portion of the Study Area (Hamelin and James 2018). Mosnier et al. (in press) reported records for waters off Nova Scotia and Newfoundland (including within the Study Area) from June through November, with most records for August and September. The majority of sightings occurred on the shelf off southern and eastern Newfoundland, as well as on the Scotian Shelf. Based on bio-energetic modeling, Wallace et al. (2018) noted that foraging areas off Nova Scotia are important to the growth of leatherback populations in the Northwest Atlantic Ocean, as they support a substantial portion of a leatherback's energy budget. In addition, Mosnier et al. (in press) suggested that the Grand Banks also provide potentially important habitat for leatherbacks. A generalized additive model showed that leatherback distribution in eastern

Canadian waters was related with environmental characteristics, with turtle occurrence increasing when sea surface temperatures are >15°C, over flat bottoms, and in areas with low primary productivity; sea surface height was also correlated to turtle occurrence (Mosnier et al. in press). As both ocean sunfish and leatherbacks feed on gelatinous prey such as jellyfish, the presence of sunfish was also a predictor of leatherback presence, but not densities (Mosnier et al. in press).

4.5 Species at Risk

The new information presented in this section does not change the effects predictions made in the EA (LGL 2018a) or its Addendum (LGL 2018b).

Updated species at risk that could potentially occur in the Study Area are provided in this section, based on available information on the *Species at Risk Act* (*SARA*) and Committee on the Status of Endangered Wildlife in Canada (COSEWIC) websites as of April 2019. Changes in species status since the preparation of the EA (LGL 2018a) and its Addendum (LGL 2018b) are described below and noted in bold font in Table 4.13.

TABLE 4.13. *SARA*-listed and COSEWIC-assessed marine species that potentially occur in the Study Area.

Common Name	Scientific Name	*SARA* [a]			COSEWIC [b]		
		E	T	SC	E	T	SC
Marine Fish							
White Shark Atlantic population)	*Carcharodon carcharias*	S1			X		
Northern Wolffish	*Anarhichas denticulatus*		S1			X	
Spotted Wolffish	*A. minor*		S1			X	
Atlantic Wolffish	*A. lupus*			S1			X
Atlantic Cod	*Gadus morhua*			S3			
Atlantic Cod Newfoundland and Labrador population					X		
Laurentian North population					**X**		
Cusk	*Brosme brosme*				X		
Deepwater Redfish **Gulf of St. Lawrence-Laurentian Channel population**	*Sebastes mentella*				**X**		
Northern population						X	
Atlantic Bluefin Tuna	*Thunnus thynnus*				X		
Porbeagle Shark	*Lamna nasus*				X		
Roundnose Grenadier	*Coryphaenoides rupestris*				X		
Smooth Skate Funk Island Deep population	*Malacoraja senta*				X		
Laurentian-Scotian population							X
Winter Skate Eastern Scotian Shelf-Newfoundland population	*Leucoraja ocellata*				X		
Acadian Redfish Atlantic population	*Sebastes fasciatus*					X	
American Plaice Newfoundland and Labrador population	*Hippoglossoides platessoides*					X	
Maritime population						**X**	

Common Name	Scientific Name	*SARA* [a]			COSEWIC [b]		
		E	T	SC	E	T	SC
Lumpfish	*Cyclopterus lumpus*					X	
White Hake Atlantic and Northern Gulf of St. Lawrence population	*Urophycis tenuis*					X	
Atlantic Sturgeon **Maritimes populations**	***Acipenser oxyrinchus***					**X**	
American Eel	*Anguilla rostrata*					X	
Atlantic Salmon South Newfoundland population	*Salmo salar*					X	
Quebec Eastern North Shore population							X
Quebec Western North Shore population							X
Anticosti Island population					X		
Inner St. Lawrence population							X
Gaspe-Southern Gulf of St. Lawrence population							X
Eastern Cape Breton population					X		
Nova Scotia Southern Upland population					X		
Outer Bay of Fundy population					X		
Basking Shark Atlantic population	*Cetorhinus maximus*						X
Shortfin Mako Shark Atlantic population	*Isurus oxyrinchus*						X
~~**Roughhead Grenadier**~~	~~***Macrourus berglax***~~						~~**X**~~
Spiny Dogfish Atlantic population	*Squalus acanthias*						X
Thorny Skate	*Amblyraja radiata*						X
Marine-associated Birds							
Ivory Gull	*Pagophila eburnea*	S1			X		
Red Knot *rufa* spp.	*Calidris canutus rufa*	S1			X		
Harlequin Duck Eastern population	*Histrionicus histrionicus*			S1			X
Barrow's Goldeneye Eastern population	*Bucephala islandica*			S1			X
Red-necked Phalarope	***Phalaropus lobatus***						**X**
Marine Mammals							
Blue Whale Atlantic population	*Balaenoptera musculus*	S1			X		
North Atlantic Right Whale	*Eubalaena glacialis*	S1			X		
Northern Bottlenose Whale Scotian Shelf population	*Hyperoodon ampullatus*	S1			X		
Davis Strait-Baffin Bay-Labrador Sea population							X
Harbour Porpoise Northwest Atlantic population	*Phocoena phocoena*		S2				X
Fin Whale Atlantic population	*Balaenoptera physalus*			S1			X
Humpback Whale Western North Atlantic population	*Megaptera novaeangliae*			S3			
Sowerby's Beaked Whale	*Mesoplodon bidens*			S1			X
Killer Whale Northwest Atlantic/ Eastern Arctic population	*Orcinus orca*						X
Sea Turtles							
Leatherback Sea Turtle Atlantic population	*Dermochelys coriacea*	S1			X		
Loggerhead Sea Turtle	*Caretta caretta*	S1			X		

Note: E = Endangered; T = Threatened; SC = Special Concern; S = Schedule.

[a] *SARA* website (https://www.canada.ca/en/environment-climate-change/services/species-risk-public-registry.html) accessed April 2019.

[b] COSWEIC website (https://www.canada.ca/en/environment-climate-change/services/committee-status-endangered-wildlife.html) accessed April 2019.

The Laurentian North population for Atlantic cod was added. This population was assessed as *endangered* by COSEWIC and has no status under *SARA*. Atlantic cod is described in Section 4.2.2.1 of the EA (LGL 2018a) and Section 4.2.1.5 above.

The Gulf of St. Lawrence-Laurentian Channel population of deepwater redfish was added. This population was assessed as *endangered* by COSEWIC and has no status under *SARA*. A description of redfishes is provided in Section 4.2.2.1 of the EA (LGL 2018a) and Section 4.2.1.6 above.

The Maritime population of American plaice was added. This population was assessed as *threatened* by COSEWIC and has no status under *SARA*. American plaice is described in Section 4.2.2.1 of the EA (LGL 2018a) and Section 4.2.1.6 above.

The Maritimes populations of Atlantic sturgeon were added. This species was assessed as *threatened* by COSEWIC and has no status under *SARA*. Additional information for this species is provided in Section 4.5.1 below.

Roughhead grenadier was removed (indicated by strikethrough text in Table 4.13), as it is no longer considered at risk. Roughhead grenadier was previously assessed as *special concern* under COSEWIC and had no status under *SARA*.

Red-necked Phalarope was added considering a previous request by ECCC-CWS (see Section 4.5 *in* LGL 2017), as it may occur in the Study Area during migration. This species was assessed as *special concern* by COSEWIC and has no status under *SARA*. Additional information on this species is provided in Section 4.5.1 *in* LGL (2017).

4.5.1 Atlantic Sturgeon

The Atlantic sturgeon is a large, cartilaginous, slow-growing, late-maturing, anadromous finfish (COSEWIC 2011). This species spends most of its life in marine waters, returning to freshwater only to spawn when females mature at age 27–28 years and males at 16–24 years (COSEWIC 2011). Juveniles inhabit freshwater for several years before migrating seaward upon reaching a length of 80–120 cm (COSEWIC 2011). The Maritimes populations of Atlantic sturgeon only spawn during June and July in/near the lower Saint John River, with females spawning every 3–5 years and males once in five years (COSEWIC 2011). It may live for several decades and feeds on benthic invertebrates while in freshwater or brackish water, and small fish in marine waters (COSEWIC 2011). There are likely at least 1,000–2,000 adults in the Maritimes Designated Unit (COSEWIC 2011). No Atlantic Sturgeon were caught during commercial harvests within the Study Area during May–November 2016 or 2017 (see Table 4.1). Atlantic sturgeon may occur within the westernmost portion of the Study Area, south of Newfoundland and east of Cape Breton, NS (see Figure 3 *in* COSEWIC 2011).

4.6 Sensitive Areas

Sensitive Areas within the Study Area are described in Section 3.8 *in* C-NLOPB (2010), Section 4.2.4 *in* C-NLOPB (2014), Section 4.7 *in* LGL (2015a,b), Section 4.6 *in* LGL (2016), and Section 4.7 *in* 2018a (see also Figure 4.40 *in* LGL 2018b). The new information presented in this section does not change the effects predictions made in the EA (LGL 2018a) and its associated addendum (LGL 2018b). Sensitive areas that overlap or are adjacent to the Study Area are shown in Figure 4.35.

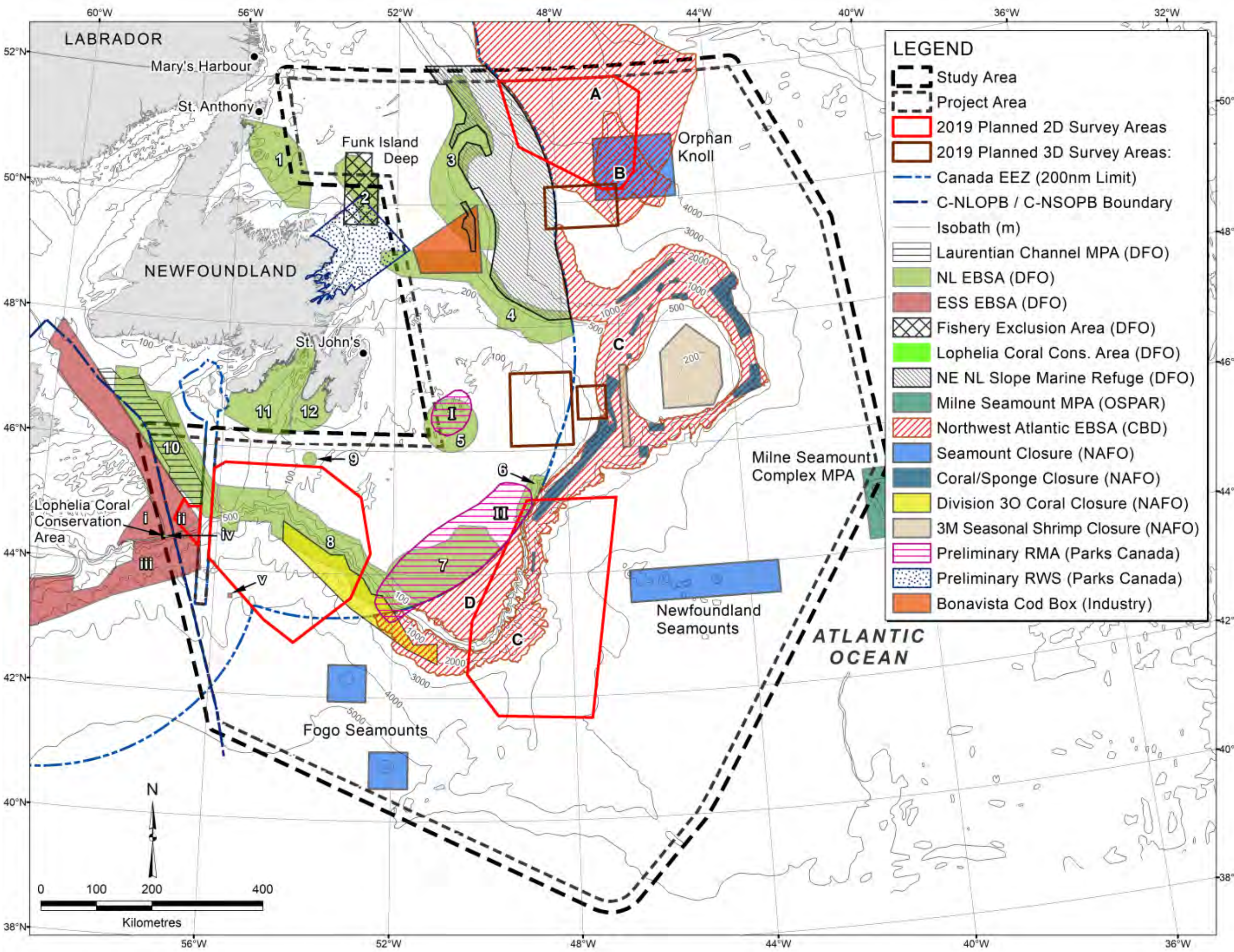


FIGURE 4.35. Sensitive areas that overlap or are adjacent to the Study Area (alpha/numeric identifiers provided in sensitive areas bulleted list below).

Sensitive areas which occur at least partially within or are immediately adjacent to the Study Area are as follows (items marked with an Asterix [*] are newly added or have been revised since the EA and its Addendum [LGL 2018a,b]; where applicable, alpha/numeric identifiers for areas in Figure 4.35 are provided in italic font within parentheses):

- NAFO 3O Coral Protection Zone
- NAFO Vulnerable Marine Ecosystem (VME) coral/sponge fishery closure areas (13 total*)
- NAFO VME seamount closure areas
    - Orphan Knoll Seamount
    - Newfoundland Seamount
    - Fogo Seamount 1
    - Fogo Seamount 2
- NAFO seasonal 3M shrimp closure area*
- DFO NL Shelves Bioregion Ecologically and Biologically Significant Areas (EBSAs)
    - (1) Grey Islands
    - (2) Notre Dame Channel
    - (3) Orphan Spur
    - (4) Northeast Slope*
    - (5) Virgin Rocks*
    - (6) Lilly Canyon-Carson Canyon*
    - (7) Southeast Shoal*
    - (8) Southwest Slope*
    - (9) Haddock Channel Sponges*
    - (10) Laurentian Channel*
    - (11) Placentia Bay*
    - (12) St. Mary's Bay*
- DFO Scotian Shelf EBSAs
    - *(i)* Eastern Shoal
    - *(ii)* Laurentian Channel Slope
    - *(iii)* Scotian Slope
    - *(iv)* Stone Fence and Laurentian Environs
    - *(v)* Laurentian Channel Cold Seep Communities
- Convention on Biological Diversity (CBD) EBSAs
    - *(A)* Southeast Shoal and Adjacent Areas on the Tail of the Grand Bank
    - *(B)* Slopes of the Flemish Cap and Grand Bank
    - *(C)* Orphan Knoll
    - *(D)* Seabird Foraging Zone in the Southern Labrador Sea
- DFO Laurentian Channel Marine Protected Area*
- Fishing Industry voluntary fishery closure area
    - Bonavista Cod Box
- DFO Marine Refuge (Fishery Exclusion Area)
    - Funk Island Deep Closure
    - Division 3O Coral Closure (note: same boundaries as NAFO 3O Coral Protection Zone)
    - Northeast Newfoundland Slope Closure
    - *Lophelia* Coral Conservation Area

- Oil Spill Prevention, Administration and Response (OSPAR) Marine Protected Area (MPA)
  - Milne Seamount Complex
- Parks Canada [Preliminary] Representative Marine Area
  - *(I)* Virgin Rocks*
  - *(II)* South Grand Bank Area*
- Parks Canada [Preliminary] Region Without Studies
  - Unknown 17*

During 2018, NAFO temporarily added a fourteenth VME coral/sponge closure area near the Flemish Cap. This area was since removed and the revised 2019 VME coral/sponge closure areas feature the same 13 areas as in earlier years (NAFO 2019). Of these 13 areas, the Flemish Pass/Eastern Canyon closure area partially overlaps the Harbour Deep SE Ext. 3D and Southeast 2D survey areas, and the Tail of the Bank closure area is entirely within the Southeast 2D survey area.

NAFO implements a seasonal closure within specifically delineated boundary points within Div. 3M and 3L, collectively referred to as the 3M seasonal shrimp closure area. No vessel is permitted to fish for shrimp within this closure area from 1 June–31 December (NAFO 2019). The closure area is located east of the Harbour Deep SE ext. 3D survey area.

EBSAs within the Placentia Bay-Grand Banks (PB-GB) portion of the NL Shelves Bioregion were recently modified, including the modification of some existing EBSA boundaries and the addition of new EBSAs. The corresponding DFO Research Document describing the modified EBSAs has been approved but is not yet released as it is currently awaiting translation (N. Wells, Biologist, Science Branch, DFO, pers. comm., 4 February 2019). EBSA descriptions will be provided in future updates once the Research Document has been released.

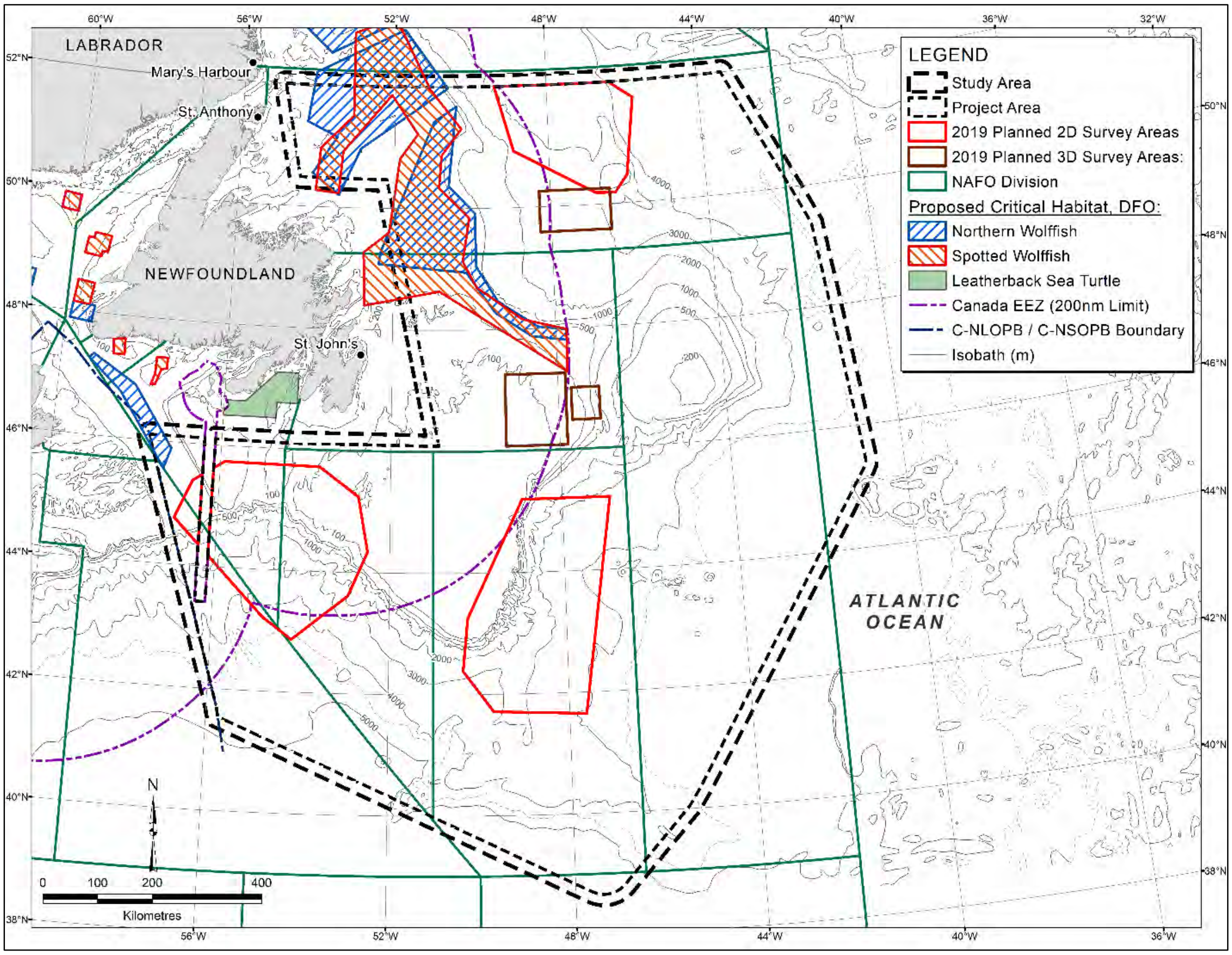
The Laurentian Channel Area of Interest (AOI) was declared an MPA during April 2019 (DFO 2019k). The MPA >1,200-km long, deep submarine valley occupies 11,580 km^2 of the Laurentian Channel's entire 35,800 km^2 area (DFO 2019k), from the intersection of the St. Lawrence and Saguenay Rivers to the edge of the Newfoundland continental shelf, and includes the seabed, subsoil to 5-m depth, and water column above the seabed (LGL 2018b; DFO 2019k). Oil and gas exploration and exploitation, commercial and recreational fisheries, and the anchoring or laying of submarine cables are prohibited within the MPA (DFO 2019k). The MPA serves as critical habitat for several marine species, hosting a high abundance of black dogfish and juvenile smooth skate, porbeagle and basking sharks during the spring and summer, northern wolffish, leatherback sea turtle, and at least 20 species of whales and dolphins (DFO 2019k). The MPA includes one of only two known porbeagle mating grounds, is a critical feeding area and migration route for marine animals transiting to/from the Gulf of St. Lawrence and features the highest sea pen concentrations of the NL Shelves Bioregion (DFO 2019k). The conservation objectives of this MPA are to protected corals, black dogfish, smooth skate, porbeagle sharks, northern wolffish, and leatherback sea turtles from harm due to anthropogenic activities within the Laurentian Channel (DFO 2019k). MKI will not conduct any Project activities within the Laurentian Channel MPA.

Parks Canada establishes National Marine Conservation Areas (NMCAs) to protect representative marine areas for the ecological, educational, and traditional benefit of Canadians, including Indigenous communities (PC 2019). To this end, Parks Canada is considering several preliminary representative marine areas within the Study Area (see Section 3.8.5.2 *in* C-NLOPB 2010), including the South Grand Bank Area which partially overlaps the northwest portion of the Southeast 2D survey area, Virgin Rocks which is west of the Jeanne d'Arc HD3D survey area, and Unknown 17, a 'region without studies' which partially overlaps the northwestern Study and Project area boundaries (C. Pierce, Ecosystem Geomatics Technician, Protected Areas Establishment Branch, Parks Canada, pers. comm., 28 September 2018). Several candidate NMCAs have been proposed by Parks Canada near the coasts of NL, however, these are well beyond the Study Area and not shown in Figure 4.35.

Critical habitat has been recently proposed for northern and spotted wolffishes and leatherback sea turtles within and/or near the Study Area (DFO 2016, 2018g; Figure 4.36).

The proposed critical habitats for northern and spotted wolffishes include deep channels and edges of the Grand Banks and Labrador Shelf, and support all portions of wolffish life history (DFO 2018g). Northern and spotted wolffishes do not exhibit large-scale movements (DFO 2018g) and may be present within the proposed critical habitats year-round. The nearest portions of the proposed northern wolffish critical habitat are located north of the Jeanne d'Arc HD3D survey area and northwest of the Southwest 2D survey area. A portion of the proposed spotted wolffish critical habitat is located north of the Jeanne d'Arc HD3D survey area, proximate to this survey area's northeast corner.

Proposed critical habitat areas for leatherback sea turtles feature sufficient gelatinous prey concentration and abundance to support leatherback survival, migration, and reproduction (which occurs in southern waters following a southward migration); low enough anthropogenic noise levels as to not be disruptive to feeding or foraging; and sufficient water quality such that the water will not cause adverse health effects (DFO 2016). Mature and large sub-adult leatherbacks are present in eastern Canadian waters from late-spring through fall (DFO 2016). Peak leatherback use of the proposed critical habitat areas occurs during the summer and fall, with migration and seasonal residency thought to positively correlate to the distribution and abundance of prey species (DFO 2016). The Placentia Bay proposed leatherback sea turtle critical habitat area is located north of the southwestern portion of the Study Area.



Source: DFO 2016, 2018g.

FIGURE 4.36. Proposed northern and spotted wolffish and leatherback sea turtle critical habitats.

5.0 Consultations

A newsletter describing the seismic activities proposed for 2019 was distributed during April 2019 to the same stakeholders/groups consulted by MKI in previous years for seismic surveys offshore Newfoundland. The newsletter and details of those consulted by MKI are presented in Appendices A and B, respectively.

Face-to-face meetings were held with DFO, the Fish, Food and Allied Workers Union/Unifor (FFAW/Unifor), and Ocean Choice International (OCI) in February and March 2019. During these meetings, no specific concerns were raised but the need for good routine communication and coordination between MKI and the fishing industry was noted particularly for 2D seismic surveys and the 3D seismic survey of the Jeanne d'Arc HD3D survey area.

6.0 Environmental Assessment

This section presents a summary of mitigation measures that will be employed by MKI during its 2019 seismic program. Additionally, it provides new and relevant literature for the effects assessment of Project activities on the following VECs: Fish and Fish Habitat, Marine-Associated Birds, and Marine Mammals and Sea Turtles.

6.1 Mitigation Measures

The mitigation measures described in the EA and EA Addendum (LGL 2018a,b) remain applicable to MKI's 2D and 3D seismic survey activities planned for 2019. A summary of mitigation measures and commitments made in EA documents for the Project is provided below along with commentary on the status of implementing the mitigation measures and commitments (Table 6.1). This summary serves as a tracking table as per § 5.1.4.1 of the C-NLOPB's *Geophysical, Geological, Environmental and Geotechnical Program Guidelines* (C-NLOPB 2018).

TABLE 6.1. Summary of environmental commitments and mitigation measures and the current status of these commitments and measures.

VEC, Potential Effects	Primary Mitigations	Status (24 April 2019)
Fisheries VEC: Interference with fishing vessels/mobile and fixed gear fisheries	• Pre-survey communications, liaison and planning to avoid fishing activity • Continuing communications throughout the program • FLOs • SPOC • Advisories and communications • VMS data • Avoidance of actively fished areas • Start-up meetings on ships that discuss fishing activity and communication protocol with fishers	• Upfront planning with FFAW, OCI, GEAC, and CAPP complete • Daily communications and weekly meetings when project commences • Contract in place • Contract in place • Planned upon commencement • Planned upon commencement • Confirmed • To be addressed as part of survey start-up meeting
Fisheries VEC: Fishing gear damage	• Pre-survey communications, liaison and planning to avoid fishing gear • Use of escort vessel • SPOC • Advisories and communications • FLOs • Compensation program • Reporting and documentation • Start-up meetings on ships that discuss fishing activity, communication protocol with fishers, and protocol in the event of fishing gear damage	• Upfront planning with FFAW, OCI, GEAC, and CAPP complete • Contracts being put in place • Contract in place • Planned upon commencement • Contract in place • In place • Upon commencement of program • To be addressed as part of survey start-up meeting
Interference with shipping	• Advisories and at-sea communications • FLOs (fishing vessels) • Use of escort vessel • SPOC (fishing vessels) • VMS data	• Planned upon commencement • Contract in place • Contracts being put in place • Contract in place • Planned upon commencement
Fisheries VEC: Interference with	• Communications and scheduling • DFO does not indicate an official spatial	• Planned upon commencement • Meetings held with FFAW and DFO

VEC, Potential Effects	Primary Mitigations	Status (24 April 2019)
DFO/FFAW research program	and/or temporal buffer mitigation method for seismic operations in the vicinity of survey stations. MKI will work cooperatively with FFAW|Unifor and DFO in an effort to avoid survey stations prior to their sampling to the best extent possible.	
Fish and Fish Habitat, Marine Mammal and Sea Turtle, and Marine-associated Bird VECs: Temporary or permanent hearing damage/disturbance to marine animals (marine mammals, sea turtles, seabirds, fish, invertebrates)	• "Pre-watch" (30 minute) of 500 m safety zone using visual and PAM • Delay start-up if any marine mammals or sea turtles are detected within 500 m with visual and PAM • Ramp-up of airguns • Use of experienced, qualified MMO(s) to monitor for marine mammals and sea turtles during all daylight periods when airguns are in use • Minimum separation distance of 30 km for simultaneous seismic surveys in the Project Area based on separation distances required in other jurisdictions (i.e., Gulf of Mexico [G. Morrow, PGS, Senior Contract Manager, pers. comm., June 2017] and Greenland [LGL 2012]).	• Confirmed • Confirmed • Confirmed • Confirmed • Confirmed
Species at Risk and Sensitive Areas VEC: Temporary or permanent hearing damage/ disturbance to Species at Risk or other key habitats	• "Pre-watch" (30 minute) of 500 m safety zone using visual and PAM • Delay start-up if any marine mammals or sea turtles are detected within 500 m with visual and PAM • Ramp-up of airguns • Shutdown of airgun arrays for endangered or threatened marine mammals and sea turtles, as well as beaked whales, detected visually or acoustically within 500 m • Use of experienced, qualified MMO(s) to monitor for marine mammals and sea turtles during daylight seismic operations. • PAM will be used during pre-watch and during periods when visibility is <500 m in order to detect cetacean vocalizations • Minimum separation distance of 30 km for simultaneous seismic surveys in the Project Area based on separation distances required in other jurisdictions (see above).	• Confirmed • Confirmed • Confirmed • Confirmed • Confirmed • Confirmed • Confirmed
Marine-associated Bird VEC: Injury (mortality) to stranded seabirds	• Daily search of seismic and support vessels • Implementation of handling and release protocols • Minimize lighting if safe	• Confirmed • Confirmed • Confirmed
Marine-associated Bird VEC: Seabird oiling	• Adherence to MARPOL • Adherence to conditions of ECCC-CWS migratory bird permit • Spill contingency and response plans • Use of solid streamers	• Confirmed • Confirmed • Confirmed • Confirmed

6.2 Fish and Fish Habitat

Recent publications relevant to the effects of airgun sound on the Fish and Fish Habitat VEC have become available since the original EA; these studies, all of which pertain to invertebrates, are summarized below.

In a recent study, McCauley et al. (2017) conducted an experiment whereby they exposed zooplankton off the coast (shallow water) of Tasmania to a 150 in^3 airgun source. Observations from the study indicate that seismic surveys may have a greater effect on zooplankton communities than previously understood. Treatment samples of zooplankton exposed to the airgun exhibited an increase of two to three-fold mortality versus the control group and impacts on zooplankton were observed as far as 1.2 km away from the airgun source. The sample size and number of replications was relatively small however since the study occurred over just two days, therefore additional sampling is required in order to determine the full extent of the impact that airgun sound has on zooplankton mortality.

A companion study completed by Richardson et al. (2017) attempted to model the impact of an airgun survey on zooplankton over a larger temporal and spatial scale than what was originally considered by McCauley et al. (2017). In total, the modeled survey area was 80 km × 36 km, with a water depth range of 300–800 m. Airgun impact was considered for a 35-day period. Modeling results indicate that significant impacts to zooplankton would most likely occur only at a local scale (i.e., within the 2.5 km linear survey area), with less of an impact on a larger spatial scale, contradictory to results obtained by McCauley et al. (2017). Richardson et al. (2017) attributes potential avoidance behaviour of the zooplankton as a possible reason why McCauley et al. (2017) observed such a marked decrease in zooplankton abundance during their study.

Of note, the U.S. Bureau of Ocean Energy Management (BOEM) are planning a follow-up study of the effects of seismic sound on zooplankton; the study is planned in deeper waters offshore the U.S. east coast or in the Gulf of Mexico (see https://www.boem.gov/FY-2019-2021-SDP/).

Other recent studies of invertebrates and seismic sound are summarized below.

Morris et al. (2018) conducted a two-year (2015–2016) Before-After-Control-Impact (BACI) study examining the effects of 2D seismic exploration on catch rates of snow crab (*Chionoecetes opilio*) along the eastern continental slope of the Grand Banks of Newfoundland. The airgun array used during both years of the study was operated from a commercial seismic exploration vessel. Overall, the findings of the study indicated that the sound from the commercial seismic survey did not significantly reduce snow crab catch rates in the short term (i.e., days) or longer term (i.e., weeks) in which the study took place. For this particular study, the experimenters attribute the natural temporal and spatial variations in the marine environment as a greater influence on observed differences of catch rates of snow crab between control and experimental sites.

Fitzgibbon et al. (2017) examined the impact of airgun sound exposure on spiny lobster through a companion study to studies by Day et al. (2016a,b, 2017). The same study site, experimental treatment methodologies, and airgun exposures were used for the lobsters in Fitzgibbon et al. (2017) as in Day et al. (2016a,b, 2017). The objectives of the study were to examine the haemolymph biochemistry and nutritional condition of groups of lobsters over a period of up to 365 days post airgun exposure. Overall, no mortalities were observed across both the experimental and control groups, however lobster total haemocyte count was determined to have decreased by 23% to 60% for all lobster groups up to 120 days post airgun exposure in the experimental group when compared to the control group. A lower haemocyte count increases the risk of disease through a lower immunological response. Also, the only other haemolyph parameter that was determined to have been significantly affected by airgun exposure was the Brix index of haemolymph at 120 and 365 days post exposure in just one of the experiments involving egg-laden females.

In summary, the new literature presented above does not change the effects assessment for the Fish and Fish Habitat VEC presented in the original EA (LGL 2018a).

6.3 Marine-Associated Birds

Recent publications relevant to the effects of airgun sound and oiling on marine-associated birds have become available since the original EA; these studies are summarized below.

6.3.1 Sound

Hearing sensitivity has only recently been measured in seabirds. Crowell (2016) measured in-air auditory brainstem response in seabird species that included Long-tailed Duck, Lesser Scaup, Red-throated Loon, and Northern Gannet. This study found that hearing sensitivity of these species is greatest between 1,500 and 3,000 Hz. Underwater hearing thresholds in Great Cormorant are similar to seals and toothed whales in the 1–4 kHz frequency range (Anderson Hansen et al. 2016; Johansen et al. 2016). Great Cormorants also respond to underwater sounds and may have special adaptations for hearing underwater (Johansen et al. 2016; Anderson Hansen et al. 2017). A recent, five-year study (2009–2013) using GPS tracking reported avoidance of a 2-D seismic survey by African Penguins (*Spheniscus demersus*) when foraging close to their breeding colonies which were located less than 100 km from the seismic survey (Pichegru et al. 2017). The airgun array had a total volume of 4,230 in^3 and nominally operated at 2,000 psi during an approximate one month period in 2013. The authors stated that it was unknown if the penguins (flightless birds which on average dive to depths of 30 m) were responding directly to airgun sound or to potential changes in the distribution of their prey. The birds reverted to normal behaviour when the seismic operation ceased. These new studies do not present findings that would change the conclusions of the original effects assessment.

6.3.2 Accidental Releases

There have been several new publications on the effects of oiling on marine birds since the original EA; the findings of these new studies confirm those from previous studies. Oiling of marine birds increases their thermoregulatory demands. Experimentally oiled Double-crested Cormorants (*Phalacrocorax auritus*) have significant decreases in surface body temperature and a predicted 13–18% increase in daily energetic demands that is consistent with an observed increase in food consumption (Mathewson et al. 2018). Oil ingested by marine birds through diet and through preening has been documented to cause oxidative injury to cytoplasmic hemoglobin (anemia) causing fatigue and reduction in energy available for metabolism in six species of marine birds, and results consistent with hemolytic anemia were found in a seventh species (Bursian et al. 2017a; Dean et al. 2017; Harr et al. 2017c; Horak et al. 2017; Maggini et al. 2017c; Pritsos et al. 2017; Fallon et al. 2018). These effects have the potential to reduce survival and fitness. Species-specific differences were found in this effect, potentially due to physiology, foraging strategies, habitat preferences, and behaviour (Fallon et al. 2018). This hemolytic anemia can have its greatest effects during migration, when metabolic oxygen requirements are very high (Bursian et al. 2017b). Increases in liver and kidney weights have been found in two species (Harr et al. 2017a; Horak et al. 2017). Lesions in kidney, liver, heart, and thyroid gland were found in one species (Harr et al. 2017a). Impaired heart function has also been noted in one species of marine bird (Harr et al. 2017b). In addition, experimentally applying a light oiling to the plumage of a marine bird reduces takeoff speed by 30 percent and increases flight energy cost by 20–45 percent (Maggini et al. 2017a,b).

These newly published studies do not change the conclusions of the effects assessment. The potential of accidental releases of hydrocarbons during the proposed seismic program is considered quite low and the evaporation/dispersion rate of any released hydrocarbons would be high.

6.4 Marine Mammals and Sea Turtles

Recent publications relevant to the effects of airgun sound on marine mammals have become available since the original EA including publications on masking, disturbance, hearing impairment, and noise exposure criteria. These studies are summarized below.

6.4.1 Masking

Sound, through masking, can reduce the effective communication distance of a marine mammal if the frequency of the sound source is close to that used by the animal, and if the sound is present for a significant fraction of time (e.g., Erbe et al. 2016; Jones et al. 2017). In addition to the frequency and duration of the masking sound, the strength, temporal pattern, and location of the introduced sound also play a role in the extent of the masking (e.g., Branstetter et al. 2016; Sills et al. 2017). Sills et al. (2017) reported that recorded airguns sounds at 1 km from the source may have masked the detection of low-frequency sounds by ringed and spotted seals completely at the onset of the airgun pulse when signal amplitude is variable (e.g., initial 200 ms).

In order to compensate for increased ambient sound, some cetaceans are known to increase the source levels of their calls in the presence of elevated noise levels from shipping, shift their peak frequencies, or otherwise change their vocal behaviour (e.g., Gridley et al. 2016; Tenessen and Parks 2016). Similarly, harbour seals increased the minimum frequency and amplitude of their calls in response to vessel sound (Matthews 2017). Several studies have shown that some marine mammals (e.g., bottlenose dolphins, false killer whales) can decrease their hearing sensitivity in order to mitigate the impacts of exposure to loud sounds (e.g., Nachtigall and Supin 2016; Nachtigall et al. 2018).

6.4.2 Disturbance

A ramp up was not superior to triggering humpbacks to move away from the vessel compared with a constant source at a higher level of 140 in^3, although an increase in distance from the airgun array was noted for both sources (Dunlop et al. 2016a). Avoidance was also shown when no airguns were operational, indicating that the presence of the vessel itself had an effect on the response (Dunlop et al. 2016a,b). Humpbacks were more likely to avoid active airgun arrays of 20 in^3 and 140 in^3 within 3 km and at received levels of at least 140 dB re 1 $\mu Pa^2 \cdot s$ (Dunlop et al. 2017a). Responses to ramp up and use of a 3130 in^3 array elicited greater behavioural changes in humpbacks when compared with small arrays (Dunlop et al. 2016c). Humpbacks reduced their southbound migration, or deviated from their path thereby avoiding the active array, when they were within 4 km of the active large airgun source, where received levels were >130 dB re 1 $\mu Pa^2 \cdot s$ (Dunlop et al. 2017b, 2018). However, some individuals did not show avoidance behaviours even at levels as high as 160–170 dB re 1 $\mu Pa^2 \cdot s$ (Dunlop et al. 2018).

Preliminary analysis of data collected on gray whales during a seismic program in 2015 showed some displacement of animals from the nearshore feeding area and responses to lower sound levels than expected (Gailey et al. 2017; Sychenko et al. 2017). Van Beest et al. (2018) exposed five harbour porpoise to a single 10 in^3 airgun for 1 min at 2–3 s intervals at ranges of 420–690 m and levels of 135–147 dB $\mu Pa^2 \cdot s$. One porpoise moved away from the sound source but returned to natural movement patters within 8 h, and two porpoises had shorter and shallower dives but returned to natural behaviours within 24 h.

McGeady et al. (2016) analyzed stranding data and found that the number of long-finned pilot whale stranding along Ireland's coast increased with seismic surveys operating offshore. Bottlenose dolphins exposed to multiple airgun pulses exhibited some anticipatory behaviour (Schlundt et al. 2016). Using a population consequences of disturbance (PCoD) framework, Farmer et al. (2018) suggested that changes in foraging behaviour associated with exposure to airgun sounds could have significant consequences on individual fitness. Pirotta et al. (2018)

used a dynamic state model of behaviour and physiology to assess the consequences of disturbance (e.g., seismic surveys) on whales (in this case, blue whales). They found that the impact of localized, acute disturbance (e.g., seismic surveys) depended on the whale's behavioural response, with whales that remained in the affected area having a greater risk of reduced reproductive success than whales that avoided the disturbance. Chronic, but weaker disturbance (e.g., vessel traffic) appeared to have less effect on reproductive success. As behavioural responses are not consistently associated with received levels, some authors have made recommendations on different approaches to assess behavioural reactions (e.g., Gomez et al. 2016; Harris et al. 2017).

6.4.3 Hearing Impairment

Research has shown that sound exposure can cause cochlear neural degeneration, even when threshold shifts and hair cell damage are reversible (Liberman et al. 2016). These findings have raised some doubts as to whether temporary threshold shift (TTS) should continue to be considered a non-injurious effect (Tougaard et al. 2016). However, Morell et al. (2017) examined the inner ears of long-finned pilot whales after a mass stranding in Scotland and reported damage to the cochlea compatible with over-exposure from underwater sound, but no specific sound-producing activity could be linked to the stranding.

Kastelein et al. (2017) reported that exposure to multiple pulses with most sound energy at low frequencies can lead to TTS at higher frequencies in some cetaceans, such as the harbour porpoise. When a porpoise was exposed to 10 and 20 consecutive shots (mean shot interval ~17 s) from two airguns with a SEL_{cum} of 188 and 191 $\mu Pa^2 \cdot s$, respectively, significant TTS occurred at a hearing frequency of 4 kHz and not at lower hearing frequencies that were tested, despite the fact that most of the airgun energy was <1 kHz; recovery occurred within 12 min post exposure (Kastelein et al. 2017).

Simulation modeling to assess the risk of sound exposure to marine mammals (gray seal and harbour porpoise) showed that sound exposure level (SEL) is most strongly influenced by weighting functions (Donovan et al. 2017). Houser et al. (2017), NMFS (2018), Tougaard and Beedholm (2019), and Southall et al. (2019) provide reviews of the development and application of auditory weighting functions, as well as recommendations for future work.

6.4.4 Noise-exposure Criteria

In 2016, NMFS released new guidance for assessing the effects of anthropogenic sound on marine mammals (NMFS 2016), taking some recommendations for science-based noise exposure criteria from Southall et al. (2007) into account. In 2018, NMFS released a revision to the technical guidance, which took into account comments from the public, regulators, and subject matter expects (NMFS 2018). NMFS did not make any changes to the dual criteria for impulsive sounds as set forth in the original Technical Guidance (which were included in the original MKI EA (LGL 2018a)), but additional scientific studies were considered and revisions to improve the implementation of the Guidance were made. Since then, Southall et al. (2019) provided updated scientific recommendations regarding noise exposure criteria. These are similar to those presented by NMFS (2016, 2018), but include all marine mammals (including sirenians), a re-classification of hearing groups, and revised noise exposure criteria and auditory weighting functions. The previous high-frequency hearing group (e.g., porpoises, *Cephalorhynchus* spp., and *Kogia* spp.) is now considered to be very high-frequency cetaceans; mid-frequency cetaceans are now referred to as high-frequency cetaceans; the pinnipeds have been split into phocid carnivores (in water and in air), and other marine carnivores (in water and in air).

In summary, the new literature presented above does not change the effects assessment for the Marine Mammal and Sea Turtle VEC presented in the original EA (LGL 2018a).

6.5 Validity of Significance Determinations

Based on MKI's planned survey activities in 2019 and the new information related to the biological environment and effects literature, the determinations of significance of the residual effects of seismic survey activities on VECs presented in the EA (LGL 2018a) and its Addendum (LGL 2018b) remain valid for the seismic survey activities planned by MKI in 2019. This includes consideration of cumulative effects; see below.

6.5.1 Cumulative Effects

Section 5.8 of the original EA (LGL 2018a) provides an assessment of cumulative effects from other activities in the Regional Area including fisheries, vessel traffic, and other oil and gas exploration and development activities. Additional information and information specific to 2019 activities are summarized below followed by an assessment that considers the combined effects of offshore activities.

6.5.1.1 Fisheries

Fishing activity (commercial, traditional and Indigenous, and recreational) in the Project Area has been summarized in this EA Update and includes the most recent commercial fisheries data (from 2017) available. In 2019, it is anticipated that the commercial harvest species, and the timing and locations of commercial fisheries within the Study Area will be similar to previous years. This has also been confirmed during consultations with the fishing industry.

6.5.1.2 Vessel Traffic

Marine transportation within the Study Area is discussed in the Eastern Newfoundland SEA (§ 4.3.5.1 of C-NLOPB 2014) and the Southern Newfoundland SEA (§ 5.3 of C-NLOPB 2010).

The Canadian Year-Round Shipping Traffic Atlas for 2013: Volume 1, East Coast Marine Waters (Simard et al. 2014) contains monthly vessel traffic density data for 2013 derived from Canadian Coast Guard's Automatic Identification System (AIS) database. However, the data does not extend eastwards beyond 49ºW; therefore, most of the MKI Study Area is not included in the Atlas. The traffic density maps do indicate that during May–November 2013, the highest traffic density occurred nearshore east and north of Newfoundland's Avalon Peninsula, particularly in the vicinity of St. John's, and south of the island of Newfoundland. Offshore vessel tracks (within the field of view presented in Simard et al. 2014) were predominantly located south of 48ºN during May, June, October and November and overall vessel traffic increased during July, August and September (see Figures 118, 141, 164, 187, 210, 233 and 256 *in* Simard et al. 2014).

A Marine Traffic (2019) website was accessed and provided information on vessel density relative to the Project Area for 2016 and 2017. While it was possible to distinguish vessel track lines by vessel type (i.e., fishing vessel, tanker, cargo, container ships, passenger vessels), track lines were not readily available for individual months or a monthly/seasonal range. More accurate assessments of regional marine traffic has been facilitated by the ubiquitous use of AIS transponders by vessels and technological advances in data storage, processing capabilities and online commercial service providers over the past decade. Figures 6.1 and 6.2 show cumulative marine traffic density that transited through the Project Area for calendar years 2016 and 2017, respectively. Source data to generate maritime routes for all vessel traffic was obtained from marine AIS tracking information archived and processed by marinetraffic.com (Marine Traffic 2019). Publicly available density maps are colour-coded to indicate concentrated maritime activity/traffic routes. Online visualizations are dynamic and based on unique vessel transits through a variable grid-cell size based on chosen zoom-level of a worldwide interactive map. Figures 6.1 and 6.2 are presented with similar scale for ease of comparison; vessel routes ranging from 1 to >800 vessel per year per 23 km^2 grid-cell. Figure outputs were centered on the Project and Study area boundaries; also, shown are the planned 2D and 3D survey areas for 2019.

Within the Project Area, marine traffic density is generally concentrated in the southeast, coastal areas of Newfoundland, and shipping routes to oil production facilities in the Jeanne d'Arc Basin (Figures 6.1 and 6.2). Also evident are seismic survey areas off eastern Newfoundland in 2016 (Figure 6.1) and 2017 (Figure 6.2). There were relatively few vessel transits recorded in the northern portion of the Project Area, including the 2D Orphan Basin and the North Tablelands 3D survey areas. Overall, shipping traffic data from 2016 and 2017 confirm the conclusions made in the relevant SEAs (C-NLOPB 2010, 2014) and the original EA for this Project (LGL 2018a).

To mitigate potential interactions between commercial shipping and the Project, MKI's seismic and escort vessels constantly monitor shipping activity and communicate with other vessels when appropriate to ensure that appropriate separation distances are maintained for safe operations.

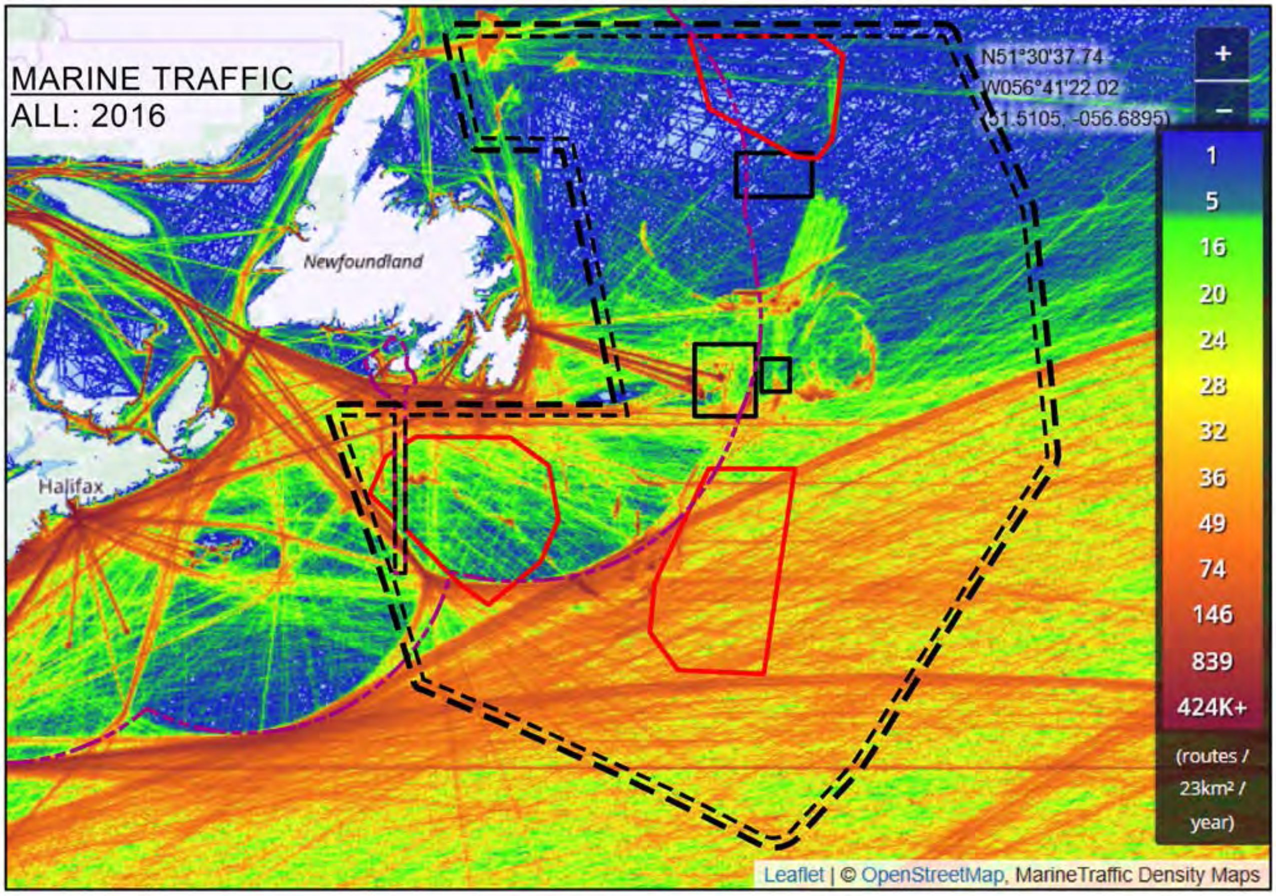


FIGURE 6.1. Marine shipping traffic density (routes per 23 km^2 grid cell) in 2016 in the MKI Project and Study Areas (depicted with small and large dashed lines, respectively) and the Planned 2019 2D and 3D Survey Areas.

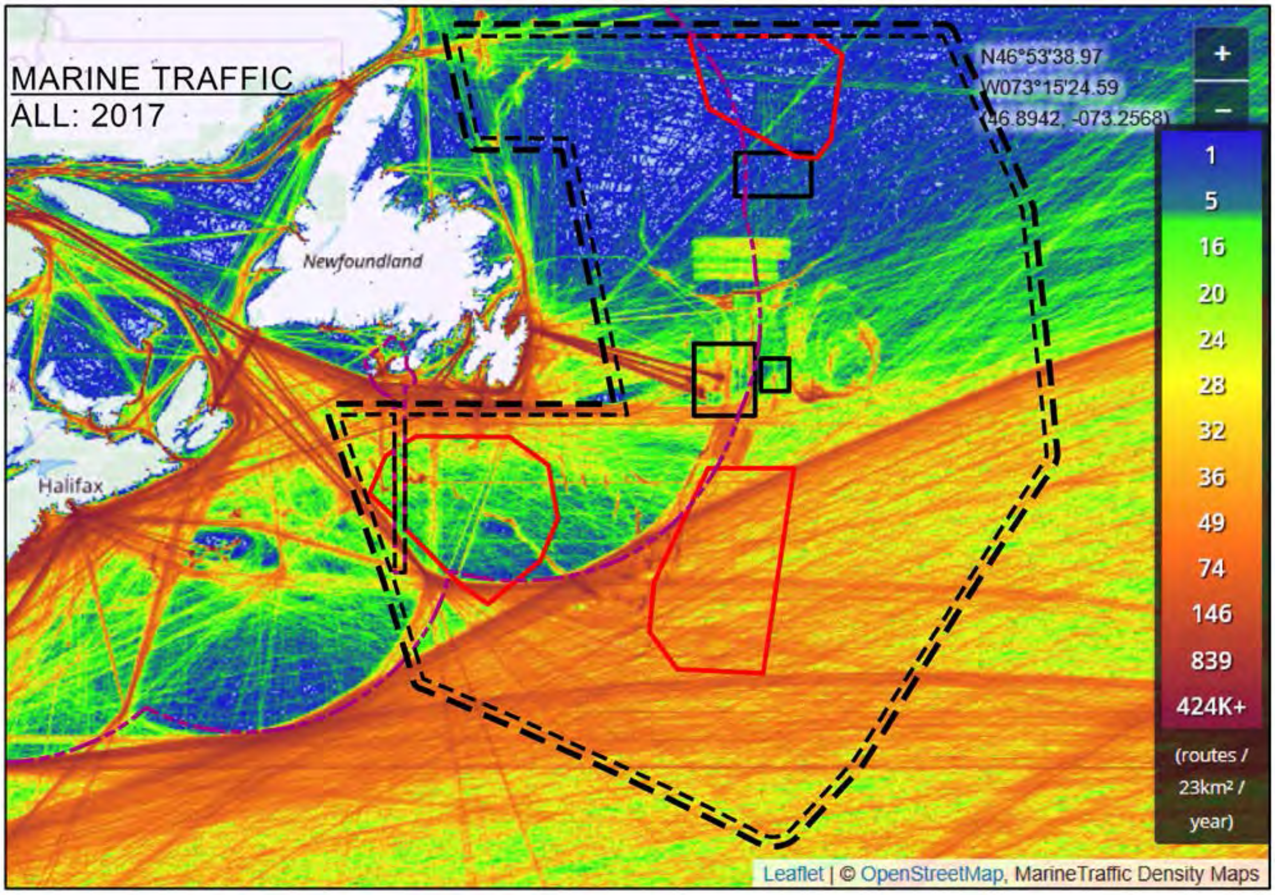


FIGURE 6.2. Marine shipping traffic density (routes per 23 km^2 grid cell) in 2017 in the MKI Project and Study Areas (depicted with small and large dashed lines, respectively) and the Planned 2019 2D and 3D Survey Areas.

6.5.1.3 Oil and Gas Activities

In 2019, MKI is planning to simultaneously conduct two 3D seismic surveys and one 2D seismic survey offshore Newfoundland and Labrador during the late May–September period (Figure 6.3). Although there are three 2D survey areas, these surveys are being conducted by one vessel (i.e., M/V *Sanco Atlantic*). The timing of the planned MKI surveys is shown in Table 6.2 including those planned for Labrador (Torngat 3D survey area and northern portion of Orphan Basin 2D survey area). Note that it is uncertain at this stage if the Harbour Deep SE Ext. 3D survey area will be surveyed in 2019. If surveying does occur there, it will not occur at the same time as surveying in the Jeanne d'Arc HD3D survey area. Likewise, simultaneous seismic surveying will not occur in the Orphan Basin 2D survey area and the North Tablelands 3D survey area. In 2019, the minimum separation distance between MKI survey areas that will be surveyed concurrently is ~100 km (i.e., the minimum separation distance between Jeanne d'Arc HD3D and Grand Banks SE 2D survey area). However, in most situations, concurrent seismic surveying would be separated by ~260 km to 400 km (Figure 6.3). Based on a review of the

C-NLOPB website, there are currently no indications that other seismic surveys will occur in 2019. However, MKI has learned through stakeholder engagement that there is a possibility of another 2D seismic survey offshore Newfoundland (a regional survey with broadly-spaced survey lines). MKI commits to communicating closely with other seismic operators to ensure appropriate spatial separation between surveys as required.

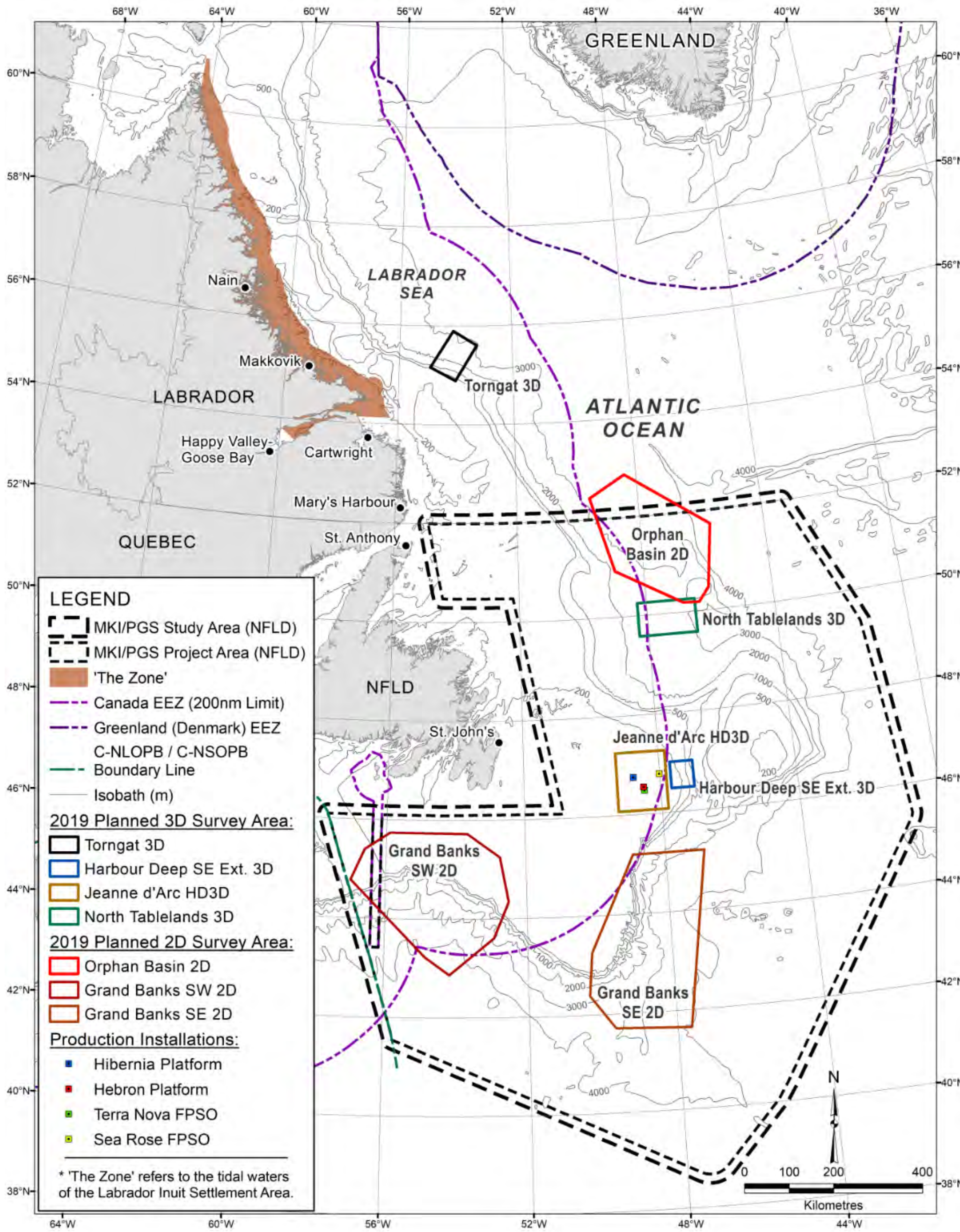


FIGURE 6.3. Locations of MKI's planned 3D and 2D seismic survey areas in 2019. Also shown are the production installations on the Grand Banks.

TABLE 6.2. Timing of MKI's planned 3D and 2D seismic surveys in 2019.

	May (week)		June (week)				July (week)				Aug (week)				Sep (week)			
3D Survey Area	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4
North Tablelands																		
Torngat 3D																		
Jeanne d'Arc HD3D																		
Harbour Deep SE Ext.																?	?	?
	May (week)		June (week)				July (week)				Aug (week)				Sep (week)			
2D Survey Area	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4
2D Southwest																		
2D Southeast																		
2D Orphan Basin																		

As discussed in the original EA, in addition to seismic survey activity, there are four existing offshore production developments (Hibernia, Terra Nova, White Rose, and Hebron) on the northeastern Grand Banks. The existing developments fall inside of the boundaries of MKI's Jeanne d'Arc HD3D survey area. Underwater sound generated from production installations and attending support vessels have lower source levels and are continuous in nature versus those produced during seismic surveys. MKI will avoid close approach to production developments and any exploratory drilling activities which may occur in its planned survey areas (and other areas of the Project Area) unless appropriate SIMOPS plans are in place. MKI commits to communicating closely with production and exploratory drilling operators to ensure appropriate spatial separation of activities.

6.5.1.4 Consideration of Combined Activities

The primary concern associated with seismic surveys in combination with other projects or activities in the Study Area is the effects of underwater sound on VECs. As discussed in §5.7 and §5.8 of LGL (2018a), the cumulative effects of airgun sound from simultaneous seismic surveys on fish and fish habitat, fisheries, seabirds, marine mammals, sea turtles, species at risk and sensitive areas are predicted to be not significant. However, there are uncertainties regarding these predictions, particularly including the effects of masking and disturbance on marine mammals, and the effects of disturbance on marine invertebrates and fishes from sound produced during multiple seismic surveys. Note that possible disturbance effects on marine invertebrates and fishes might not only impact key life history components but also commercial fisheries and science surveys. However, disturbance effects on fisheries are more readily mitigated primarily through communication and temporal and spatial avoidance of seismic surveys from fishing activity. The uncertainties with the effects of underwater sound increase with the number of seismic surveys and additional sources of underwater sound in the area (e.g., commercial shipping, fishing vessels, oil developments, and exploratory drilling). Sound from vessels and sound associated with offshore production and drilling are generally continuous (vs. pulsed sound from airguns) and at much lower sound levels. There is little potential for hearing impairment or physical effects on VECs associated with underwater sound from vessels and offshore oil production. Any avoidance of vessels and offshore oil developments by VECs, including species at risk, is likely to be localized and temporary (e.g., see §5.7 of the EA; LGL 2018a).

As discussed in the EA for this Project, negative effects (auditory, physical, and behavioural) on key sensitive VECs, such as marine mammals, appear unlikely beyond a localized area from the sound source. In addition, all seismic programs will use mitigation measures such as ramp-ups, delayed startups, and shut-downs of the airgun arrays as well as spatial separation between concurrent seismic surveys (in 2019, a minimum separation distance of 100 km between MKI survey areas). Seismic programs and other ocean users (commercial shipping, fishing, oil developments) will have to maintain an appropriate separation distance for safe operations. Marine mammal response (including species at risk) to commercial shipping noise is expected to be localized and temporary especially for vessels maintaining a constant course and speed, which is typical for transiting commercial vessels. Marine invertebrate and fish response to commercial shipping noise is also expected to be localized and temporary, especially given the much lower sound levels associated with commercial shipping. Thus, it seems likely that while some animals may receive sound from multiple seismic programs, other vessels, oil developments, and exploratory drilling in the Study Area, the current prediction is that no significant residual effects will result from exposure to underwater sound. The level of confidence associated with this prediction is rated as low to medium given the scientific data gaps.

7.0 Concluding Statement

The 2D and 3D seismic survey activities proposed by MKI for 2019 have been reviewed and determined to be within the scope of the EA (LGL 2018a) and its Addendum (LGL 2018b). The original EA assessed the potential effects of three 3D surveys and one 2D survey occurring simultaneously in a given year (i.e., during May–November 2018–2023). However, the 2019 seismic program includes two 3D surveys and one 2D survey.

The environmental effects predicted in the EA and its associated Addendum remain valid. MKI reaffirms its commitment to implement the mitigation measures proposed in these assessment documents.

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Personal Communications

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Lawson, J.	DFO Research Scientist. 23 April 2019.
Mello, L.	Stock Assessment Biologist, Marine Fish Species at Risk and Fisheries Sampling, Northwest Atlantic Fisheries Centre, DFO. 27 March 2019.
Pierce, C.	Ecosystem Geomatics Technician, Protected Areas Establishment Branch, Parks Canada. 28 September 2018.
Wells, N.	Biologist, Science Branch, DFO. 4 February 2019.

List of Appendices

Appendix A – MKI Newsletter Distributed to Consultees

Appendix B – List of Consultees Contacted by MKI

Appendix A

MKI Newsletter Distributed to Consultees

Multiklient Invest AS — Seismic Programs Offshore Newfoundland 2019 Update

Resumption of the Program in 2019

This news update is to inform stakeholders and other interested parties of the continuation of MKI's current seismic program, started in 2012, in waters offshore Newfoundland and Labrador. The Project Area is within the regulatory jurisdiction of the Canada-Newfoundland and Labrador Offshore Petroleum Board (C-NLOPB) and it is expected that the Ramform Atlas, Ramform Titan and Sanco Atlantic will be acquiring data between early June and September 2019

Figure 1: Seismic Vessels due to work in the province during 2019

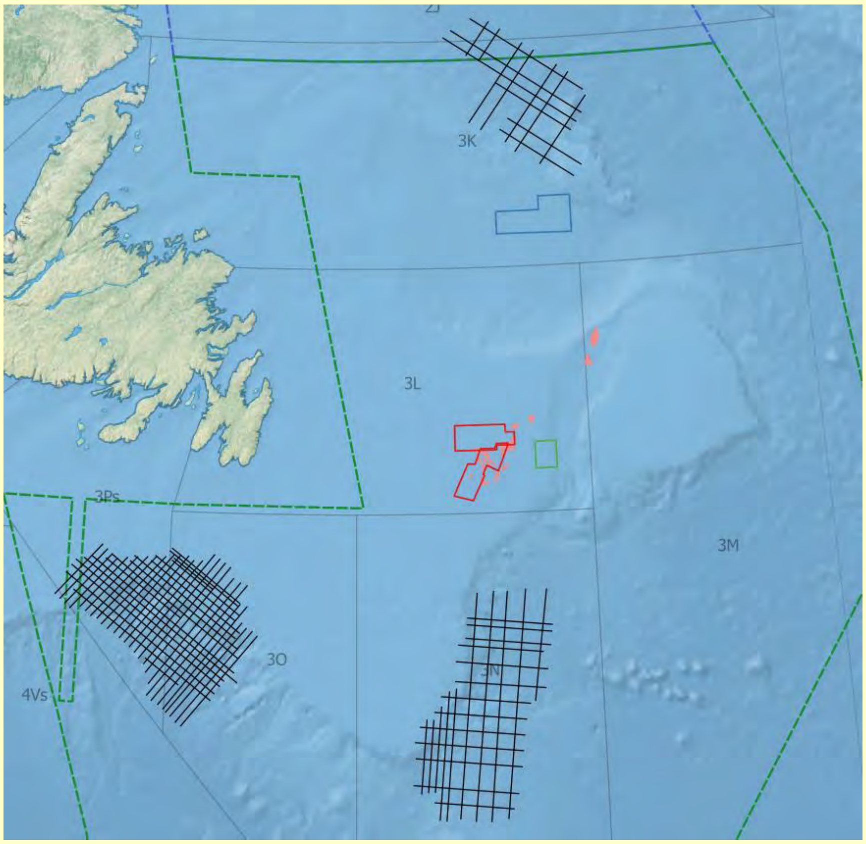

Figure 2: MKI Planned 2019 Seismic Activity Offshore Newfoundland

How to Access Environmental Information about the Project

The Environmental Assessment (EA) for the Multiklient Invest AS Newfoundland Seismic Program 2018-2023 along with additional documentation including the Annual EA Update can be accessed on the C-NLOPB website (www.cnlopb.ca).

From the C-NLOPB homepage, click on the "*Environment*" link near the bottom of the page. Then click on the "Project-Based Environmental Assessment" link. Click on the "*Active*" link. Once this page has opened, scroll down to the project titled *"Multiklient Invest AS Newfoundland Seismic Program 2018-2023"* and click on the link. Here you can find all environmental documents related to this project.

The EA provides a comprehensive and detailed overview of the project. The overview includes: information on the Physical and Biological Environment, including Fisheries, Fish and Fish Habitat, Marine Mammals and Species at Risk, and a Cumulative Effects Assessment.

Upon the completion of every acquisition season an Environmental Report is supplied to the C-NLOPB and other government agencies. This report summarizes the marine mammal observations, bird observations and interactions with fishing

Ongoing Communication

As a component of the ongoing communications between MKI and local fisheries organizations, MKI will be providing weekly briefing materials including information such as updated schedules, maps, and/or revised timelines.

Employment Opportunities

Employment opportunities associated with this year's operating season have been considered and it has been determined that there will be possible hiring opportunities as part of the maritime crew. The recruitment process through a local agency will commence in the coming weeks and interested parties should look out for notices posted in community employment offices and other advertisements

Contact Information

If you have any inquiries regarding the Newfoundland Offshore Seismic Program (2018-2023) please feel free to contact:

Petroleum Geo-Services
15375 Memorial Drive, Suite 100
Houston, Texas, 77079
(P) 1-281-509-8000
(F) 1-281-509-8500
canada@pgs.com

Appendix B

List of Consultees Contacted by MKI

Organization or Group Name	Email Address	Contact Name
Aquaforte		
Aquaforte Town Council	rhondaokeefe@aim.com	Rhonda O'Keefe
Argentia		
Argentia Management Authority Inc.	w.brenton@argentia.ca	Harvey Brenton
Arnold's Cove		
Town of Arnold's Cove	acadmin@bellaliant.com	Angie Gale
Avalon Ocean Products Inc.	Avalon.ocean@nf.aibn.com	Aloysius Wadman
Icewater Seafoods Inc.	awareham@icewaterseafoods.com	Alberto Wareham
Bay Bulls		
Town of Bay Bulls	townofbaybulls@nf.aibn.com	Not available
Burin		
Town of Burin	lhartson@townofburin.com	Leo Hartson, Town Manager
Burin Harbour Authority	morrisfudge@yahoo.ca	Morris Fudge
Burin Peninsula Environmental Reform Committee	info@greenburin.ca	Not available
College of the North Atlantic		
Wave Energy Research Centre	mike.graham@cna.nl.ca	Michael Graham, Administrator
Come by Chance		
Town of Come by Chance	townofcbc@eastlink.ca	Stephanie Eddy, Clerk
Conne River		
Miaqpukek First Nation	thowse@mfngov.ca	Tracey Howse, Director, Training and Economic Development
Corner Brook		
Qalipu Mi'kmaq First Nation Band	reldridge@qalipu.ca	Ralph Eldridge, Manager of Community Economic Development
Ferryland		
Town of Ferryland	Town.ferryland@nf.aibn.com	Not available
M. & A. Fisheries Limited	Ma.fisheries@nf.aibn.com	Angus O'Connell
Fortune		
Town of Fortune	norma@townoffortune.ca	Norma Stacey, Clerk
Fortune Harbour Authority	fortuneharbour@hotmail.com	
Atlantic Ocean Farms Limited	walsheslogybay@nl.rogers.com	David Walsh, President
Grand Bank		
Town of Grand Bank	Sdurnford@townofgrandbank.net	Sheila Durnford Office Administrator
Grand Bank Harbour Authority	hagb@bellaliant.com	Arch Evans
Marystown		
Town of Marystown	info@townofmarystown.ca	Dennis Kelly, Clerk
Burin Peninsula Community Business Development Corporation	Audrey.hennebury@cbdc.ca	Audrey Hennebury, Admin Assistant
Burin Peninsula Chamber of Commerce	administration@bpchamber.ca	Not available
Marystown Shipyard and Offshore Facilities	butlerwa@hotmail.com	Wayne Butler, President
Placentia		
Town of Placentia	dgear@placentia.ca	Debbie Gear, Executive Assistant
Placentia Area Chamber of Commerce	Eugene.collins@placentiachamber.ca	Eugene Collins, Executive Director
Harbour Authority of Placentia Area	cnrpomeroy@bellaliant.com	Carter Pomeroy
Avalon Gateway Regional Economic Development Inc.	contact@avalongateway.ca	Michael Mooney, Executive Director
Avalon West Community Business Development Corporation	Tanya.white@cbdc.ca	Tanya White, Administrative Assistant
Placentia Area Development Association	Pada44@hotmail.com	Tiffany Seay-Hepditch, Executive Director
Southern Harbour		

Town of Southern Harbour	twnsouthernhr@nf.aibn.com	Renee Hickey
St. Brides		
Town of St. Brides	Joanmorrissey01@yahoo.ca	Joan Morrissey, Clerk
St. Bride's Harbour Authority	Lorettaconway59@gmail.com	Loretta Conway
St. John's		
Fisheries and Oceans Canada-Coast Guard	Jason.kelly@dfo-mpo.gc.ca	Jason Kelly, Senior Fisheries Protection Biologist
Environment Canada	Glenn.troke@ec.gc.ca	Glenn Troke. EA Coordinator
Transport Canada	Clement.murphy@tc.gc.ca	Clement Murphy, Manager, Examinations, and Enforcement
Parks Canada	Randy.thompson@pc.gc.ca	Randy Thompson, Resource Management Officer
National Defence	information@forces.gc.ca	
St. Johns Port Authority	jmcgrath@sjpa.com	Jeff McGrath, Director of Marine Safety and Security
Newfoundland and Labrador Fisheries and Aquaculture	Davidlewis@gov.nl.ca	David Lewis, Deputy Minister
City of St. Johns	rellsworth@stjohns.ca	Ron Ellsworth, Deputy Mayor
Food, Fish, and Allied Workers	jjoensen@ffaw.net	Johan Joensen, Petroleum Industry Liaison
One Ocean	Maureen.murphy@mi.mun.ca	Maureen Murphy, Director
Groundfish Enterprise Allocation Council	bchapman@sympatico.ca	Bruce Chapman, Executive Director
Association of Seafood Producers	dbutler@seafoodproducers.org	Derek Butler, Executive Director
Seafood Processors of Newfoundland and Labrador	gjoyce@nf.sympatico.ca	George Joyce, Executive Director
Beothic Fish Processors Ltd.	pgrant@beothic.com	Paul Grant, Executive Vice President
Breakwater Fisheries Limited	rrbarnes@nf.sympatico.ca	Randy Barnes
Conche Seafoods Inc.- Quinlin Brothers Subsidiary	dphilpott@quinsea.com	Derrick Philpott, Director
Deep Atlantic International Inc.	Martha@deepatlanticsea.com	Martha Mullowney, Director
GC Rieber Carino Ltd.	John.c.kearley@carino.ca	John Kearley, CEO
HSF Ocean Products Limited	todd@hsfgroup.ca	Todd Hickey, Director
Nataaqnaq Fisheries	keith@natfish.ca	Keith Coady, Fleet Manager
Newfound Resources Limited	jeff@nrl.nf.net	Jeff Simms, Operations Manager
Notre Dame Seafoods Inc.	jeveleigh@notredameseafoods.com	Jason Eveleigh, President
San-Can Fisheries Limited	sgoff@san-can.com	Sandra Goff, Director
Ocean Choice International	rellis@oceanchoice.com	Rick Ellis, Director of Fleet Operations
Quinlan Brothers Ltd.	dearle@quinlanbros.ca	David Earle, Chief Financial Officer
Nature Newfoundland and Labrador	zedel@mun.ca	Len Zedel
St. Lawrence		
Town of St. Lawrence	townofstlawrence@nf.aibn.com	Not available
St. Mary's		
Town of St. Mary's	townofstmarys@nf.aibn.com	Not available
Deep Atlantic Sea Products (plant manager in St. Johns)	Martha@deepatlanticsea.com	Martha Mullowney, Plan Manager
Sunnyside		
Town of Sunnyside	townofsunnyside@eastlink.ca	Philip Smith, Town Manager
Trepassey		
Town of Trepassey	jill@townoftrepassey.com	Jill MacNeil, Clerk
Trepassey Management Corporation	chairperson@nf.aibn.com	Rita Pennell, Chairperson
Southern Avalon Development Association	southernavalondev@nf.aibn.com	Anita Molloy, VP and Board Member
Witless Bay		
Town of Witless Bay	townofwitlessbay@nl.rogers.com	Geraldine Caul, Clerk