Environmental Assessment of HMDC's 2D/3D/4D Seismic Projects 2013-Life of Field Newfoundland Offshore Area

Prepared by

LGL LIMITED
environmental research associates

for

Hibernia

May 2013
LGL Project No. SA1207

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List of Acronyms

CAPP	Canadian Association of Petroleum Producers
CEAA	Canadian Environmental Assessment Act
CFA	Crab Fishing Area
CIL	Cold Intermediate Layer
COSEWIC	Committee on the Status of Endangered Species in Canada
CPA	Closest Point of Approach
CPUE	Catch-per-unit-effort
CSEM	Controlled Source Electromagnetic
CWS	Canadian Wildlife Service
DFO	Department of Fisheries and Oceans Canada
EA	Environmental Assessment
EBSA	Ecologically and Biologically Significant Areas
ECSAS	Eastern Canadian Seabirds at Sea
EF	End of Field
EL	Exploration Licenses
EMCP	ExxonMobil Canada Properties Ltd.
ESRF	Environmental Studies Research Funds
FFAW	Fish, Food and Allied Workers
FLO	Fisheries Liaison Officer
FRCC	Fisheries Resource Conservation Council
GBS	Gravity Based Structure
HMDC	Hibernia Management and Development Company
HSE	Health, Safety and Environment
IBA	Important Bird Area
ICOADS	International Comprehensive Ocean-Atmosphere Data Set
IFMP	Integrated Fisheries Management Plan
L-DEO	Lamont-Doherty Earth Observatory of Columbia University
LF	Low Frequency
LOMA	Large Ocean Management Areas
MANMAR	Manual of Marine Weather Observing
MKI	Multi Klient Invest
MMO	Marine Mammal Observer
NAFO	North Atlantic Fisheries Organization
NL	Newfoundland and Labrador
NMFS	National Marine Fisheries Service
NSF	National Science Foundation
NSIDC	National Snow and Ice Data Center
OBC	Ocean Bottom Cables
OBS	Ocean Bottom Seismic
OPS	Operational Policy Statement

List of Acronyms (Cont'd)

PAM	Passive Acoustic Monitoring
PBGB	Placentia Bay Grand Banks
PIROP	Programme intégré de recherches sur les oiseaux pélagiques
PL	Production Licenses
PTS	Permanent Threshold Shift
RA	Regulatory Area
RV	Research Vessel
SAR	Species at Risk
SARA	Species at Risk Act
SBO	Seabird Observer
SEL	Sound Exposure Levels
SPL	Sound Pressure Levels
SPOC	Single Point of Contact
SWSS	Sperm Whale Seismic Study
TTS	Temporary Threshold Shift
USFWS	United States Fish and Wildlife Services
VEC	Valued Ecosystem Component
VMS	Vessel Monitoring Systems
WREP	White Rose Extension Project

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1.0 Introduction

Hibernia Management and Development Company Ltd. (referred to here as HMDC, the Proponent or Operator) is proposing to conduct seismic surveys offshore Newfoundland in the region of the Jeanne d'Arc Basin (Figure 1.1). HMDC may conduct 2-D, 3-D or 4-D seismic surveys in one or more years within a 2013-end of field (EF) timeframe. This constitutes "the Project" as assessed herein.

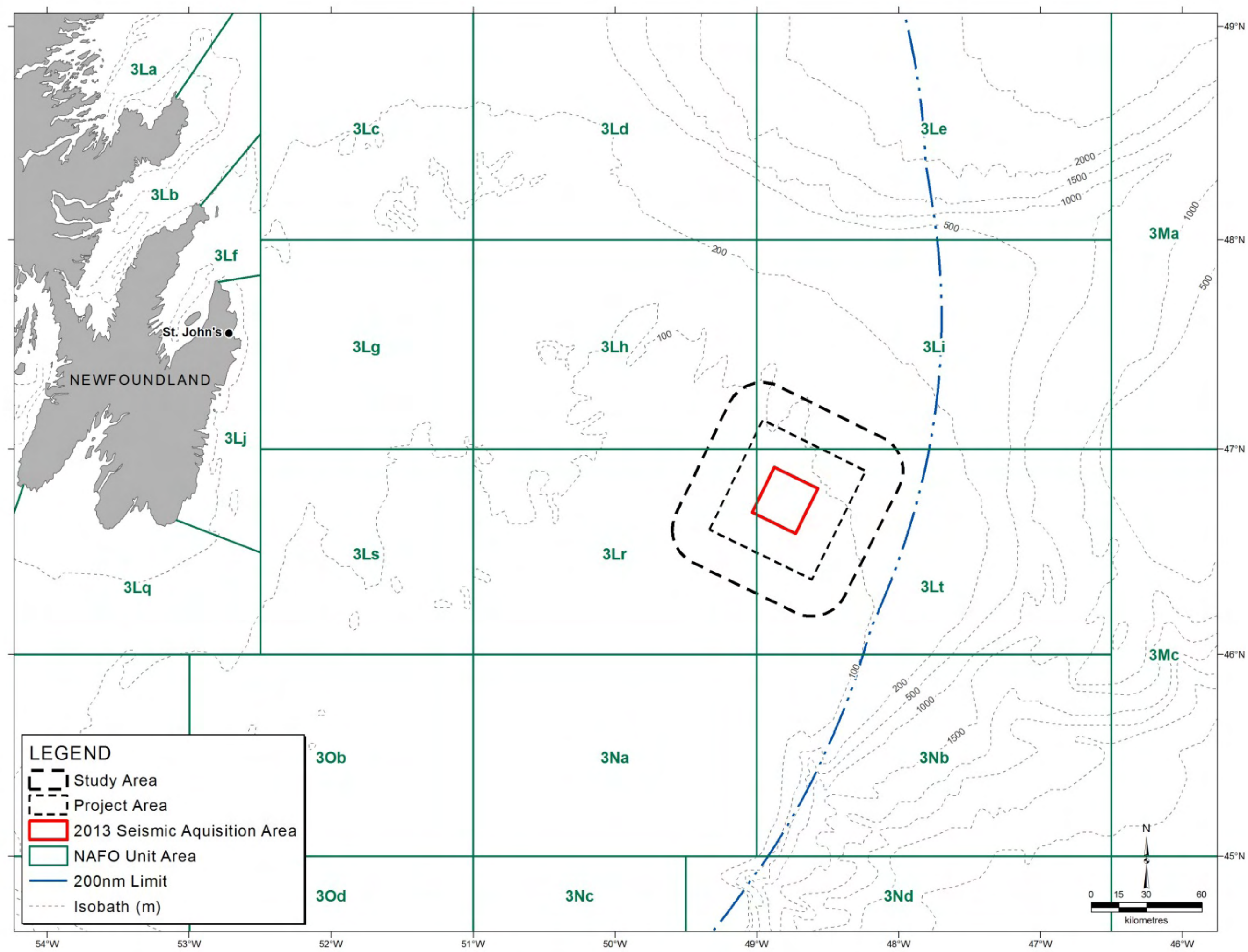

Figure 1.1 HMDC's Proposed Project and Study Area Encompassing the Proposed 2013 Seismic Survey Area.

The HMDC Project Area and immediate surrounding area have been subject to numerous geophysical, drilling, and production EAs since the early 1980s. Each EA tended to build on the ones before. In assembling this EA, HMDC has attempted to produce a concise summary type document based on previous EAs while at the same time meeting the C-NLOPB Scoping Document in a comprehensive manner. Thus, repeated references are made to the most recent seismic EA (e.g., Husky Grand Banks Seismic EA-LGL 2012) for the general area which is appended in electronic form for the convenience of reviewers. While this EA covers 2013 to EF, details on any post-2013 surveys will be provided in EA validation documents to be submitted to the C-NLOPB. For seismic projects conducted beyond 2013, this EA will be updated accordingly if it is determined the Project differs substantially from the activity assessed herein.

1.1 Relevant Legislation and Regulatory Approvals

This EA has been prepared in accordance with the C-NLOPB's requirements to support the issuance of an authorization; the process established by the C-NLOPB is similar to previous assessments conducted under the *Canadian Environmental Assessment Act* (*CEAA*); a scoping document has been prepared by the C-NLOPB based on a project description filed by HMDC; these documents are available on the Board's website at www.cnlopb.nl.ca.

Legislation relevant to the environmental aspects of the Project includes:

- *Canada-Newfoundland Atlantic Accord Implementation Act*
- *Oceans Act*
- *Fisheries Act*
- *Navigable Waters Act*
- *Canada Shipping Act*
- *Migratory Bird Convention Act*; and
- *Species at Risk Act (SARA)*

Specific guidelines issued by the C-NLOPB, the *Geophysical, Geological, Environmental and Geotechnical Program Guidelines* (2012), are directly relevant to this undertaking.

The Board has formally delegated the responsibility of an acceptable environmental assessment report and any supporting documents to HMDC, the Project Proponent.

1.2 The Operator

Headquartered in St. John's, Newfoundland and Labrador (NL), Hibernia Management and Development Company Ltd. (HMDC) was the first company to be involved in offshore oil production on the Grand Banks. HMDC is the management and operating company under Production Licenses (PL) for 1001 and 1005 and Exploration Licenses (EL) 1093. Most recent estimates of recoverable reserves for the Hibernia field are provided on the C-NLOPB website at http://www.cnlopb.nl.ca/pdfs/estrr_hib.pdf.

Information on HMDC's commitment to Health, Safety and Environment (HSE) is provided at http://www.hibernia.ca/she.html some of which reads: "The principles of environmental responsibility and stewardship are integrated throughout the Hibernia organization and are reflected in every action and initiative. HMDC recognizes that environmental objectives, based on relevant scientific and socio-economic data, are best achieved by defining specific goals and developing appropriate standards through government consultation. Input from local communities is also essential in order to strike a balance between environmental needs and the technical and socio-economic demands of the project.

HMDC is applying some of the most stringent measures in the industry to prevent and clean up oil spills. All production, storage, off-loading and transportation systems have been designed to minimize the likelihood of any oil spills, large or small, and an effective Oil Spill Response Plan has been incorporated into the project's overall emergency response procedures.

In keeping with its commitment to community involvement, Hibernia continues to work closely with representatives of the Canada-Newfoundland and Labrador Offshore Petroleum Board and fishers and fish processors that represent Newfoundland and Labrador and Maritimes fishing interests on the Grand Banks."

ONE OCEAN is the liaison organization established by the fishing and petroleum industries of Newfoundland and Labrador. Under the direction of an advisory board, ONE OCEAN promotes mutual understanding between these two vital industries and their common marine environment.

1.3 Canada-Newfoundland and Labrador Benefits

Consistent with the requirements of the *Canada-Newfoundland and Labrador Atlantic Accord Implementation Newfoundland and Labrador Act* and the *Canada-Newfoundland Atlantic Accord Implementation Act*, HMDC is committed to enhancing the opportunities for Canadian and, in particular, Newfoundland and Labrador, participation.

HMDC maintains an office in St. John's, and manages its Grand Banks operations from St. John's. HMDC provides full and fair opportunity to Canadian individuals and organizations, in particular those from NL, to participate in HMDC's activities in NL. HMDC supports the principle that first consideration be given to personnel, support and other services that can be provided within NL, and to goods manufactured in NL, where such goods and services can be delivered at a high standard of Health, Safety and Environmental competency, be of high quality and are competitive in terms of fair market price. Contractors and sub-contractors working for HMDC in NL must also apply these principles in their operations.

1.4 Contacts

The relevant HMDC contacts for this EA are provided below.

1.4.1 Executive Contact

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1.4.2 Health, Environment & Safety Contact

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1.4.3 Geophysical Operations Contact

Geophysical contact, please direct inquiries to Jamie Long (as above).

2.0 Project Description

The official name of the Project is the 2D/3D/4D Seismic Projects, (2013-Remaining Life of Field) Newfoundland Offshore Area. The Project is located in an offshore area about 255 km east-southeast of St. John's, Newfoundland and Labrador (Figure 1.1).

2.1 Spatial and Temporal Boundaries of the Project

In terms of spatial boundaries, the Project Area includes the 2013 Survey Area (Figure 1.1). The Study Area encompasses the Project Area plus a 20-km buffer area around the Project Area (Figure 1.1). This buffer accounts for any propagation of seismic survey sound beyond the Project Area that could potentially affect marine biota. It also includes any additional turning area if required. The Study Area is equivalent to the "Affected Area" described in the Scoping Document. The temporal boundaries include 2013-EF wherein surveys may occur anytime between 1 May and 30 December.

For the 2013 survey, the intent is to commence data acquisition as a direct follow-on program to Hebron's 2013 3D/4D Baseline Seismic Program. Depending upon the start date of Hebron's 2013 3D/4D Baseline Seismic Program, weather and other factors, the HMDC survey program could commence as early as the beginning to mid July 2013 and conclude by the end of November.

Detailed information on seismic surveys for 2014 to End of Field (EF) will be provided prior to commencement of these surveys including a review of the EA to ensure all information is current and relevant, particularly with respect to Commercial Fisheries and Species at Risk (SAR).

2.2 Project Overview

The Proponent proposes, over the remaining life of the Hibernia field, to conduct marine geophysical programs within an approximate 4,035 km^2 area which is generally centered on the Hibernia GBS location (Figure 1.1 – Project Area). The 2013 survey program will be contained within a 702 km^2 area for the completion of a high quality 4-D monitor seismic survey (Figure 1.1 – 2013 Survey Area).

In 2013, the Operator is proposing to conduct a 4-D seismic survey starting as early as 1 May and concluding as late as 31 December. Four-D data acquisition simply means that successive 3-D survey data sets for the same area are interpreted to delineate changes in the reservoir over time. A typical application of this technique is using a previous 3-D data set and comparing it with a recently acquired 3-D survey to try and detect changes in, and hence, the behaviour of a reservoir in the production phase. This requires precise survey location control to ensure accurate comparison of the two seismic survey data sets.

The timing of the survey is subject to the Proponent's priorities and circumstances, weather and ice conditions, contractor availability and regulatory approvals. Any potential other seismic surveys conducted during subsequent seasons in 2014-End of Field (EF) will also occur during the same temporal window of 1 May to 31 December.

The proposed future surveys could include 2-D, 3-D and 4-D programs. Traditional towed solid streamer technology will be used in 2013; however, other programs may include use of ocean bottom cables (OBC) starting as early as 2014. An OBC consists of a string of sensors (e.g., hydrophones, geophones, accelerometers) temporarily placed on the seabed to record seismic signals similar to sensors embedded in towed streamers. The exact dates of the 2013 Hibernia 4-D survey will depend upon the weather conditions and the completion date of a prior program over the Hebron field. It is expected that the survey vessel will be available sometime in July 2013. If the survey cannot commence or be completed in 2013, it may be completed in subsequent years.

The seismic survey vessel(s) used during the Project will be approved for operation in Canadian waters and will be typical of the worldwide seismic fleet. In the case of either 2-D or 3-D surveys, the seismic survey ship will have air source arrays and multiple streamers (up to approximately 8 km in length). In 2013, the vessel will tow a dual sound source and up to twelve seismic streamers of an approximate length of six kilometers.

The C-NLOPB's *Geophysical, Geological, Environmental and Geotechnical Program Guidelines* (C-NLOPB 2012) will be used as the basis for the marine mammal monitoring and mitigation program for the seismic surveys. Dedicated marine mammal observers (MMOs) will monitor for marine mammals (and sea turtles if present) and implement mitigation measures as appropriate. A fisheries liaison officer (FLO) will be on board, as required, to ensure implementation of communication procedures intended to minimize conflict with the commercial fishery.

2.2.1 Objectives and Rationale

The purpose of a seismic survey is to acquire data to assess the presence of geological structures suitable for the containment and accumulation of hydrocarbons and to determine the hydrocarbon characteristics.

In 2013, the seismic survey is intended to acquire high quality 4-D monitor survey data. The 4-D imaging will be used to monitor fluid and pressure changes in the reservoirs and also aid in optimization of future development well locations. The 4-D monitor seismic data will become part of the reservoir management plan.

2.2.2 Alternatives to the Project/Alternative Means within the Project

The alternatives to the Project are:

1. To not explore for oil and gas offshore Newfoundland but pursue opportunities elsewhere in the world in order to assist in meeting market demand for petroleum products;
2. To not conduct seismic surveys prior to drilling, or
3. To not conduct surveys as part of reservoir management.

If the first alternative were selected, it would mean that the Proponent, government, and people of the province, East Coast region, and Canada would not benefit from the economic accruals of the Project in terms of wages, profits, taxes and royalties. The second and third alternatives are contrary to current best practice in the industry and would potentially waste significant resources drilling in the wrong locations.

Alternatives within the Project include the different contractors' vessels and equipment as described in the following sections. These alternatives will be decided by the competitive bidding process.

2.2.3 Project Phases

The Project may have a number of phases (the various survey types over time) depending upon the reservoir management plan. The actual timing of these within the temporal scope will be dependent on economic feasibility, seismic vessel availability and the interpretation of survey data from preceding phases.

2.2.4 Project Scheduling

The first seismic survey is intended to take place between May and December in 2013 and future programs may be conducted during that same time period for the remaining life of the Hibernia oil field. For the 2013 survey, the intent is to commence data acquisition as a direct follow-on program to the 2013 Hebron Seismic Streamer Program. Depending upon the start date of the 2013 Hebron Seismic Streamer Program and weather and other factors, the program could commence as early as the beginning to mid July 2013 and conclude by the end of November.

2.2.5 Site Plans

The Project Area proposed for the 2012-EF seismic program is shown in Figure 1.1. Water depths in the Project Area range from <100 m to <200 m. Survey area for 2013 is also indicated in Figure 1.1. The survey line orientations for the proposed seismic surveys have not yet been determined.

2.2.6 Project Components

The components of a seismic survey typically include a seismic vessel; the towed seismic air source array; the towed receiver (hydrophone) array; a picket vessel; a logistics supply vessel; helicopter; and a shorebase.

Survey parameters as they are presently known are provided in Table 2.1.

Table 2.1 Known Seismic Survey Parameters.

General Information	
Operating Company:	Hibernia Management & Development Company Ltd. (HMDC) and ExxonMobil Canada Properties Ltd., a partnership (EMCP)
Vessel Name(s):	TBD
Location:	See Figure 1.1 and Table 2.2 (in Section 2.4)
Type of Survey:	2013 4-D Monitor Survey (subsequent years 2-D, 3-D, 4-D, OBC)
Area:	Seismic project area = 4035 km^2 includes turning area). Life of field (data acquisition) Project Area = 702 km^2 (may vary in subsequent years)
Average line length (including 3 km run-out):	2013 4-D program 18 km (may vary in subsequent years)
Line direction:	24.5º / 204.5º (may vary in subsequent years)
Source Parameters	
Source type	Bolt, Sodera G or sleeve (steerable source preferred)
Number of sources	2 (flip-flop)
Shot to shot interval	18.75 m (37.5 m per source)
Total volume per source	3,000-6,000 cu inch
Source operating pressure	2,000 psi (may vary in subsequent years)
Source depth	6 m +/- 0.5 meters tolerance (TBC)
Output	Up to 120 bar-meter peak to peak
Streamer Parameters	
Streamer type	Digital 24 bit (solid or gel-filled streamers required)
Number of active streamers	2013 4-D program 12 streamers (on 8 streamer pre-plot) (may vary in subsequent years)
Streamer separation	50 or 75 meters
Active streamer length (each nominal)	4,500 or 6,000 meters
Steerable streamer device (REQUIRED)	DigiFin, Qfin, eBird, Nautilus or equivalent
Streamer depth	7-24 m +/- 1.0 m tolerance (TBC)
Minimum line run-in distance	1.5 x active streamer length (unobstructed areas)

2.2.7 Personnel

A typical seismic vessel can accommodate approximately 50-100 personnel depending on size and capabilities of the contract vessel. Personnel on a seismic vessel includes individuals representing the Operator, the vessel owner/operator (ship's officers and marine crew), and technical and scientific personnel from the main seismic contractor. The seismic vessel will have a Fisheries Liaison Officer (FLO) and Marine Mammal Observers (MMO) on board, as well as an Operator representative (s). The representative serves as Client Quality Control, Navigation data Processing Quality Control, and HSE oversight. All project personnel will have all of the required certifications as specified by relevant Canadian legislation and the C-NLOPB.

2.2.8 Seismic Vessel

Vessel specifics will be provided in subsequent document submissions once the contractors are selected. The selected ship will be a fully equipped, modern vessel suited to the environment and task.

2.2.9 Seismic Energy Source Parameters

The proposed 2013 4-D survey sound source will consist of two air source arrays, with sufficient volume to output up to 120 bar-meters peak to peak (Table 2.1). The air source will operate at a towed depth of approximately six meters. The air sources will be operated with compressed air at a pressure of approximately 2,000 psi. While towing the survey lines, the two air source arrays are discharged alternately, one each 18.75 meters down the line or approximately every six seconds. Seismic air source array specifications may vary in subsequent years.

A typical 2-D or 3-D survey sound source consists of one or two air source arrays, 3,000 to 6,000 in^3 in total volume, which operate at towed depths between 6 m and 15 m. The air source operates on compressed air at pressures 1,800 to 2,500 psi, and produce approximate peak-to-peak pressures 100 to 180 bar-m.

2.2.10 Seismic Survey Receivers

The 2013 4-D seismic survey will use 12 towed streamers with a length of 4,500 or 6,000 m and deployed at a depth of approximately seven to 24 meters (Table 2.1). The streamers will be separated by 50 or 75 meters. The streamers will be solid or gel-filled to minimize the environmental impact in the case of breaks or tears. Streamer configurations may vary in subsequent years.

In subsequent surveys, 2-D and 3-D seismic surveys may use up to 12 towed streamers with an approximate length of up to 8,100 m and deployed at depths ranging from five to 30 m. Streamer equipment specifications will be provided when program designs are complete.

The proposed OBS (Ocean Bottom Seismic) survey sound source will consist of two air source arrays, with sufficient volume to output up to 120 bar-meters peak to peak. The air source will operate at a towed depth of approximately six meters. The air sources will be operated with compressed air at a pressure of approximately 2,000 psi. While towing the survey lines, the two air source arrays are discharged alternately, one each 25 meters down the line or approximately every eight seconds. Seismic air source array specifications may vary in subsequent years.

2.2.11 On Bottom Cables

On bottom cables (OBC) may be used by HMDC in future programs. An OBC seismic survey would use ocean bottom cables or nodes as receivers with a length of 6,000-12,000m and deployed on the seabed. The cables or nodes will be solid or liquid-filled and routinely inspected for breaks or tears in order to minimize the environmental impact. The cables or nodes will be placed on the sea floor during data acquisition, and will be picked up from the sea floor by the cable boat after acquisition has been completed. There will be no trenching of subsea equipment on the sea floor.

More specifics can be provided in the future if and when OBCs are to be used and a contractor is selected. No OBC data will be collected in 2013.

2.2.12 Logistics/Support

Details of logistical operations to support the Project will largely depend on the contracted seismic acquisition company. The seismic vessel will use shorebase facilities in St. John's, NL for initial clearance into Canadian waters and exit from Canadian waters at the end of the survey. Re-supply of the seismic vessel during the survey will be accomplished with a chartered supply vessel from the Port of St. John's.

A picket vessel will be used to scout ahead for hazards and for interacting and communicating with other users of the area about the survey and associated trailing gear, and assist in working with fishers in the area (if any). A supply vessel will provide a means for towing the seismic vessel in the case of a loss of propulsion. This will avoid a major loss of equipment and potential environmental damage.

Due to varying weather conditions, the contractor will likely use a supply vessel for crew changes rather than a helicopter. However, it is possible the seismic vessel may use a helicopter for crew changes. Helicopters can also be used in case of medical and other emergencies and for minor re-supply.

The seismic contractor will use existing shorebase facilities in St. John's whenever necessary and a dedicated shore-based representative or contact person will be located in St. John's for the duration of the Project.

2.2.13 Waste Management

Waste will be managed consistent with applicable regulations and industry best practices in offshore Newfoundland.

2.2.14 Air Emissions

Air emissions will be those associated with standard operations for marine vessels, including the seismic vessel, any potential picket and/or supply vessel. There are no anticipated implications for the health and safety of workers on these vessels.

2.2.15 Accidental Events

In the unlikely event of the accidental release of hydrocarbons during the Project, the Operator and its seismic survey contractor will implement the measures outlined in its oil spill response plan which will be filed with the C-NLOPB. In addition, the Operator has emergency response plans in place which will be bridged with the seismic contractor's response plans prior to commencement of the seismic program.

2.3 Mitigations

Guidance provided in the C-NLOPB's *Geophysical, Geological, Environmental and Geotechnical Program Guidelines* (C-NLOPB 2012) will be used as the basis for the management and mitigation of environmental risks associated with the project. These guidelines recommend that operators implement the mitigations listed in the Fisheries and Oceans Canada *Statement of Canadian Practice with Respect to the Mitigation of Seismic Sound in the Marine Environment*.

This Statement recommends the use of a marine mammal observer (MMO) to continuously observe, for a minimum of 30 minutes, a 500 m safety zone (centered on the air source array) prior to start up and to ramp-up the array gradually over a 20 minute period beginning with the activation of a single source element. Further, it recommends the ramp-up to be delayed if a cetacean, sea turtle or *Species at Risk Act* (*SARA*) listed (Schedule 1) marine mammal is detected within the safety zone. In addition, the air source array will be shut down any time a marine mammal or sea turtle listed as endangered or threatened on Schedule 1 of the *SARA* is observed in the safety zone. In periods of low visibility (i.e., very heavy fog and/or night time), the seismic operator will utilize the additional mitigation technique of passive acoustic monitoring in areas of critical habitat for endangered or threatened cetaceans or where a cetacean may be significantly and adversely affected as identified through the EA process and as prescribed in the Statement of Canadian Practice.

A Canadian Wildlife Service (CWS) permit will also be obtained to enable the MMO to salvage and release seabirds which may strand on the seismic vessel. A seabird salvage log will be maintained to record all seabird interactions as per the permit conditions. Handling of stranded, oiled and non-oiled birds will be in accordance with the CWS Bird Handling Permit.

To mitigate risks to fishers and fishing gear, a fisheries liaison officer (FLO) will be utilized as needed to assess risks prior to departure; to recommend mitigations while at sea; and to communicate directly with fishers as needed. Meetings will also be held with the fishing industry to share details of the project; to assess the likelihood of fishing activity in the area; and to address any concerns or issues identified.

2.4 Project Site Information

Project location is in the offshore Newfoundland area (see Figure 1.1).

The seismic Project Area is approximately 4,035 km^2 in size and generally centered upon the Hibernia gravity based structure (GBS) (charted position 46 45.01N, 48 46.9W) (Table 2.2). The Study Area includes a 20 km turning area (buffer around Project Area) to accommodate ship turning, holding, and streamer deployment (Figure 1.1). The Study Area is contained entirely inside the North Atlantic Fisheries Organization (NAFO) 3Lh, i, r, t Unit Areas and in an area generally referred to as the Jeanne d'Arc Basin. The Project and Study Areas also include the area which is the focus of the 2013 survey (Figure 1.1) and all HMDC future seismic programs.

Table 2.2 Area Coordinates (WGS-84 UTM Zone 22 N).

Area	Corner	Easting (m)	Northing (m)	Latitude (DD)	Longitude (DD)
2013 Seismic Area	NE	685436	5186840	46.809290	-48.569463
2013 Seismic Area	SE	674233	5162273	46.591404	-48.725480
2013 Seismic Area	SW	650576	5173061	46.694153	-49.030590
2013 Seismic Area	NW	661779	5197628	46.912467	-48.875480
Project Area	NE	710844	5197280	46.895577	-48.231988
Project Area	SE	683660	5137689	46.367839	-48.612217
Project Area	SW	627615	5163253	46.610700	-49.333473
Project Area	NW	654800	5222847	47.140926	-48.958437
Study Area	NE	737337	5207185	46.975646	-47.879508
Study Area	SE	693565	5111196	46.126872	-48.494440
Study Area	SW	601122	5153348	46.526100	-49.681501
Study Area	NW	644895	5249340	47.381439	-49.080394

The 2013 survey program is focused on an area approximately 702 km^2 in size with a survey line heading of 24.5º/204.5º and with an average line length of approximately 18 kms. The 702 km^2 area and a 20 km turning zone are defined by the coordinates in Table 2.2.

2.4.1 Environmental Features

HMDC and other operators have been conducting seismic surveys in and around the Jeanne d'Arc Basin for many years and are thoroughly familiar with local conditions of weather, sea state, and ice. In addition, they are supported by state of the art weather and ice observation and forecasting.

The physical and biological environments of the general area have been described in a number of recent EAs for the northern Grand Banks (LGL 2011a, b; 2012; and others). A summary of the physical and biological environments, based on the previous EAs plus any new information is provided in the following sections (Sections 3.0 and 4.0, respectively).

2.4.2 Physical Environment and Effects on the Project

A description of the general physical environment of the area is contained in recent EAs for the northern Grand Banks (e.g., LGL 2011a, b; LGL 2012) and is summarized in Section 3.0. The survey will be conducted in water depths ranging from <100 m to <200 m. The scheduling seismic surveys during a period (May to December) when NW Atlantic operating conditions (e.g., temperatures, wind, wave, and ice conditions) are generally better than the January-April period, should lessen any effects of the environment on the Project.

A summary of expected effects of the physical environment on the Project, based on information in previous EAs, as well as any new information, are provided in Section 5.5.

2.4.3 Fish and Fish Habitat

The fish species that inhabit the Project Area are typical of the Grand Banks at Project depths. The species (e.g., invertebrates) and habitats that support them have been discussed in detail in previous EAs for the Jeanne d'Arc Basin. These components of the ecosystem are summarized in Section 4.0, based on previous EAs and other relevant documents.

2.4.4 Species at Risk

The Project Area is not known to contain any sensitive areas or critical habitats for species listed on Schedule 1 of the *Species at Risk Act* (*SARA*) (see Section 4.7). Seven species listed as *threatened* or *endangered* on Schedule 1 including the blue whale, North Atlantic right whale, leatherback sea turtle, Ivory Gull, two wolffish species and white shark, while rare, may possibly occur in the Project Area. The potential effects on these species and those currently considered *threatened* or *endangered* by the Committee on the Status of Endangered Species in Canada (COSEWIC) which may occur in the Study Area are discussed in Section 5.6.5.

2.5 Other Users

2.5.1 Commercial Fisheries

The Project Area supports a variety of commercial fisheries as described in Section 4.2.4 based on latest available DFO geo-referenced catch data (2010). Some of the most important fisheries in and adjacent to the Project Area include those for northern shrimp, snow crab, and Greenland halibut.

2.5.2 Navigable Waters

In addition to foreign and domestic fisheries vessels, potential users of the navigable waters in the Grand Banks regional area may include cargo and passenger vessels, recreational, aboriginal/subsistence vessels, other oil industry-related vessels, transport and military vessels, and other commercial ships.

2.5.3 Consultations

During the course of the assessment, HMDC consulted with stakeholders with an interest in the Project. Consultations with the fishing industry were undertaken through the established One Ocean mechanism and the Fish, Food and Allied Workers (FFAW), and directly with other relevant fishing interests as necessary. Those consulted and the results of those consultations are presented in Section 5.1.1.

2.6 Effects of the Project on the Environment

The proposed Project will be similar to many other programs routinely conducted offshore Newfoundland and elsewhere in eastern Canada, and is not expected to produce any adverse significant environmental effects on the marine environment in or adjacent to the Project Area. Nonetheless, potential environmental effects are examined in detail with focus on the commercial fishery, *SARA* species, marine mammals, and cumulative effects from interactions with other users of the area, particularly any other seismic programs. Accidental events (such as an unplanned hydrocarbon release) associated with Project activities are also assessed in this EA.

2.6.1 Assessment Boundaries

The assessment boundaries for the Project are shown in Figure 1.1. Consideration was given to the Regional Area (i.e., the Grand Banks) when analyzing cumulative effects as this is the area of current and anticipated future oil industry activities for the duration of the Project. The temporal boundaries for the proposed Project are 2012 to EF, with the timing of seismic surveys between 1 May and 31 December within any particular year.

2.6.2 Valued Ecosystem Components

As is common practice on the East Coast and as recommended in the Scoping Document (C-NLOPB 2013), a valued ecosystem component (VEC) approach was used in this EA. The VECs include:

- Fish and fish habitat;
- Commercial fisheries;
- Marine birds;
- Marine mammals and sea turtles, and
- Species at Risk and sensitive areas.

2.6.3 Environmental Mitigation and Monitoring

As noted previously, MMO (s) will be on board the vessel (s) to provide proper identification of marine mammals and species at risk for mitigation purposes and to collect opportunistic data on marine mammal behaviour and distribution with and without air sources operating. Information on marine bird occurrence and distribution will also be collected during the seismic surveys.

Plans will be developed to avoid or lessen any potential effects on the commercial fishery. These plans will include mitigations such as good communications (e.g., fishery broadcast notifications), the presence of a dedicated FLO on the vessel, avoidance of areas during times of heavy fixed gear use, and a fishing gear damage compensation program.

3.0 Physical Environment

A detailed description of the physical environment on the Grand Banks and the edge of the Continental Shelf as prepared by Oceans Ltd. is provided in LGL (2012) (electronic copy appended). A brief summary abridged directly from LGL (2012) follows below.

3.1 Climatology

The Jeanne d'Arc Basin experiences weather conditions typical of a marine environment with the surrounding waters having a moderating effect on temperature. In general, marine climates experience cooler summers and milder winters than continental climates and have a narrower annual temperature range. Furthermore, a marine climate tends to be fairly humid, resulting in reduced visibilities, low cloud heights, and significant amounts of precipitation.

The climate of the Jeanne d'Arc Basin is very dynamic, being largely governed by the passage of high and low pressure circulation systems. These circulation systems are embedded in and steered by the prevailing westerly flow that typifies the upper levels of the atmosphere in the mid-latitudes and arises due to the normal tropical to polar temperature gradient. The mean strength of the westerly flow is a function of the intensity of this gradient, and as a consequence is considerably stronger in the winter months (i.e., January-March) than during the summer months (July-September) due to an increase in the south to north temperature gradient.

The data sources to describe the climatology of the Jeanne d'Arc Basin came from four main sources: (1) the International Comprehensive Ocean-Atmosphere Data Set (ICOADS); (2) rig observations (MANMAR); (3) the MSC50 N Atlantic wind and wave climatology database; and (4) the National Hurricane Centre's best-track data set. These are described in detail in LGL (2012). In addition, Colbourne et al. (2012) described regional conditions for 2011 based on a large number of oceanographic stations.

Wind and wave statistics were compiled using MANMAR data from several offshore platforms located in the region. The location, period of observation and anemometer height for each of these stations is presented in Table 3.1. Note: The Glomar Grand Banks and the GSF Grand Banks are the same platform under different names at the time of the observations.

Wave statistics were also compiled from wave data measured on the White Rose field. The White Rose data set from October 2003 to December 2010 has been split due to the change in measuring equipment from a TRYAXIS directional waverider buoy to a Datawell Directional Waverider Buoy in August 2007.

Table 3.1 Locations of MANMAR Observations.

	Latitude	Longitude	Anemometer Height	Period
Sea Rose FPSO	46.8°N	48.0°W	42	August 02, 2007 – September 30, 2011
Terra Nova FPSO	46.4°N	48.4°W	50	August 12, 2007 - September 30, 2011
Glomar Grand Banks	46.5°N	48.4°W	82.5	December 31, 1998 - July 02, 2000
GSF Grand Banks	46.7°N	48.0°W	82.5	August 01, 2007 - September 30, 2011
Henry Goodrich	46.4°N	48.6°W	95	February 23, 2000 - September 30, 2011
Hibernia	46.7°N	48.7°W	139	January 01, 1999 - September 30, 2011

Source: LGL (2012).

3.1.1 Wind

Wind in the Regional Area is discussed in detail in Section 3.1.3 of LGL (2012). Some relevant excerpts are provided below.

The Hibernia area experiences predominately southwest to west flow throughout the year. There is a strong annual cycle in the wind direction. West to northwest winds which are prevalent during the winter months begin to shift counter-clockwise during March and April resulting in a predominant southwest wind by the summer months. As autumn approaches, the tropical-to-polar temperature gradient strengthens and the winds shift slightly, becoming predominately westerly again by late fall and into winter. Low pressure systems crossing the area are more intense during the winter months. As a result, mean wind speeds tend to peak during this season.

In addition to mid-latitude low pressure systems crossing the Grand Banks, tropical cyclones often move northward out of the influence of the warm waters south of the Gulf Stream, passing near the Island of Newfoundland. Once the cyclones move over colder waters they lose their source of latent heat energy and often begin to transform into a fast-moving and rapidly developing extratropical cyclone producing large waves and sometimes hurricane force winds.

Low pressure systems crossing the area are more intense during the winter months. As a result, mean wind speeds tend to peak during this season. Mean wind speeds for all data sets peak during the month of January (Table 3.2).

Wind speed typically increases with increasing heights above sea level. Statistics provided in Table 3.2 are presented in order of increasing height, with the MSC50 data set being the lowest and the Hibernia Platform being the highest. The anemometer heights for each platform are found in Table 3.1 in Section 3.1.2.3 of LGL (2012) (appended). Statistics for each anemometer level are presented to give a better idea of winds at varying levels above sea level.

Monthly wind roses along with histograms of the frequency distributions of wind speeds can be found in Appendix 1 of LGL (2012) (appended). Wind speeds are much lower in the summer than in winter.

At three locations in the Hibernia region, light winds (0.5 to ≤5.7 m/s) occur about 30% of the time, moderate about 37% (5.7 to ≤9.8 m/s), strong (9.8 to ≤17 m/s) about 30%, and gale to storm (17.0 to 32.4 m/s) about 3% of the time (see Figures 3.6 to 3.8 in LGL 2012).

Table 3.2 Mean Wind Speed (m/s) Statistics.

	MSC50 Grid Point 10636	MSC50 Grid Point 11809	MSC50 Grid Point 11818	ICOADS	Sea Rose FPSO	Terra Nova FPSO	Glomar Grand Banks	GSF Grand Banks	Henry Goodrich	Hibernia
January	11.0	11.1	11.3	14.1	12.8	13.8	12.9	13.2	15.5	16.1
February	10.9	11.0	11.1	13.7	12.1	13.6	11.9	12.8	15.4	15.6
March	9.8	9.9	10.0	12.6	11.0	12.2	11.9	12.1	14.0	14.5
April	8.3	8.4	8.4	11.8	10.3	11.6	11.4	12.0	13.0	13.6
May	7.0	7.1	7.1	10.4	8.9	10.5	9.7	10.9	11.8	12.2
June	6.5	6.6	6.6	10.2	8.6	9.8	9.4	9.8	11.6	11.7
July	6.0	6.2	6.1	9.9	8.4	9.6	9.5	9.6	11.0	11.4
August	6.3	6.5	6.4	9.2	10.3	9.2	8.4	8.8	9.7	10.6
September	7.5	7.6	7.6	10.4	10.7	10.5	10.3	9.7	10.8	11.7
October	8.8	8.9	8.9	11.8	12.5	11.7	12.8	10.2	12.3	13.3
November	9.5	9.6	9.7	12.4	12.7	12.3	11.0	11.5	13.0	13.7
December	10.6	10.7	10.8	14.0	13.9	14.5	12.6	13.4	14.7	15.9

Source: LGL (2012). Note: Anemometer heights provided in Table 3.1.

Monthly maximum wind speeds for each of the available data sets are presented in Table 3.3. Rapidly deepening storm systems known as weather bombs (intense low-pressure systems with a central pressure that falls 24 millibars or more in a 24-hour period) frequently cross the Grand Banks. These storm systems typically develop in the warm waters of Cape Hatteras and move northeast across the Grand Banks. Wind speeds of 49.4 m/s and 52.5 m/s from the southwest were recorded by the Hibernia Platform and the Henry Goodrich anemometers respectively, at 21Z on February 11th, 2003. During this storm, a low pressure developing off Cape Hatteras on February 10th, 2003 rapidly deepened to 949 mb as it tracked northeast across the Avalon Peninsula around 18Z on February 11th, 2003. Another storm, following a similar track to the February 10th, 2003 storm passed over the area on October 15, 2009. During this event, the low pressure deepened from 1,002 mb at 00Z October 14th, to 963 mb as it lay northeast of the Avalon on October 15th. A wind speed of 43.7 m/s was recorded by the Sea Rose FPSO at 00Z and 03Z October 15, 2009.

Table 3.3 Maximum Wind Speed (m/s) Statistics.

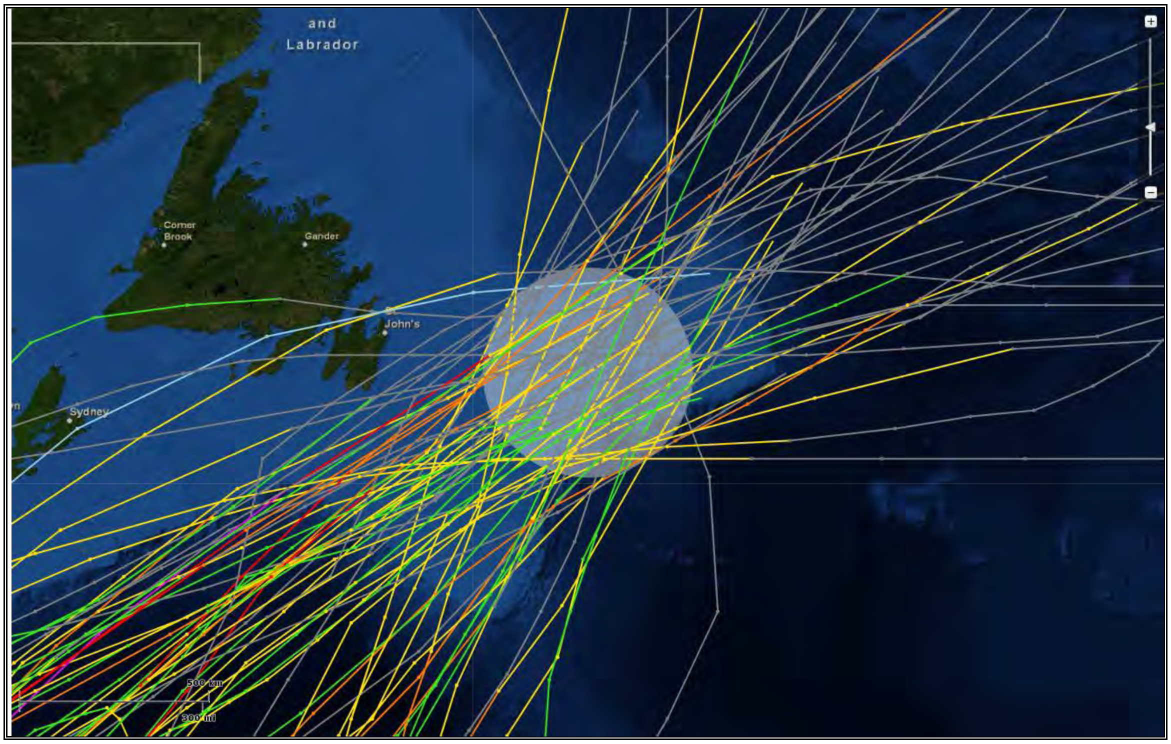
	MSC50 Grid Point 10636	MSC50 Grid Point 11809	MSC50 Grid Point 11818	ICOADS	Sea Rose FPSO	Terra Nova FPSO	Glomar Grand Banks	GSF Grand Banks	Henry Goodrich	Hibernia
January	28.8	28.1	28.8	43.7	25.7	31.9	30.9	37.6	44.2	43.2
February	32.3	31.9	30.5	49.4	29.8	34.0	26.8	31.4	52.5	49.4
March	27.6	29.7	31.7	38.0	23.7	29.8	23.7	28.8	32.9	37.6
April	25.0	24.4	25.4	36.0	24.7	26.8	26.8	33.4	35.0	37.6
May	22.1	22.8	23.5	33.9	21.6	25.2	22.1	25.7	32.9	32.4
June	23.1	23.6	23.7	35.5	18.5	24.2	21.1	27.3	31.4	35.5
July	20.5	17.9	19.8	31.9	18.0	23.2	20.1	25.2	28.3	31.9
August	30.5	27.8	30.1	36.0	33.4	29.8	25.7	26.2	30.9	41.2
September	24.0	28.1	25.8	43.2	30.9	34.5	29.3	27.8	35.0	43.2
October	27.6	27.8	27.0	44.8	43.7	31.9	32.9	30.9	33.4	44.8
November	27.4	27.1	27.9	38.1	25.2	28.3	25.7	25.2	37.6	38.1
December	30.0	30.1	29.2	39.6	24.7	37.6	27.3	29.3	39.6	39.1

Source: LGL (2012). Note: Anemometer heights provided in Table 3.1.

3.1.1.1 Tropical Systems

The hurricane season in the N Atlantic basin normally extends from June through November, although tropical storm systems occasionally occur outside this period. While the strongest winds typically occur during the winter months and are associated with mid-latitude low pressure systems, storm force winds may occur at any time of the year as a result of tropical systems. Once formed, a tropical storm or hurricane will maintain its energy as long as a sufficient supply of warm, moist air is available. Tropical storms and hurricanes obtain their energy from the latent heat of vapourization that is released during the condensation process. These systems typically move east to west over the warm water of the tropics. However, some of these systems turn northward and make their way towards Newfoundland and the Project Area. Since the capacity of the air to hold water vapour is dependent on temperature, the hurricanes begin to lose their tropical characteristics as they move northward over the colder ocean waters. By the time these weakening cyclones reach Newfoundland, they are usually embedded into a mid-latitude low and their tropical characteristics are usually lost.

Since 1960, 39 tropical systems have passed over the Regional Area. Their tracks over the Regional Area are shown in Figure 3.1.



Source: LGL (2012).

Figure 3.1 Storm Tracks of Tropical Systems Passing within 200 nm of 46°55'N, 47°52.5'W (1960 to 2010).

3.1.2 Waves

Waves are discussed in detail in Section 3.1.4 of LGL (2012). Some relevant excerpts are provided below.

The main parameters for describing wave conditions are the significant wave height, the maximum wave height, the peak spectral period, and the characteristic period. The significant wave height is defined as the average height of the 1/3 highest waves, and its value roughly approximates the characteristic height observed visually. The maximum height is the greatest vertical distance between a wave crest and adjacent trough. The spectral peak period is the period of the waves with the largest energy levels, and the characteristic period is the period of the 1/3 highest waves. The characteristic period is the wave period reported in ship observations, and the spectral period is reported in the MSC50 data set.

A sea state may be composed of the wind wave alone, swell alone, or the wind wave in combination with one or more swell groups. A swell is a wave system not produced by the local wind blowing at the time of observation and may have been generated within the local weather system, or from within distant weather systems. The former situation typically arises when a front, trough, or ridge crosses the point of concern, resulting in a marked shift in wind direction. Swells generated in this manner are usually of low period. Swells generated by distant weather systems may propagate in the direction of the winds that originally formed to the vicinity of the observation area. These swells may travel for thousands of miles before dying away. As the swell advances, its crest becomes rounded and its surface smooth. As a result of the latter process, swell energy may propagate through a point from more than one direction at a particular time.

The wave climate of the Grand Banks is dominated by extra-tropical storms, primarily during October through March; however, severe storms may, on occasion, occur outside these months. Storms of tropical origin may occur during the early summer and early winter, but most often from late August through October. Hurricanes are usually reduced to tropical storm strength or evolve into extra-tropical storms by the time they reach the area. They are still capable of producing storm force winds and high waves.

Significant wave heights on the Grand Banks peak during the winter months with the majority of data sources peaking in January. The lowest significant wave heights occur in the summer with July month the lowest mean monthly significant wave height. Significant wave height statistics are provided in Tables 3.4 and 3.5 below.

Combined significant wave heights of 10.5 m or more occurred in each month between September and April in the MSC50 data, with the highest waves occurring during the month of February. The highest combined significant wave heights of 14.7 m and 12.0 m in the Terra Nova and Hibernia data sets, respectively, occurred during the February 11, 2003 storm event mentioned previously.

Table 3.4 Combined Significant Wave Height Statistics (m).

	MSC50 Grid Point 10636	MSC50 Grid Point 11809	MSC50 Grid Point 11818	Terra Nova FPSO	White Rose (2003-2007)	White Rose (2007-2010)	Glomar Grand Banks	GSF Grand Banks	Henry Goodrich	Hibernia
January	4.1	4.2	4.3	4.1	4.9	4.2	3.7	3.3	4.2	4.0
February	3.9	3.9	4.0	3.8	4.5	3.8	3.1	3.8	4.0	3.7
March	3.4	3.4	3.5	3.4	4.3	3.2	2.7	3.2	3.4	3.2
April	2.8	2.8	2.9	2.6	2.7	2.5	2.6	2.7	2.7	2.5
May	2.2	2.2	2.3	2.2	2.6	2.4	1.9	2.2	2.1	2.1
June	1.9	1.9	1.9	1.8	2.6	1.9	1.5	1.9	1.8	1.9
July	1.7	1.7	1.7	1.5	2.4	1.6	1.6	1.7	1.6	1.6
August	1.8	1.8	1.8	1.8	2.3	1.9	1.8	1.8	1.7	1.8
September	2.4	2.4	2.4	2.3	2.8	2.3	2.8	2.3	2.3	2.3
October	3.0	3.0	3.0	3.0	3.8	3.1	3.5	2.9	2.9	3.0
November	3.4	3.4	3.4	3.1	3.8	3.0	3.0	2.9	3.2	3.0
December	4.0	4.0	4.1	3.8	4.2	4.2	3.5	4.1	3.7	3.7

Source: LGL (2012).

Table 3.5 Maximum Combined Significant Wave Height Statistics (m).

	MSC50 Grid Point 10636	MSC50 Grid Point 11809	MSC50 Grid Point 11818	Terra Nova FPSO	White Rose (2003-2007)	White Rose (2007-2010)	Glomar Grand Banks	GSF Grand Banks	Henry Goodrich	Hibernia
January	13.0	12.6	13.3	12.5	12.2	11.8	9.0	10.0	12.0	11.5
February	14.6	14.9	15.5	14.7	11.9	10.2	6.5	10.6	14.1	12.0
March	11.7	11.1	11.5	9.7	12.8	8.8	5.0	8.7	9.0	9.4
April	10.8	10.9	10.6	8.6	11.0	5.7	7.5	5.7	8.0	7.6
May	10.1	10.4	10.9	6.4	10.9	6.6	4.6	6.3	6.5	6.6
June	9.9	10.0	10.5	6.5	9.2	5.6	3.5	4.8	7.0	6.7
July	6.2	6.2	6.6	4.1	8.5	3.5	3.0	3.8	9.0	5.0
August	9.5	8.5	9.2	8.0	9.3	7.3	4.0	6.7	8.0	8.0
September	11.2	12.9	12.5	12.6	11.1	12.9	10.0	7.2	10.5	9.5
October	12.1	11.9	12.6	10.6	12.2	9.5	9.0	7.2	10.5	11.0
November	11.5	11.4	12.0	10.2	11.2	9.4	6.3	8.5	9.5	9.7
December	13.9	13.3	14.1	11.7	11.1	11.1	8.5	9.9	10.0	10.0

Source: LGL (2012).

While maximum significant wave heights tend to peak during the winter months, a tropical system could pass through the area and produce wave heights during any month.

On an annual basis, wave heights range from 0 to ≤ 3.0 m about 61% of the time, from 3.0 to ≤ 6.0 about 33% of the time, and from 6.0 to ≤ 8.0 m about 6% of the time (see Figures 3.16 to 3.19 in LGL 2012).

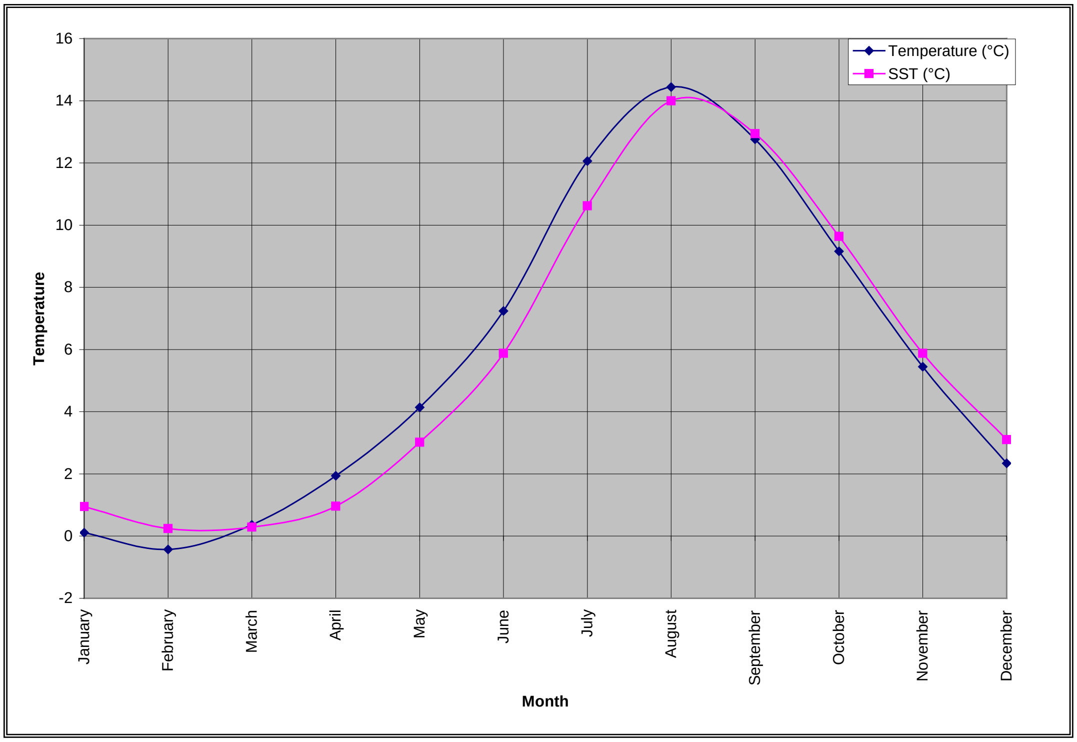
3.1.3 Weather Variables

Weather variables are discussed in Section 3.1.5 of LGL (2012) and briefly summarized below.

3.1.3.1 Temperature

The moderating influence of the ocean serves to limit both the diurnal and the annual temperature variation on the Grand Banks. Diurnal temperature variations due to the day/night cycles are small. Short-term, random temperature changes are due mainly to a change of air mass following a warm or cold frontal passage. In general, air mass temperature contrasts across frontal zones are greater during the winter than during the summer season.

Mean air and sea temperatures for the area (1980-2010) are shown in Figure 3.2. Air temperatures over the NW Atlantic in 2011 decreased from the above normal temperatures but still remained somewhat above normal (Colbourne et al. 2012).



Source: ICOADS Data Set (1980-2010) in LGL (2012).

Figure 3.2 Monthly Mean Air and Sea Surface Temperature for the ICOADS Region.

3.1.3.2 Visibility

Visibility is defined as the greatest distance at which objects of suitable dimensions can be seen and identified. Horizontal visibility may be reduced by any of the following phenomena, either alone or in combination:

- Fog
- Mist
- Haze
- Smoke
- Liquid Precipitation (e.g., drizzle)
- Freezing Precipitation (e.g., freezing rain)
- Frozen Precipitation (e.g., snow)
- Blowing Snow

During the winter months, the main obstruction is snow; however, mist and fog may also reduce visibilities at times. As spring approaches, the amount of visibility reduction attributed to snow decreases. As the air temperature increases, so does the occurrence of advection fog. Advection fog forms when warm moist air moves over cooler waters. By April, the sea surface temperature south of Newfoundland is cooler than the surrounding air. As warm moist air from the south moves over the colder sea surface, the air cools and its ability to hold moisture decreases. The air will continue to cool until it becomes saturated and the moisture condenses to form fog. The presence of advection fog increases from April through July. The month of July has the highest percentage of obscuration to visibility, most of which is in the form of advection fog, although frontal fog can also contribute to the reduction in visibility. In August the temperature difference between the air and the sea begins to narrow and by September, the air temperature begins to fall below the sea surface temperature. As the air temperature drops, the occurrence of fog decreases. Reduction in visibility during autumn and winter is relatively low and is mainly attributed to the passage of low-pressure systems. Fog is the main the cause of the reduced visibilities in autumn and snow is the main cause of reduced visibilities in the winter. September and October have the lowest occurrence of reduced visibility since the air temperature has, on average, decreased below the sea surface temperature and it is not yet cold enough for snow.

Fog also occurs in the Jeanne d'Arc Basin as relatively warm rain falls through cooler air beneath a frontal surface. Typically, the base of the cloud layer lowers as the air becomes saturated and condensation occurs. If the cloud base reaches the surface, frontal fog occurs. Most frequently, frontal fog occurs ahead of a warm front associated with a frontal disturbance. As the front moves through, clearing of the fog may occur but frequently, frontal fog gives way to advection fog in the warm sector of a low pressure system. Typically, fog clears as drier air is advected into the region from continental source regions to the west.

3.1.3.3 Precipitation

The frequency of precipitation type for each region was calculated by Oceans Ltd. using data from the ICOADS data set, with each occurrence counting as one event. Precipitation statistics for these regions may be low due a fair weather bias. That is, ships tend to either avoid regions of inclement weather, or simply do not report during these events.

The frequency of precipitation type (Table 3.6) shows that annually, precipitation occurs 22.0% of the time within the ICOADS region. Winter has the highest frequency of precipitation with 34.8% of the observations reporting precipitation. Snow accounts for the majority of precipitation during the winter months, accounting for 58.6% of the occurrences of winter precipitation. Summer has the lowest frequency of precipitation with a total frequency of occurrence of 12.9%. Snow has been reported in each month from August to May; however, this is may be due to coding error rather than the actual presence of snow.

The percentage of occurrences of freezing precipitation data was also calculated from the ICOADS data set. Freezing precipitation occurs when rain or drizzle aloft enters negative air temperatures near the surface and becomes super-cooled so that the droplets freeze upon impact with the surface. This situation typically arises ahead of a warm front extending from low pressure systems passing west of the area. The frequency of freezing precipitation was slightly higher in the winter months than during the spring. No freezing precipitation occurred during summer and autumn.

Thunderstorms occur relatively infrequently over the Study Area though they may occur in any month of the year. Spring has the least number of thunderstorms occurring only 0.02% of the time while summer has the highest frequency of thunder storms with 0.12%. It should be noted that hail only occurs in the presence of severe thunderstorms, yet in Table 3.6, the frequency of hail is higher than the frequency of thunderstorms during the months of November to February. This may be due to observer inexperience, classifying what should be ice pellets (formed through entirely different atmospheric processes) as hail or mistyping what should have been “Thunderstorm without Hail – Code 95” as “Thunderstorm with Hail – Code 96” in the original Manmar data.

Table 3.6 Percent Frequency (%) Distribution of Precipitation.

	Rain / Drizzle	Freezing Rain / Drizzle	Rain / Snow Mixed	Snow	Thunder Storm	Hail	Total
January	13.0	0.5	0.6	23.5	0.0	0.2	37.9
February	10.3	0.8	0.4	22.4	0.0	0.1	34.0
March	11.6	0.9	0.3	14.3	0.0	0.0	27.0
April	13.1	0.2	0.2	4.8	0.0	0.0	18.3
May	14.1	0.0	0.1	1.0	0.0	0.0	15.2
June	13.3	0.0	0.0	0.0	0.1	0.0	13.4
July	10.9	0.0	0.0	0.0	0.1	0.0	11.0
August	14.0	0.0	0.0	0.1	0.2	0.0	14.4
September	15.5	0.0	0.0	0.1	0.1	0.0	15.6
October	20.2	0.0	0.1	1.1	0.1	0.1	21.6
November	19.3	0.0	0.4	5.7	0.0	0.2	25.7
December	16.0	0.1	0.5	15.4	0.0	0.3	32.3
Winter	13.2	0.5	0.5	20.4	0.0	0.2	34.8
Spring	13.0	0.3	0.2	6.3	0.0	0.0	19.9
Summer	12.7	0.0	0.0	0.0	0.1	0.0	12.9
Autumn	18.4	0.0	0.2	2.3	0.1	0.1	21.0
Total	14.3	0.2	0.2	7.2	0.1	0.1	22.0

Source: LGL (2012).

3.1.3.4 Sea Spray Vessel Icing

Potential sea spray icing conditions start within the Project Area during the month of November with a frequency of icing potential of just 0.4%. As the temperature falls throughout the winter, the percentage of occurrence of icing increases to a maximum of 29.4% in February. Extreme sea spray icing conditions were calculated to occur 1.0% of the time during February. Icing potential decreases rapidly after February in response to warming air and sea surface temperatures, and by June the frequency of icing conditions is 0.0%.

3.2 Wind and Wave Extreme Value Analyses

The wind and wave extreme values analyses are contained in Section 3.2 of LGL (2012) (appended).

3.3 Physical Oceanography

3.3.1 General Circulation

Water circulation and current data were described in detail by Oceans Ltd. in Section 3.3 of LGL (2012). Some information relevant to surface towed and bottom mounted seismic operations is provided in this section.

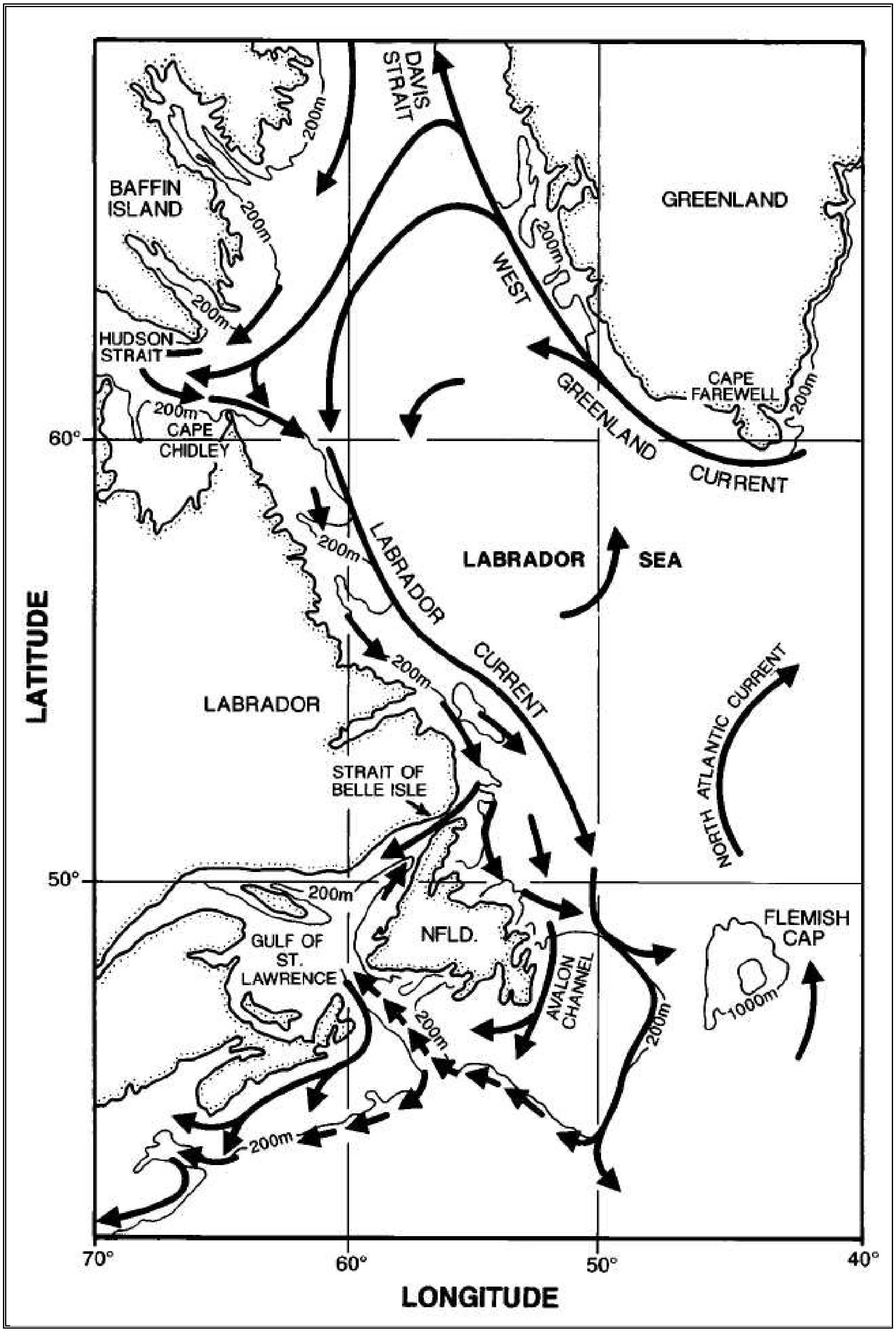
The regional oceanic circulation on the Grand Banks and surrounding areas is governed by the bathymetric features of the continental shelf (Figure 3.3). A major characteristic of ocean currents is their tendency to follow local and regional underwater bathymetry.

The Grand Banks–Flemish Cap bathymetric features exert a major influence on the regional oceanic circulation. The shape of the banks and channels steers the flow of the Labrador Current. The Labrador Current is comprised of two main streams; an inshore stream near the coast, and a more intense offshore stream over the shelf break between the 400 and 1,200 m isobaths (Lazier and Wright 1993). There is some exchange between these two streams which occurs in the channels and saddles that separate the banks offshore Labrador and Newfoundland. The inshore branch of the Labrador Current flows through the Avalon Channel, while the offshore branch flows along the northern slope of the Grand Banks. This branch of the Labrador Current divides east of 48°W, resulting in part of the branch flowing to the east around Flemish Cap and the other flowing south around the eastern edge of the Grand Banks and through Flemish Pass (Figure 3.3).

The general circulation and mean currents on the Grand Banks are well understood from geostrophic calculations, drifter data, current modeling, and direct measurements. The variabilities are becoming more understood as the quantity of data collected on the Grand Banks increases.

Oceans Ltd. (in LGL 2012) analyzed currents in the Regional Area in what they called Subarea 1. Subarea 1 is the shallow section of the Grand Banks where Terra Nova and Hibernia are located. There have been continuous current measurements at Terra Nova since 1999. The measurements are at 20 m below the surface, mid-depth and 10 m above bottom. There are also some measurements in the boundary layer at approximately 1 m above bottom. These current measurements are representatives of the Study Area because the bathymetry is relatively flat. Tables 3.7 to 3.9 present the mean speeds, velocities and the maximum speeds by month for a 10-year period between 1999 and 2009.

Table 3.7 shows that the mean speeds at 20 m below the surface range between 11.4 cm/s in April to 17.5 cm/s in September. The maximum speed was 79.9 cm/s in September 2001. Due to the high degree of current variability, the mean velocities ranged from 2.1 cm/s in June to 7.4 cm/s in January.



Source: Colbourne et al. (1997).

Figure 3.3 Major Ocean Circulation Features in the NW Atlantic.

The currents speeds were slightly lower at mid-depth and at 10 m above bottom. At mid-depth the mean speeds ranged from 8.7 cm/s in August to 11.4 cm/s in February, and the mean velocities ranged between 1.4 cm/s and 3.7 cm/s. The maximum speed was 73.6 cm/s in September 1999 during the passage of Hurricane Gert. At 10 m above the bottom the mean speeds ranged between 7.0 cm/s in June to 11.9 cm/s in January. The mean velocities ranged between 1.0 cm/s and 3.6 cm/s. The maximum speed was 48.1 cm/s in March, 2005.

Table 3.7 Near-surface Currents at Terra Nova.

Month	Mean Speed (cm/s)	Mean Velocity (cm/s)	Maximum Speed (cm/s)	Year of Speed
January	16.2	7.4	57.0	2009
February	14.3	4.2	59.0	2003
March	13.1	4.2	51.5	2007
April	11.4	2.5	41.0	2001
May	12.7	4.0	57.2	2003
June	13.2	2.1	52.5	2001
July	14.4	3.0	52.4	2006
August	14.8	2.6	60.4	2001
September	17.5	3.6	79.9	2001
October	16.7	5.9	61.8	2004
November	14.3	6.7	56.3	2000
December	15.6	5.0	71.5	2006

Source: LGL (2012).

Table 3.8 Mid-depth Current at Terra Nova.

Month	Mean Speed (cm/s)	Mean Velocity (cm/s)	Maximum Speed (cm/s)	Year of Speed
January	10.5	3.3	43.5	2006
February	11.4	2.5	47.0	2005
March	10.3	3.2	40.9	2005
April	9.5	1.4	37.0	2000
May	8.6	2.3	33.7	2006
June	9.1	2.4	34.8	2004
July	9.0	2.2	38.0	2006
August	8.7	2.0	39.2	2004
September	9.8	2.6	73.6	1999
October	11.2	3.7	53.4	2006
November	10.0	3.0	58.4	2003
December	9.8	2.7	44.1	2006

Source: LGL (2012).

Table 3.9 Near-bottom Currents at Terra Nova.

Month	Mean Speed (cm/s)	Mean Velocity (cm/s)	Maximum Speed (cm/s)	Year of Speed
January	11.9	3.6	36.1	2001
February	11.4	2.5	45.6	2005
March	11.1	2.7	48.1	2005
April	8.7	1.8	29.2	2008
May	7.4	2.0	27.7	2000
June	7.0	1.3	25.9	2000
July	8.2	2.0	30.4	2000
August	8.8	1.0	26.8	2008
September	10.1	1.0	45.1	1999
October	10.6	1.4	40.8	2000
November	9.3	1.5	29.0	2006
December	11.3	1.5	43.9	2006

Source: LGL (2012).

3.3.2 Water Mass Structure

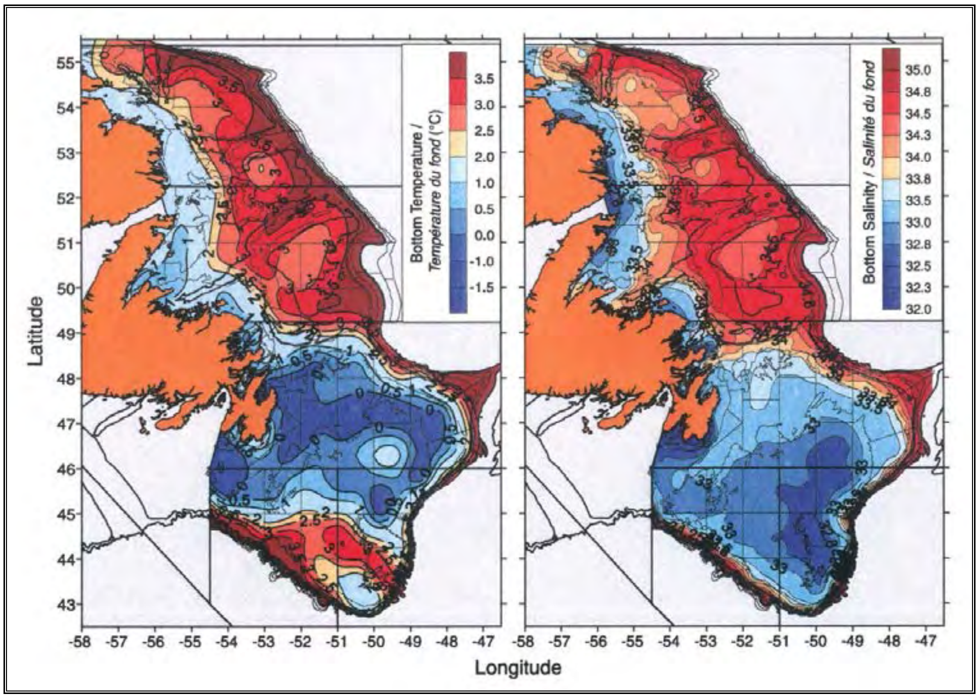
The water structure on the north-eastern section of the Grand Banks of Newfoundland is characterized by the presence of three identifiable features (as described by Oceans Ltd. in Section 3.3 in LGL 2012).

The first identifiable feature is the surface layer which is exposed to interaction with the atmosphere, and experiences temperature variations from subzero values in January and February to above 15°C in summer and early fall. Salinity at this layer is strongly impacted by wave action and local precipitations. Considering that a water mass is a body of water which retains its well defined physical properties, over a long time period, the surface layer of variable temperature and salinity is usually left out of a water mass analysis for a particular region. During the summer, the stratified surface layer can extend to a depth of 40 m or more. In winter, the stratification in the surface layer disappears and becomes well mixed due to atmospheric cooling and intense mixing processes from wave action.

A second element of the thermohaline structure on the Grand Banks is the Cold Intermediate Layer (CIL) (Petrie et al. 1988). In areas where the water is deep enough, this layer of cold water is trapped during summer between the seasonally heated upper layer and warmer slope water near the seabed (Colbourne 2002). Its temperatures range from less than -1.5°C to 0°C (Petrie et al. 1988; Colbourne et al. 1996) and salinities vary within 32 and 33 psu. It can reach a maximum vertical extent of over 200 m (Colbourne 2004). The CIL is the residual cold layer that occurs from late spring to fall and is composed of cold waters formed during the previous winter season. It becomes isolated from the sea surface by the formation of the warm surface layer during summer, and disappears again during late fall and winter due to the intense mixing processes that take place in the surface layer from strong winds, high waves and atmospheric cooling. In winter the two layer structure is replaced by a mixed cold body of water which occupies the entire water column. In 2011, the area of the CIL on the Grand Bank was the second lowest on record (Colbourne et al. 2012).

Bottom temperature and salinity maps were produced by Colbourne et al. (2007) by trawl-mounted CTD data from approximately 700 fishing tows during the fall of 2005. These maps are presented in Figure 3.4. Figure 3.4 shows the presence of the CIL near bottom in the Study and Regional areas.

A third element is the sharp density boundary near the Shelf break which separates the water on the shelf from the warmer, more saline water of the Continental Slope. The water over the Slope is the Labrador Sea water which is formed in the Labrador Sea as a result of the deep convection processes that take place during severe winters. The Labrador Sea has temperatures between 2°C to 4°C and salinities between 34.8‰ to 35‰.



Source: Colbourne et al. (2007).

Figure 3.4 Bottom Temperature and Salinity Maps Derived for the Trawl-mounted CTD Data.

3.4 Sea Ice and Icebergs

Sea ice and icebergs of the Regional Area are described in Section 3.4 of LGL (2012).

3.4.1 Sea Ice

The annual sea ice extent on the Newfoundland and Labrador shelf was below normal for the 16th consecutive year (Colbourne et al. 2012). A weekly analysis of the Canadian Ice Service's 30-Year Frequency of Presence of Sea Ice over the area shows that the Study Area may be affected by sea ice beginning the week of January 22 and lasting until the week beginning April 30 (analysis by Oceans Ltd. in LGL 2012 appended). This timing is outside the temporal boundary of the HMDC project and thus is not discussed further.

3.4.2 Icebergs

An analysis has been performed by Oceans Ltd. for Husky Energy to determine the threat posed by icebergs in Husky's 2012-2020 Seismic Project Area (see LGL 2012 appended) which encompasses the proposed HMDC Project Area defined in the present EA. The International Ice Patrol Iceberg Sightings Database from 1974 to 2009 was used as the primary data source in this analysis; (NSIDC 1995) shows the number of iceberg sightings from 1974 to 2009.

A monthly analysis shows that icebergs have been spotted within the region from January to August, October and December; however, they are most prominent during the month of April (see Table 3.5.3 and Figure 3.5.1 in LGL 2012). This peak is prior to the start of the Project in any given year. However, May has the second highest frequency and approximately 40% of the icebergs may be present in the area during the Project's time window of May through December. With respect to size, the most prominent icebergs are small, accounting for 28.7% of observed icebergs within the region. Large icebergs occur 9.8% of the time.

Colbourne et al. 2012 reports that in 2011: "Only three icebergs were detected south of 48°N on the Northern Grand Bank, compared to one in 2010, substantially fewer than the 1981-2010 mean of 767."

4.0 Biological and Socio-economic Environments

The biological and socio-economic environments in and near the Study Area have been described in a number of exploration and drilling EAs and associated amendments for Jeanne d'Arc (e.g., Christian 2008; LGL 2006a, 2007a,b, 2008a,b, 2011a, 2012; and others). In addition to updated information, summaries of relevant information from these documents are presented in the following sections for fish and fish habitat, seabirds, marine mammals, sea turtles and commercial fisheries, species at risk and potentially sensitive areas. In addition, the most recent seismic EA that includes the HMDC Project Area is appended in electronic form (LGL 2012).

4.1 Ecosystem

Following guidance in the Scoping Document (C-NLOPB 2013), this EA focuses on components of the ecosystem such as selected species and stages of fish, seabirds and marine mammals that are important ecologically, economically, and/or socially, with potential to interact with the Project (i.e., valued ecosystem components or VECs as defined in Section 5.2).

4.2 Fish and Fish Habitat

This section provides a description of the existing fish and fish habitat in the Study Area. Fish habitat in the Study Area is considered first, followed by a discussion of fish (macroinvertebrates and fishes) in the area.

4.2.1 Fish Habitat

Defined broadly, fish habitat includes physical, chemical, and biological aspects of the marine environment used by invertebrate and fish species in the Study Area. The physical and chemical nature of the water column and bottom substrate is a critical factor affecting the characterization of associated marine biological communities. The biological component of fish habitat includes phytoplankton, zooplankton, and benthos (i.e., infaunal and epibenthic invertebrates such as polychaetes and echinoderms not commercially harvested in the Study Area).

4.2.2 Plankton

Plankton is composed of free-floating organisms that form the basis of the pelagic ecosystem. Members include bacteria, fungi, phytoplankton, and zooplankton (mostly invertebrates, but may also include eggs and larvae of fishes, known as ichthyoplankton). An understanding of plankton production is important because areas of enhanced production and (or) biomass are areas where fish, seabirds, and marine mammals congregate to feed (LGL 2003).

Phytoplankton distribution, productivity, and growth regulation in high-latitude ecosystems constitute a complex system with light, nutrients, and herbivore grazing being the principal factors limiting phytoplankton regulations (Harrison and Li 2008). In the NW Atlantic, there is generally a spring plankton bloom (May/June) which is often followed by a smaller bloom in the fall (September/October). This general pattern likely applies to the Study Area. Zooplankton reproduction is tied to the phytoplankton bloom, which either coincides with or immediately follows the brief but intense phytoplankton blooms in the high latitudes (Huntley et al. 1983; Head et al. 2000; Head and Pepin 2008). Zooplankton is the foremost link between primary production and higher-level organisms in the offshore marine ecosystem. They transfer organic carbon from phytoplankton to fish, marine mammals, and birds higher in the food chain. Zooplankton is a food source for a broad spectrum of species and they contribute carbon via faecal matter and dead zooplankton to benthic food chains. Pepin et al. (2011) noted plankton distribution in the Study Area to be primarily influenced by local advective transport and mixing processes, with several species of *Calanus* copepods acting as key contributors to the regional secondary production. Plankton is discussed in more detail in the appended report (Section 4.2.2 in LGL 2012).

Planktonic organisms are so ubiquitous and abundant, and many have such rapid generation times that there will be essentially no or negligible effect on planktonic communities from the proposed seismic Project. Therefore, no further assessment of the potential effects of the Project on phytoplankton and zooplankton will be discussed here. However, planktonic stages of commercial invertebrates (e.g., shrimp, snow crab) and fishes (e.g., cod) are described in following sections because of their VEC status.

4.2.3 Benthic Invertebrates

Benthic invertebrates are bottom-dwelling organisms that can be classified into three categories: infaunal organisms, sessile organisms, and epibenthic species (Barrie et al. 1980). Infaunal organisms live on or are buried in soft substrates and include bivalves, polychaetes, amphipods, sipunculids, ophiuroids, and some gastropods. Sessile organisms (epifauna) live attached to hard substrates and would include barnacles, tunicates, bryozoans, holothurians, and some anemones. The epibenthic organisms are active swimmers that remain in close association to the seabed and include mysids, amphipods, and decapods.

There are large gaps in the knowledge of benthic ecosystems of the offshore waters of Newfoundland and Labrador. The existing literature, although extensive in appearance, tends to be spatially restricted and often species-specific (discussed further in the appended EA).

4.2.3.1 Deep-water Corals and Sponges

Deepwater corals are receiving increased scientific attention off the east coast of Canada in recent years because of their potential importance to the ecosystem (e.g., as cover for various life stages of fish) and likely sensitivity to certain types of disturbance such as increased sedimentation or physical destruction. As a result, information on corals known to occur within and adjacent to the Study Area is presented below.

A variety of coral groups occur in Newfoundland and Labrador waters and include scleractinians (solitary stony corals), antipatharians (black wire corals), alcyonaceans (large and small gorgonians, and soft corals), and pennatulaceans (sea pens) (Wareham and Edinger 2007; Wareham 2009). Off Newfoundland and Labrador, corals are mostly distributed along the edge of the continental shelf and slope (Edinger et al. 2007; Wareham and Edinger 2007). Typically, they are found in canyons and along the edges of channels deeper than 200 m (Breeze et al. 1997). Off Newfoundland, soft corals are distributed in both shallow and deep waters, while horny and stony corals (hard corals) are normally restricted to deep water areas. Most grow on hard substrate (Gass 2003), including other corals such as large gorgonian corals (Breeze et al. 1997). Others, for example small gorgonians, cup corals, and sea pens, prefer sand or mud substrates (Edinger et al. 2007). In total, at least 30 species of corals have been documented including two antipatharians (black wire corals), 13 alcyonaceans (large gorgonians, small gorgonians, and soft corals), four scleractinians (solitary stony corals), and 11 pennatulaceans (sea pens) for offshore Newfoundland and Labrador.

Several recently published reports present knowledge on the ecology of deep cold-water corals of Newfoundland and Labrador waters, including information on biogeography, life history, biochemistry, and relation to fishes (e.g., Gilkinson and Edinger 2009; Kenchington et al. 2010a,b; Baillon et al. 2012; Baker et al. 2012). Wareham (2009) updated deep-sea coral distribution data for the Newfoundland and Labrador and Arctic Regions to partially fill information gaps previously identified by Wareham and Edinger (2007). A recent DFO Science Advisory Report (DFO 2010a) also discusses the occurrence and ecological function of corals in Canadian waters.

According to distribution maps provided by Wareham (2009), there are approximately four species of corals reported for the Study Area. The species identified include large gorgonians (*Paramuricea* spp.) and soft corals (*Duva florida*, *Gersemia rubiformis*, and *Nephtheid spp.*). DFO RV surveys during 2007 to 2011 also noted the presence of the large gorgonian *Paragorgia arborea*, and the scleractinian *Flabellum alabastrum* (common cup coral). The majority of coral species were observed to occur on or near the continental slope of Flemish Pass, with the exception of several soft corals (e.g., *Gersemia rubiformis* and *Duva florida*) found distributed on the shelf of Jeanne d'Arc Basin. Based on DFO RV survey data collected in the Study Area from 2007 to 2011, most of the corals were caught at mean water depths around 89 and 92 m in the spring and fall surveys, respectively.

The patterns of association between deep-sea corals, fish, and invertebrate species, based on DFO scientific surveys and ROV surveys are discussed by Edinger et al. (2009). Although there were no dramatic relationships observed between corals and abundance of the ten groundfish species studied, there was a weak but statistically significant positive correlation between coral species richness and fish species richness. For various sample segment lengths and depth ranges in the southern Grand Banks, Baker et al. (2012) found significant positive relationships between the presence and/or abundance of roundnose grenadier (*Coryphaenoides rupestris*) with that of large skeletal corals and cup corals, of roughhead grenadier (*Macrourus berglax*) with large gorgonians/antipatharians and soft corals, and of marlin-spike grenadier (*Nezumia bairdii*) with small gorgonians. Baillon et al. (2012) determined that several types of coral, particularly sea pens (e.g., *Anthoptilum grandiflorum*) were hosts to eggs and/or larvae of two redfish species (*Sebastes fasciatus* and *S. mentella*), lantern fish (*Benthosema glaciale*) and greater eelpout

(*Lycodes esmarkii*) in the Laurentian Channel and southern Grand Banks. This suggests that habitats that support diverse corals may also support diverse assemblages of fishes. Although relationships between corals and groundfish or invertebrates are not obligate and may result from coincidence, conservation areas established for corals may effectively protect populations of groundfish, including some commercial species (Edinger et al. 2009). By increasing the spatial and hydrodynamic complexity of habitats, deep-sea corals may provide important, but probably not critical, habitat for a wide variety of fishes. Effects of deep-sea corals on fish habitat and communities may include higher prey abundance, greater water turbulence, and resting places for a wide variety of fish size classes (Auster et al. 2005, and Costello et al. 2005 *in* Edinger et al. 2009).

Sponges also provide fish habitat, enhance species richness and diversity, and exert clear ecological effects on other local fauna. Sponge grounds and reefs support increased biodiversity compared to structurally-complex abiotic habitats or habitats that do not contain these organisms (DFO 2010a). Kenchington et al. (2013) noted the association of several demersal fish taxa with *Geodia*-dominated sponge grounds on the Grand Banks and Flemish Cap, although the precise nature of this association is unknown. According to the DFO RV survey data collected in the Study Area from 2007 to 2011, most of the sponges were collected in approximately 80 m depth in spring and fall.

Morphological forms such as thick encrustations, mounds, and branched, barrel- or fan-like shapes influence near bottom currents and sedimentation patterns. They provide substrate for other species and offer shelter for associated fauna through the provision of holes, crevices, and spaces. Siliceous hexactinelid sponges can form reefs as their glass spicules fuse together such that when the sponge dies, the skeleton remains. This skeleton provides settlement surfaces for other sponges, which in turn form a network that is subsequently filled with sediment (DFO 2010a).

Although some of the siliceous spicules of non-reef-forming species dissolve quickly, there is some accumulation of shed spicules forming a thick sediment-stabilizing mat, which constitutes a special bottom type supporting a rich diversity of species. Organisms commonly associated with sponges and sponge grounds include species of marine worms and bryozoans, as well as higher fauna. Live glass sponge reefs have been shown to provide nursery habitat for juvenile rockfish and high-complexity reefs are associated with higher species richness and abundance (DFO 2010a).

In 2008 and 2009, the NAFO Scientific Council identified areas of significant coral and sponge concentrations within the NAFO Regulatory Area. NAFO Coral/Sponge Closure Area Five was updated in 2012. These areas that have been closed to fishing with bottom gear are outside the HMDC Study Area as shown in Section 4.7 (see "Potentially Sensitive Areas" DFO 2010a).

4.2.4 Fish

For the purposes of this EA, the fish VEC includes commercial fishery-targeted macroinvertebrate and fish species, incidental commercial fishery bycatch species, and macroinvertebrates and fishes caught during DFO Research Vessel (RV) surveys in the Study Area.

4.2.4.1 Commercial Fisheries (Primary Species)

The total commercial fisheries catch weight within the Study Area amounted to 1,432 metric tonnes (mt) from May to December 2005 to 2010; the average weight was 239 mt (DFO Landings Data 2005-2010). Snow crab (*Chionoecetes opilio*) dominated the reported landings of commercial catches within the Study Area during May to December 2005 to 2010 (average catch weight approximately 98% of total). Northern Shrimp (*Pandalus borealis*) accounted for the remaining ~2% of the May to December 2005 to 2010 average total catch weight. The life histories of these species, along with those found within the Study Area during DFO surveys which are of special concern under COSEWIC and/or *SARA*, are profiled in the appended EA (Sections 4.2.4.1 and 4.2.4.2, LGL 2012); summaries are presented below for snow crab and northern shrimp. The occurrence and/or proportional abundance of snow crab and northern shrimp within the Study Area are presented below.

Snow Crab

The following summary is derived from the snow crab profile in Section 4.2.4.1 of LGL (2012). Snow crab occurs over a broad depth range in the NW Atlantic from Greenland south to the Gulf of Maine (DFO 2010b *in* LGL 2012). Large males are most common on mud or mud/sand, while smaller crabs are common on harder substrates. After spring hatching, snow crab undergo a multi-stage 12 to 15 week planktonic larval period before settlement. Benthic juveniles molt frequently, and at about 4 years of age they may become sexually mature. Females carry the fertilized eggs for about two years (DFO 2010b *in* LGL 2012). Snow crab typically feed on fish, clams, benthic worms, brittle stars, shrimps and crustaceans, including smaller snow crabs. Their predators include various groundfish and seals (DFO 2010b *in* LGL 2012).

Geo-referenced commercial catch data for the May to December period, 2005-2010, indicate a relatively limited distribution of catch locations for snow crab. Most snow crab catches were made beyond the 100 m isobath of the Jeanne d'Arc Basin in the north and northeastern portions of the Study Area. Scattered harvest locations were also reported for the shallower regions of the Jeanne d'Arc Basin and the Flemish Pass, in the western, southern and central-eastern portions of the Study Area. Based on DFO RV survey data collected in the Study Area from 2007 to 2011, most of the snow crab during those surveys was caught at respective mean water depths around 92 and 89 m during spring and fall surveys respectively. In terms of total catch weight, the greatest proportion of snow crab was caught in the north-eastern half of the Study Area during DFO RV surveys from 2007 to 2011.

Northern Shrimp

The following summary is derived from the northern shrimp profile in Section 4.2.4.1 of LGL (2012). Northern shrimp is distributed from Davis Strait to the Gulf of Maine. It usually occupies soft muddy substrates up to depths of 600 m in temperatures of 1°C to 6°C (DFO 2008a *in* LGL 2012), with larger individuals generally occurring in deeper waters (DFO 2006a *in* LGL 2012). A diel vertical migration is undertaken with shrimp moving off the bottom into the water column during the day, and up the water column at night to feed on small pelagic crustaceans (DFO 2006a *in* LGL 2012).

Northern shrimp are protandric hermaphrodites (Orr et al. 2009 *in* LGL 2012). They first mature as males, mate for one to several years, and then change to females for the remainder of their lives (DFO 2008a *in* LGL 2012). Eggs are typically extruded in the summer and remain attached to the female until the following spring, when the female spawns in shallow coastal waters (Nicolajsen 1994 *in* Ollerhead et al. 2004 *in* LGL 2012). The hatched larvae float to the surface and feed on planktonic organisms (DFO 2006a *in* LGL 2012). Northern shrimp are known to live for more than eight years in some areas and are large enough for recruitment to the fishery as early as three years of age (DFO 2008a *in* LGL 2012).

Northern shrimp grow by moulting their shells. During this period, the new shell is soft, causing them to be highly vulnerable to predators such as Greenland halibut, Atlantic cod (DFO 2006a *in* LGL 2012), Atlantic halibut, skates, wolffish and harp seals (*Pagophilus groenlandicus*) (DFO 2000a *in* LGL 2012).

Geo-referenced commercial catch data for the May to December period, 2005-2010, indicate that most northern shrimp catches within the Study Area occurred beyond the 100 m isobath in the north-eastern region of the Study Area. Scattered shrimp catches were also reported within the 100 m isobath of the Jeanne d'Arc Basin, in the north-central and north-western portions of the Study Area. Based on DFO RV survey data collected in the Study Area from 2007 to 2011, most of the northern shrimp were caught at mean water depths around 90 m during both spring and fall surveys. In terms of total catch weight, the greatest proportion of northern shrimp was caught in the western half of the Study Area during DFO RV surveys from 2007 to 2011.

4.2.4.2 Other Fishes Caught in the Commercial Fishery

Other species that have been caught during commercial fisheries being prosecuted around (though not within) the Study Area during May to December in recent years were profiled in the appended EA (Sections 4.2.4.1 and 4.2.4.2, LGL 2012). These species include:

- Stimpson's Surf Clam (*Mactromeris polynyma*);
- Cockle (likely Greenland cockle, *Serripes groenlandicus*);
- Rock Crab (*Cancer irroratus*);
- Capelin (*Mallotus villosus*);
- Skate sp.;
- Atlantic Halibut (*Hippoglossus hippoglossus*);
- Greenland Halibut (*Reinhardtius hippoglossoides*);
- Redfishes (*Sebastes* spp.);
- American Plaice (*Hippoglossoides platessoides*);
- Squid (*Illex* sp.);
- Wolffishes (*Anarhichas* spp.)
- Bluefin Tuna (*Thunnus thynnus*);
- White and Blue Hakes (*Urophycis tenuis*; *Antimora rostrata*); and
- Whelk sp.

Based on the profiles in Sections 4.2.4.1 and 4.2.4.2 in LGL (2012), the life histories of Atlantic cod (*Gadus morhua*), and witch and yellowtail flounders (*Glyoptocephalus cynoglossus* and *Limanda ferruginea*) (May to December, 1990 to 2000), are summarized below. These commercial species were historically exploited in the Study Area.

Atlantic Cod

The Atlantic cod is a demersal fish that inhabits cold (10 to 15°C) and very cold (less than 0 to 5°C) waters in coastal areas and in offshore waters overlying the continental shelf throughout the NW and NE Atlantic Ocean (COSEWIC 2003a *in* LGL 2012). Atlantic cod typically spawn over a period of less than three months in water that may vary in depth from tens to hundreds of metres (COSEWIC 2003a *in* LGL 2012). Cod are batch spawners, as only a small percentage (5 to 25%) of the female's egg total is released at any given time during a three to six week period. Cod eggs and larvae are pelagic for several weeks, and then juveniles settle on the bottom and tend to occur in nearshore habitats with vertical structure such as eelgrass (*Zostera marina*) and macroalgae. As adults, the habitat requirements of cod are more diverse.

Dispersal in Atlantic cod appears to be limited to the egg and larval phases of life, during which surface and near-surface water currents and turbulence are the primary determinants of horizontal and vertical displacement in the water column (COSEWIC 2003a *in* LGL 2012). Long-term movements by cod take the form of seasonal migrations (COSEWIC 2003a *in* LGL 2012). These migrations can be attributed to geographical and seasonal differences in water temperature, food supply, and possibly spawning grounds. At one extreme, some inshore populations are suspected to have extremely short migrations, possibly limited to tens of kilometres, or less, in distance. By contrast, cod in other populations are known to traverse hundreds of kilometres during their seasonal migrations.

A moratorium was declared on directed commercial fishing of Atlantic cod in NAFO Divisions 2J3KL in 1992. A small fishery was directed at inshore populations in Divisions 3KL in 1998, however declining catch rates led to a closure of this and the inshore food/recreational fishery in 2003 (DFO 2011a). Stewardship and recreational fisheries were re-opened and have been ongoing in the inshore since 2006 (DFO 2012a). DFO fall RV surveys indicated increases in total abundance, biomass and spawning stock biomass in the early 2000's, however these trends did not continue beyond 2009 (DFO 2012a). Total mortality rates of the offshore population declined and remained low from 2003 to 2007, however the rates have increased substantially each year as of 2009 (DFO 2012a). In combination with prolonged low recruitment levels, prospects for future stock growth are poor if the total mortality rates continue to increase (DFO 2012a).

Atlantic cod (NL population) is currently designated as *endangered* under COSEWIC, but has no status under *SARA* (*SARA* website 2013).

Witch Flounder

Witch flounder range from the Hamilton Inlet Bank to North Carolina in the NW Atlantic (DFO 2011c *in* LGL 2012). They preferentially inhabit gullies with clay, muddy sand, or pure mud bottoms, and usually move from shallower, soft mud bottoms in the summer to deeper gullies in the winter, with bottom temperatures ranging from -1 to +11ºC (DFO 2011c *in* LGL 2012). Witch flounder are most abundant between 185 and 400 m, although some have been caught deeper than 1,500 m (DFO 2011c *in* LGL 2012). Witch flounder form dense prespawning concentrations between winter and spring, and spawning occurs in shallow water and on the slopes of the Grand Banks area, in late spring to late summer or early fall (DFO 2011c *in* LGL 2012). Eggs and larvae of witch flounder are pelagic, while juveniles can be either pelagic or deepwater fishes. Witch flounder mainly prey on polychaetes, small crustaceans and shellfish (DFO 2011c *in* LGL 2012). Although a considerable portion of witch flounder catch occurs as by-catch of other fisheries, it has been a component of the Canadian Atlantic groundfisheries since the early 1940s (DFO 2011c *in* LGL 2012).

Yellowtail Flounder

Yellowtail flounder inhabit the continental shelf of the NW Atlantic from Labrador to Chesapeake Bay at depths ranging from 10 to 100 m, where substrate consists primarily of sand. Yellowtail spawning on the Grand Banks generally occurs between May and September with peaks during the latter part of June. It tends to occur at depths less than 100 m and at water temperatures exceeding 2ºC (LGL 2006a *in* LGL 2012). The eggs, larvae and early juvenile stages of yellowtail are pelagic. The most common prey of yellowtail flounder includes polychaetes, amphipods, shrimp, cumaceans, isopods and small fish (LGL 2006a *in* LGL 2012).

4.2.5 Species Collected during DFO RV Surveys

DFO research vessel data collected during annual multi-species trawl surveys provide distributional information for important species not discussed in the commercial fisheries as well as additional information for commercial species.

Data collected during 2007 to 2011 spring and fall DFO RV surveys in the Study Area were analyzed, and catch weights and catch numbers of species/groups with combined annual catch weights of at least approximately 100 kg (along with species of concern under COSEWIC and/or *SARA*, corals, and sponges) are presented in Table 4.1.

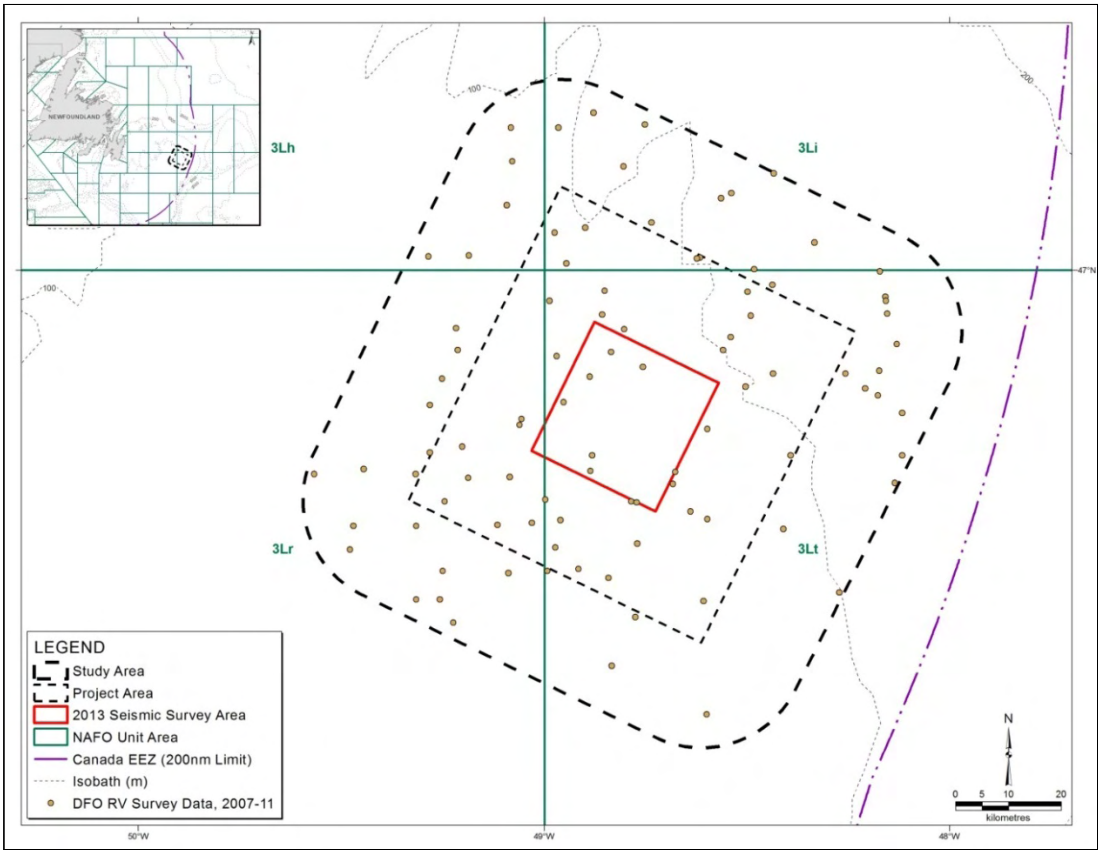
Sand lance accounted for 57.0% of the total 2007-2011 catch weight; followed by yellowtail flounder (10.7%), snake mackerel (6.8%); snow crab (4.6%); capelin (2.8%); comb-jelly (2.8%); thorny skate (2.1%); and sea urchin (1.4%). All remaining species/groups in Table 4.1 represent <1% of the RV survey total catch weight. The distribution of geo-referenced catch locations reported during the 2007 to 2011 DFO RV surveys within the Study Area are shown in Figure 4.1.

Catches were somewhat consistent between survey years for species type, with an average contribution to yearly total catch weight of 80.0, 19.9, and 0.1% for fish, invertebrates, and corals, respectively. An exception occurred in 2007 (fish: 95.9%, invertebrates: 4.1%), which was driven by higher catches of sand lance and lower snow crab catch.

Table 4.1 Catch Weights and Numbers of Macroinvertebrate and Fish Species Collected during 2007 to 2011 DFO RV Surveys within the Study Area.

Species	Catch Weight (kg)	Catch Number
Sand Lance	4,597	334,115
Yellowtail Flounder	860	2,252
Snake Mackerel	550	4,908
Snow Crab	371	1,638
Capelin	225	16,486
Comb-jelly	223	n/a
Thorny Skate	168	68
Sea Urchin (*Strongylocentrotus* sp.)	112	9,705
Atlantic Cod	46	45
Northern Shrimp	28	5,072
Corals	6	n/a
Spotted Wolffish	5	2
Atlantic (Striped) Wolffish	4	4
Northern Wolffish	3	1
Sponge (Porifera)	3	n/a
Deepwater Redfish	1	4

Source: DFO RV Survey Data (2007-2011). Note: n/a denotes data unavailable.



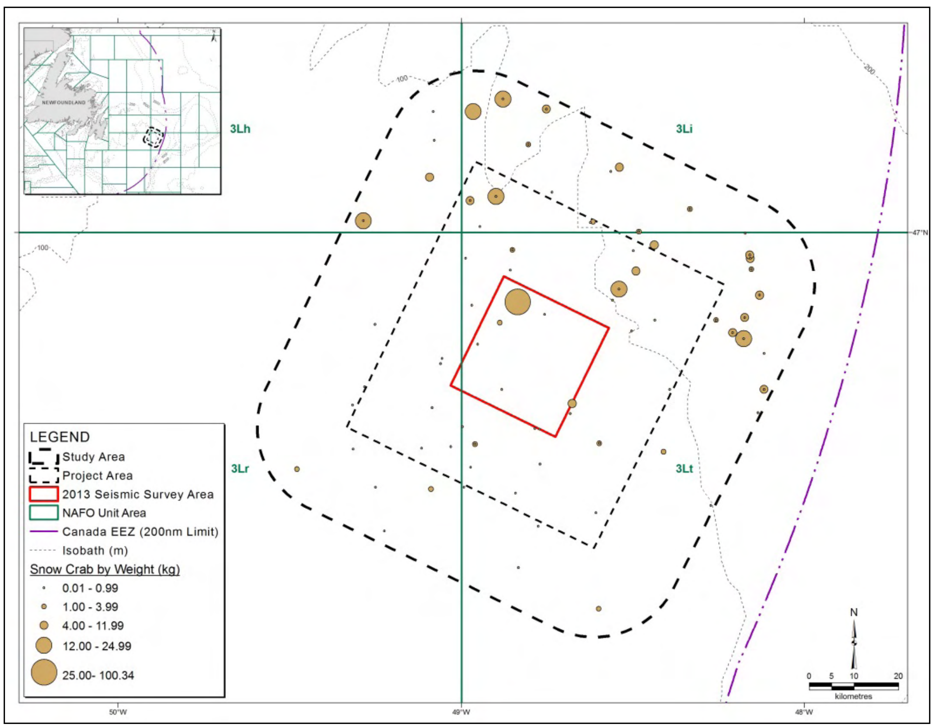
Source: DFO RV Survey Data (2007-2011).

Figure 4.1 DFO RV Survey Catch Locations within the Study Area, 2007 to 2011 Combined.

Across all species caught during the 2007 to 2011 DFO RV surveys in the Study Area, total catch weights were greatest in 2007 (2,413 kg), 2010 (1,989 kg), and 2009 (1,763 kg), and lowest in 2011 (771 kg). The total catch weight of the 2007 to 2011 DFO RV surveys in the Study Area was divided into spring (May, June, and July) and fall (November). Spring surveys accounted for 27.9% of the total catch weight, and fall surveys accounted for 72.1%. The average mean depths of catch during spring and fall surveys from 2007 to 2011 were 86 m (minimum=31 m; maximum=123 m) and 84 m (minimum=64 m; maximum=124 m), respectively.

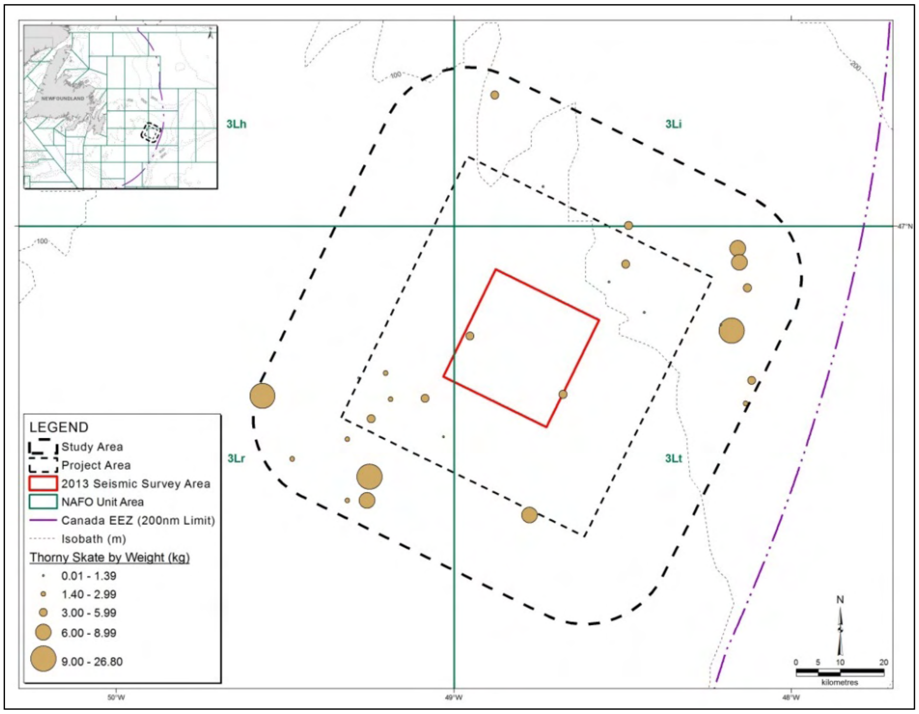
Figures 4.2 to 4.7 indicate proportional catch locations for snow crab, thorny skate, Atlantic cod, northern shrimp, wolffishes (non-proportional), and deepwater redfish, respectively. The top five species/groups in terms of catch weight during the spring surveys were sand lance, yellowtail flounder, American plaice, capelin, and snow crab. The top five species/groups in terms of catch weight during the fall surveys were sand lance, yellowtail flounder, American plaice, comb-jelly, and snow crab.

Species/groups that were caught predominantly during the spring RV surveys included Northern wolffish and capelin. Species/groups that were caught predominantly during the fall RV surveys included Atlantic wolffish, deepwater redfish, northern shrimp, and thorny skate. With respect to capelin and comb-jelly, the survey depth differences between spring and fall surveys likely account for some of the seasonal differences; depths were similar between seasons for the remaining species (Table 4.2).



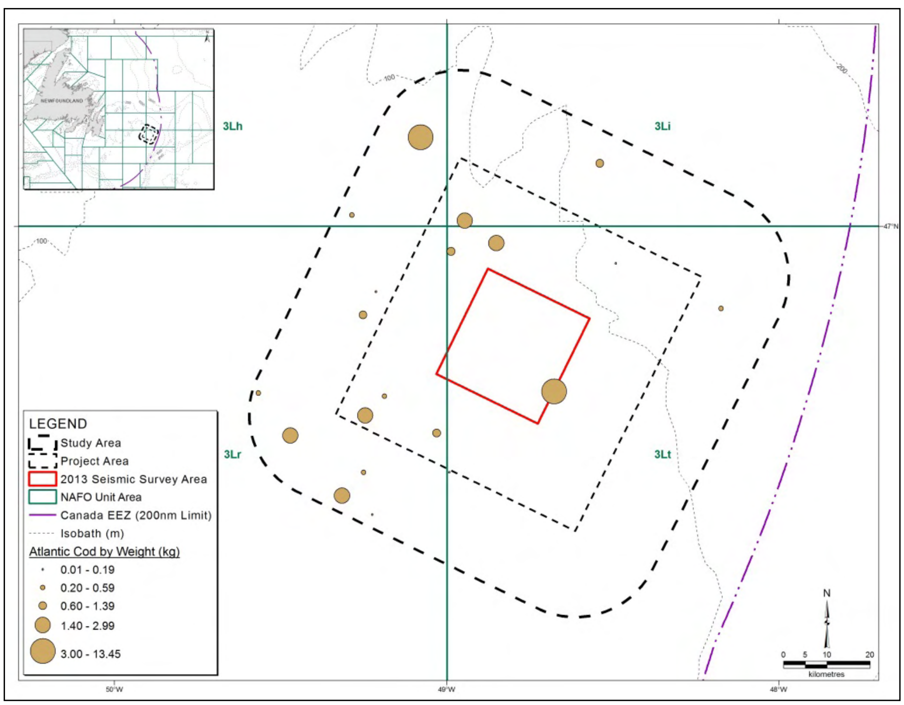
Source: DFO RV Survey Data (2007-2011).

Figure 4.2 DFO RV Survey Proportional Catch Locations of Snow Crab within the Study Area, 2007 to 2011 Combined.



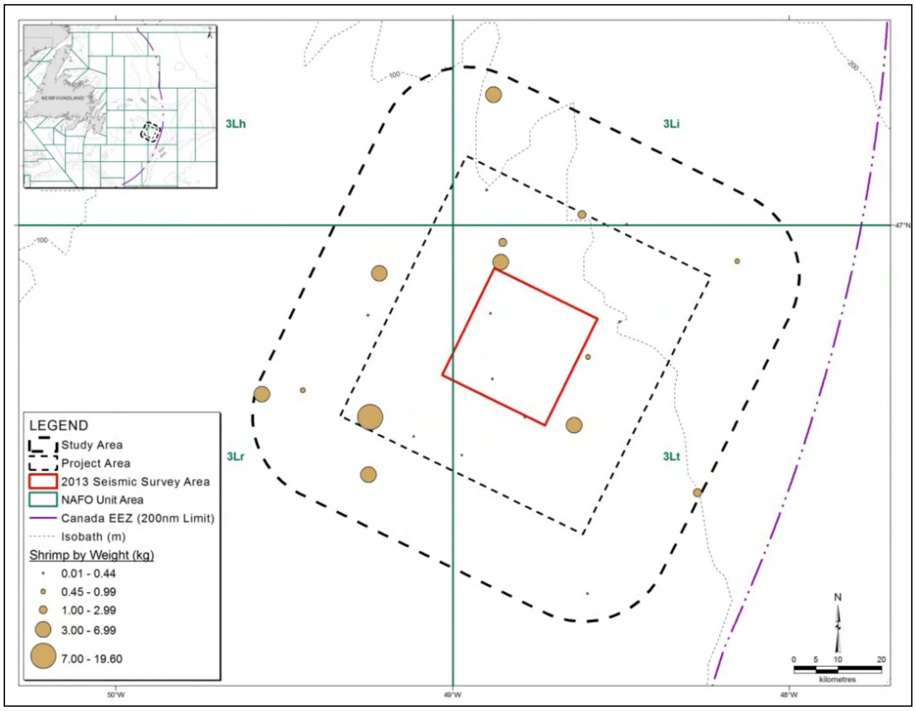
Source: DFO RV Survey Data (2007-2011).

Figure 4.3 DFO RV Survey Proportional Catch Locations of Thorny Skate within the Study Area, 2007 to 2011 Combined.



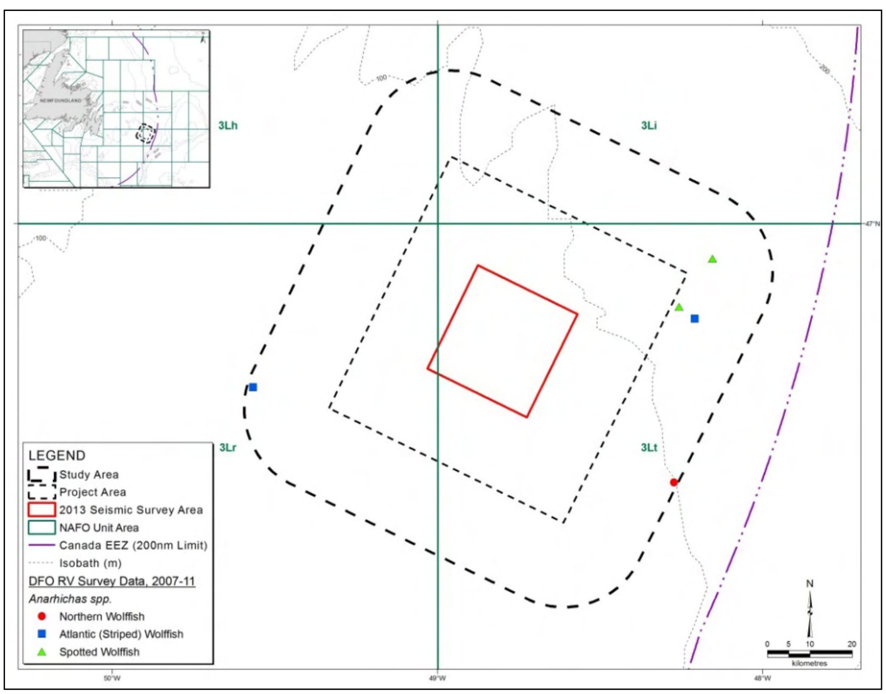
Source: DFO RV Survey Data 2007-2011.

Figure 4.4 DFO RV Survey Proportional Catch Locations of Atlantic Cod within the Study Area, 2007 to 2011 Combined.



Source: DFO RV Survey Data (2007-2011).

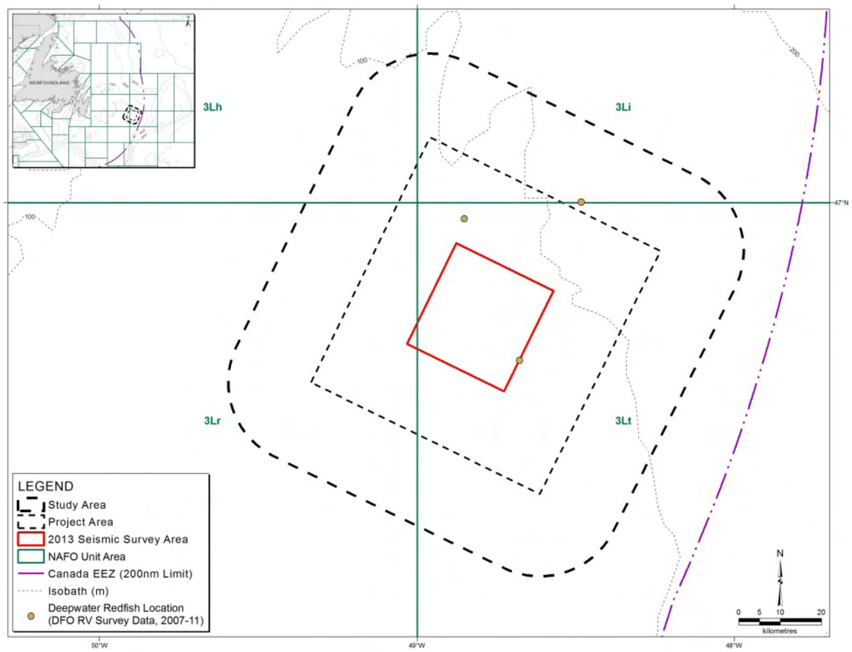
Figure 4.5 DFO RV Survey Proportional Catch Locations of Northern Shrimp within the Study Area, 2007 to 2011 Combined.



Source: DFO RV Survey Data (2007-2011).

Proportional catch locations were not plotted as there were only one to two total catches per species.

Figure 4.6 DFO RV Survey Non-proportional Catch Locations of Northern, Atlantic (Striped) and Spotted Wolffishes within the Study Area, 2007 to 2011 Combined.



Source: DFO RV Survey Data (2007-2011).

Figure 4.7 DFO RV Survey Proportional Catch Locations of Deepwater Redfish within the Study Area, 2007 to 2011 Combined.

Table 4.2 Percentage Catch and Mean Catch Depth by Survey Season for Macroinvertebrates and Fishes Caught during DFO RV Surveys within the Study Area, 2007 to 2011 Combined.

Species	Percentage Catch in Spring Surveys (%)	Spring Survey Mean Catch Depth (m)	Percentage Catch in Fall Survey (%)	Fall Survey Mean Catch Depth (m)
Sand Lance	48	86	52	84
Yellowtail Flounder	49	72	51	68
Snake Mackerel	51	87	49	85
Snow Crab	51	92	49	89
Capelin	95	86	5	107
Comb-jelly	68	77	32	67
Thorny Skate	21	89	79	86
Sea Urchin (*Strongylocentrotus* sp.)	50	87	50	87
Atlantic Cod	45	85	55	73
Northern Shrimp	< 1	90	> 99	91
Corals	67	88	33	92
Spotted Wolffish	50	117	50	105
Atlantic (Striped) Wolffish	-	-	100	87
Northern Wolffish	100	97	-	-
Sponge (Porifera)	67	81	33	82
Deepwater Redfish	-	-	100	91

Source: DFO RV Survey Data (2007-2011).

DFO RV survey catch weights in the Study Area from 2007 to 2011 were analyzed for two mean catch depth ranges and results are presented in Table 4.3.

Table 4.3 Total Catch Weights and Predominant Species Caught at Various Mean Catch Depth Ranges during DFO RV Surveys within the Study Area, 2007 to 2011 Combined.

Mean Catch Depth Range	Total Catch Weight (kg)	Predominant Species
<100 m	6,940	Sand Lance (61%) Yellowtail Flounder (12%) Snake Mackerel (5%) Snow Crab (4%) Comb Jelly (3%) Capelin (3%)
≥100 m to <200 m	1,122	Sand Lance (35%) Snake Mackerel (16%) Snow Crab (11%) Brittle Star (Ophiuroidea) (9%) Thorny Skate (6%) Sea Urchin (*Strongylocentrotus* sp.) (4%)

Source: DFO RV Survey Data (2007-2011).

4.2.6 Reproduction in the Study Area

Temporal and spatial details of macroinvertebrate and fish reproduction within or near the Study Area are provided in Table 4.4.

Table 4.4 Reproduction Specifics of Macroinvertebrate and Fish Species Likely to Spawn within or near the Study Area.

Species	Locations of Reproductive Events	Times of Reproductive Events	Duration of Planktonic Stages
Northern shrimp	On banks and in channels over the extent of its distribution	Spawning in late summer/fall Fertilized eggs carried by female for 8 to 10 months and larvae hatch in the spring	12 to 16 weeks
Snow crab	On banks and possibly along some upper slope regions over the extent of its distribution	Mating in early spring Fertilized eggs carried by female for 2 years and larvae hatch in late spring/early summer	12 to 15 weeks
Stimpson's surf clam	Eastern Grand Banks	Fall	4 to 8 weeks
Greenland halibut	Spawning grounds extend from Davis Strait (south of 67°N) to south of Flemish Pass between 800 m and 2,000 m depth	Spring/summer or winter months	Uncertain
Greenland cockle	Eastern Grand Banks	Uncertain	Uncertain

Species	Locations of Reproductive Events	Times of Reproductive Events	Duration of Planktonic Stages
Yellowtail flounder	Shallower sandy areas – typically <100 m water depth – at bottom	May to September, typically peaking in June/July Both eggs and larvae are planktonic.	Pelagic larvae are brief residents in the plankton
Witch flounder	Throughout the Grand Banks, particularly along slopes >500 m	Late spring to late summer/early fall	Uncertain
Thorny skate	Throughout distribution range	Year-round Eggs deposited in capsule (one egg per capsule), possibly on bottom	None
Roundnose grenadier	Uncertain	Year-round Eggs are free-floating	Uncertain
Roughhead grenadier	Likely along southern and southeastern slopes of Grand Banks	Winter/early spring	Uncertain
Capelin	Spawning generally on beaches or in deeper waters	Late June to early July	Several weeks
Atlantic halibut	Uncertain	Likely spawns between January and May. Both eggs and larvae are planktonic	6 to 8 weeks
American plaice	Spawning generally occurs throughout the range the population inhabits.	April to May	12 to 16 weeks
Redfish	Primarily along edge of shelf and banks, in slope waters, and in deep channels	Mating in late winter and release of young between April and July (peak in April)	No planktonic stage
Atlantic cod	Spawn along outer slopes of the shelf in depths from tens to hundreds of metres	March to June	10 to 12 weeks
Wolffishes	Along bottom in deeper water, typically along continental slope	Summer to early winter (species dependent)	Uncertain
Cusk	Uncertain	May to August Eggs are buoyant	Presumed to be 4 to 16 weeks
Porbeagle shark	Very little known about the location of the pupping grounds; likely southern Grand Banks	Mating in late summer/fall and pupping between early April and early June	Uncertain
Sand lance	On sand in shallow water of the Grand Banks	November to January	Several weeks

4.2.7 Concluding Summary of Marine Fish and Shellfish in Study Area

The distribution, abundance and habitats of important fish and shellfish species are described in the preceding sections with additional information contained in the following commercial fisheries sections. More detail is contained in the previously approved seismic EA for the area (LGL 2012, appended).

In summary, while many of the species discussed in this section likely occur in the Study Area to varying degrees, there are no reports of critical spawning, overwintering, nursery, or migration habitats or large concentrations in the HMDC Study Area.

4.3 Commercial Fisheries

This section describes the existing commercial fisheries in the Study Area for HMDC's potential 2013 seismic survey. It also describes economic and logistical aspects of the fisheries. The biological characteristics and status of the main commercial and other marine species, including prey for commercial species were described in the preceding Section 4.2 and the appended EA (Sections 4.2.4.1 and 4.2.4.2, LGL 2012).

There are no recreational, aboriginal and/or subsistence fisheries that occur within or in the immediate area surrounding the Study Area.

Relatively little commercial fishery occurs within the Study area itself, particularly when compared to fisheries that take place along the slopes of the Grand Banks north of the Study Area (see Figure 4.13 in Section 4.3.3.3). With respect to underutilized species that occur within the Study Area, sand lance are considered one of the most unexploited fish resources in the northwest Atlantic (DFO 2013), and were the most prevalent species caught in the Study Area during recent DFO ROV surveys (Table 4.1). In contrast to the multinational, industrial sand lance fish operation in the North Sea and the minor bait fishery in New England, there is no Canadian fishery for sand lance (DFO 2013). The lack of sand lance fishery on the Grand Banks is likely mainly due to lack of market demand, lack of special methodology for capture, and distance from desirable markets (DFO 2013).

4.3.1 Data and Information Sources

The majority of the data used to characterize the fisheries in this subsection are quantities of harvest rather than harvest values since quantities are directly comparable from year to year, while values (for the same quantity of harvest) may vary annually with negotiated prices, changes in exchange rates and fluctuating market conditions. Some species vary greatly in landed value (e.g., snow crab vs. turbot), and thus potential effects on fisheries are best examined by catch quantity as an indicator of fishing effort and by gear types utilized.

4.3.1.1 Fisheries Data Sets

Fisheries within the Study Area are primarily managed by DFO, while NAFO manages the 3L northern shrimp fishery. The domestic commercial fisheries analysis in this subsection is based on data derived from the DFO Newfoundland and Labrador Region catch and effort data sets. Foreign catches landed outside the regions are not included in these DFO data sets. The date range of 2005 to 2010 was used for the DFO data sets for this EA, due in part to incompatibility issues with newer DFO data formats. DFO is currently in the process of altering the delivery method of commercial fishery catch data for 2011 onward, from specific georeferenced point locations (as used in this EA) to summarized "data blocks," which are not directly comparable to historical catch data. NAFO datasets were not analyzed as they are not geo-referenced and therefore are specific only to the NAFO Division level (e.g., 3L) rather than Unit Areas (UAs; e.g., 3Lh). As the Study Area only partially occupies UAs 3Lhirt (Figure 4.8), the NAFO datasets would reflect a gross overestimation of the northern shrimp fishery within the Study Area.

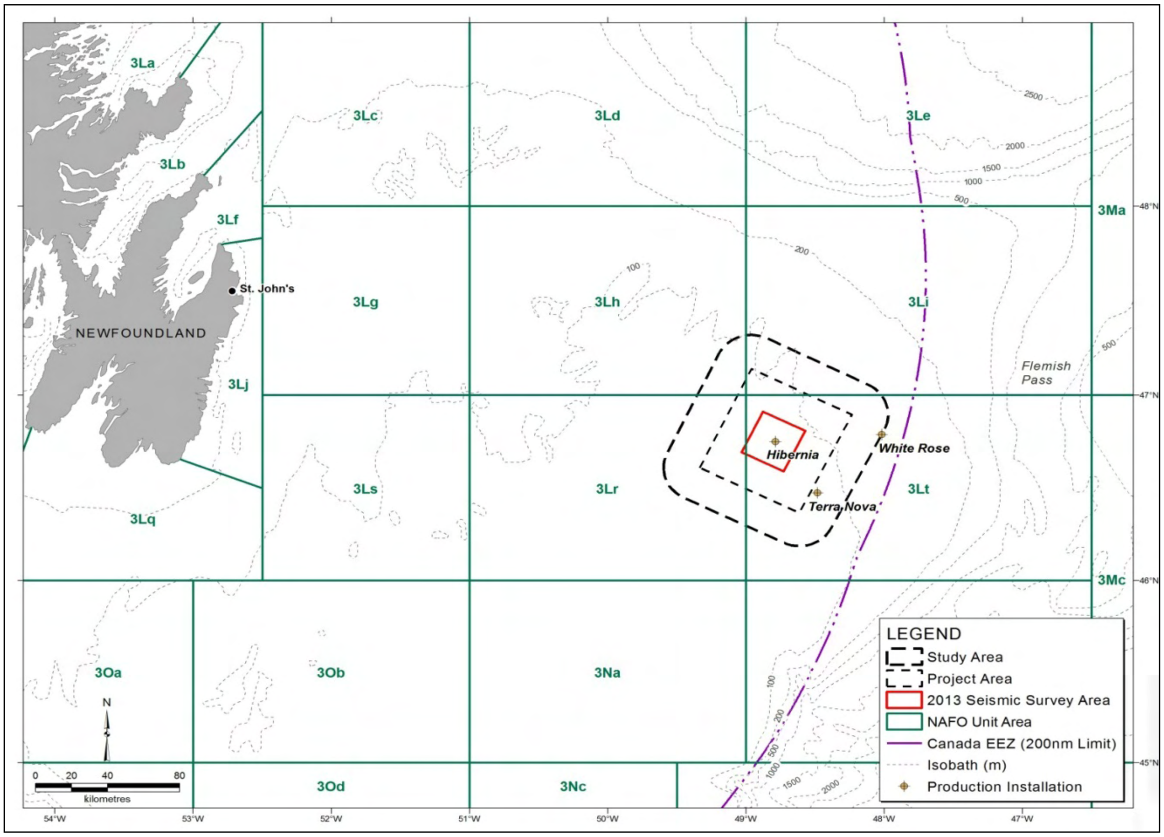


Figure 4.8 Study Area Location Relative to NAFO Unit Areas.

The DFO data used in the report (2005 to 2010) represent all catch landed within the Newfoundland and Labrador region. The DFO catch data within the Study Area are geo-referenced (typically >95% of the harvest, by quantity), so that past harvesting locations can be plotted with a high level of accuracy, and these locations are shown on the fisheries maps in this subsection. The positions given in the data sets are those recorded in the vessel's fishing log, and are reported in the database by degree and minute of latitude and longitude; thus the positions should be accurate within approximately 0.5 nautical miles of the reported co-ordinates. For some gear, such as mobile gear towed over an extensive area, or for extended gear, such as longlines, the reference point does not represent the full distribution of the gear or activity on the water. However, over many data entries, the reported locations create a fairly accurate indication of where such fishing activities occur. In addition, in order to provide a historical summary of catches in the general area of the proposed Study Area, DFO data for UAs 3Lhirt (the Study Area UAs) for 1990 to 2010 were used.

4.3.1.2 Consultations

The consultations were undertaken to inform stakeholders about the proposed HMDC seismic program, to gather information about fishing activities, and to determine any issues or concerns. Fisheries-related information provided is reported in the discussions of the commercial fisheries below. Further information about the 2013 offshore fisheries obtained from industry stakeholders, as well as any issues and concerns raised by industry representatives, are discussed in Section 5.1.1.

4.3.1.3 Other Information Sources

Other sources consulted for this subsection include fisheries management plans, quota reports and other DFO documents, such as Science Advisory and Stock Status reports.

4.3.2 Regional NAFO Fisheries

The entirety of the Study Area is within Canada's 200-nm EEZ, overlapping relatively small portions of NAFO Division 3L (see Figure 4.8). As such, the commercial fisheries species discussed above are managed by DFO, with one key fishery cooperatively managed with NAFO (northern shrimp). Most fishing in the NAFO Convention Regulatory Area (RA) is conducted using mobile bottom-tending trawls.

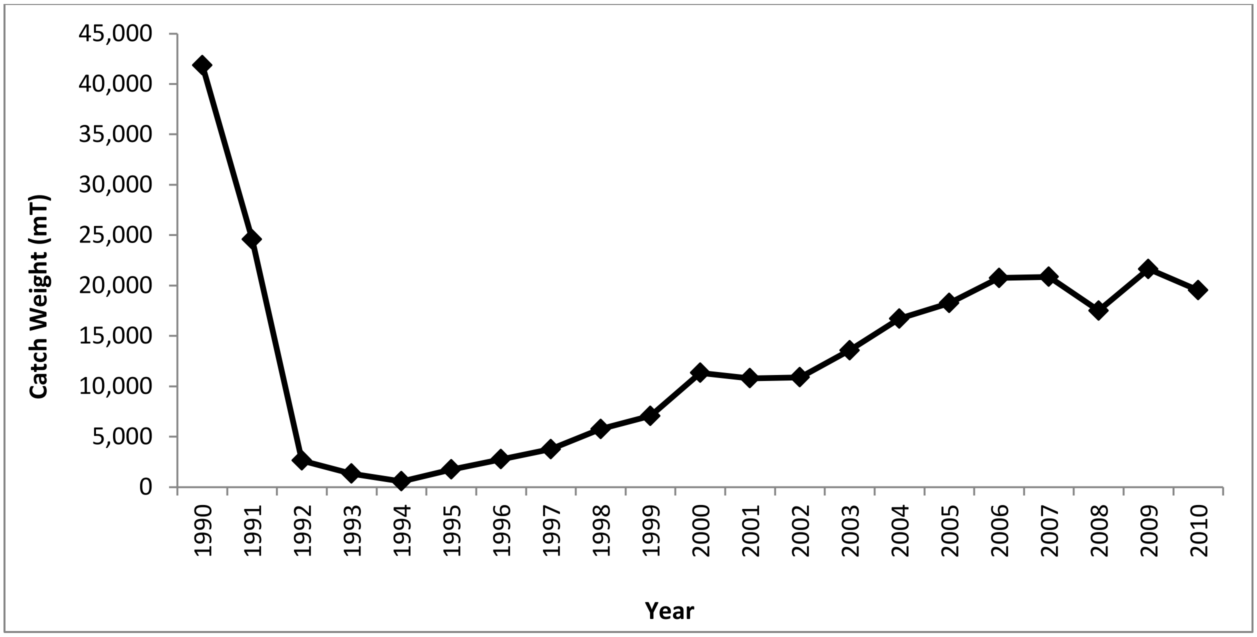
The Division 3L northern shrimp fishery has a 2013 TAC of 8,600 mt (down from 12,000 mt in 2012), of which Canada is allocated just over 83%. The TAC for all the NAFO-managed species (including the Canadian and foreign allocations) can be found at the NAFO website (http://www.nafo.int/fisheries/frames/fishery.html).

In 2013, several other NAFO managed species in Convention areas were under moratorium. Relevant to the general Study Area, there are bans on fishing cod, American plaice, and witch flounder in NAFO Division 3L. Additional information on Regional NAFO fisheries can be found in Section 4.3.2 of LGL (2012).

4.3.3 Study Area Domestic Fisheries

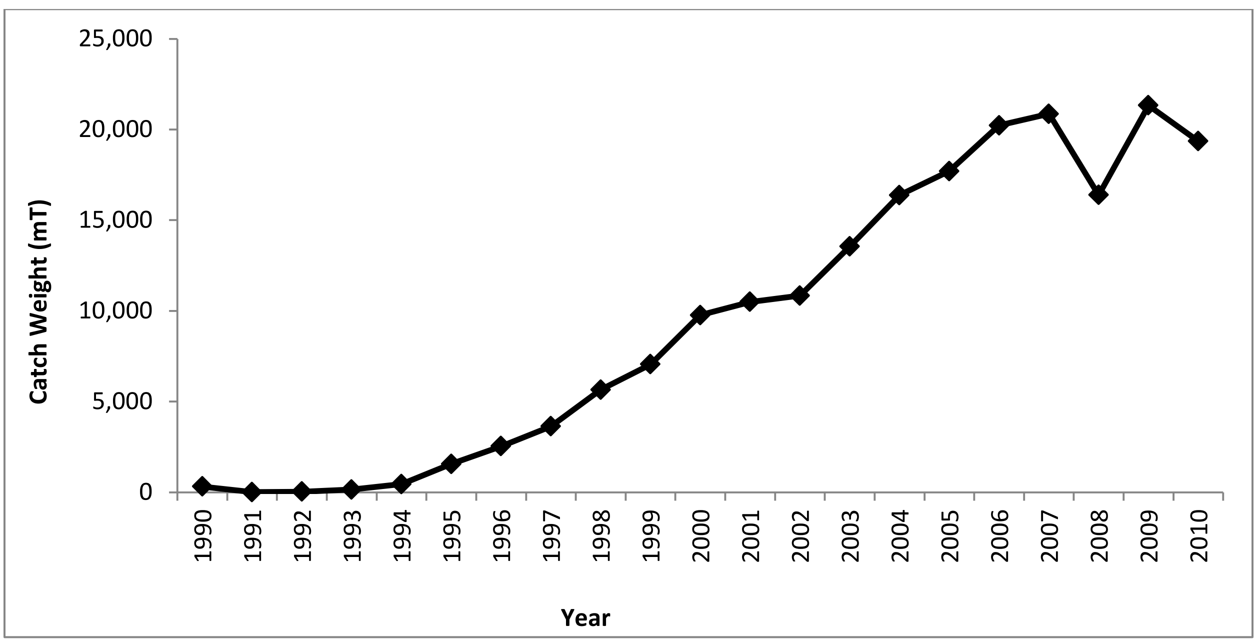
4.3.3.1 Catch Trends 1990 to 2010

The Canadian fisheries in the eastern Grand Banks area were dominated until the early 1990s by groundfish harvesting using stern otter trawls, primarily harvesting Atlantic cod, American plaice and a few other species. In 1992, with the acknowledgement of the collapse of several groundfish stocks, a harvesting moratorium was declared and directed fisheries for cod virtually vanished in this area. Since the collapse of these fisheries, other species, mainly snow crab and northern shrimp, have come to replace groundfish as the principal harvest on and in the waters east of the eastern Grand Banks, as they have in many other areas. Based on geo-referenced DFO datasets, Figures 4.9 to 4.11 summarize catch data for the four fisheries UAs that the Study Area overlaps (Study Area UAs) and show the quantity of the total annual harvest in that Area from 1990 to 2010, the snow crab and northern shrimp harvest, and the total groundfish harvest for the same period. Although UA 3Lr was the source of practically all of the harvest in the early 1990s, UAs 3Li (62%), 3Lh (17%) and 3Lt (14%) accounted for nearly 93% of the Study Area catch from the mid 1990's to 2010.



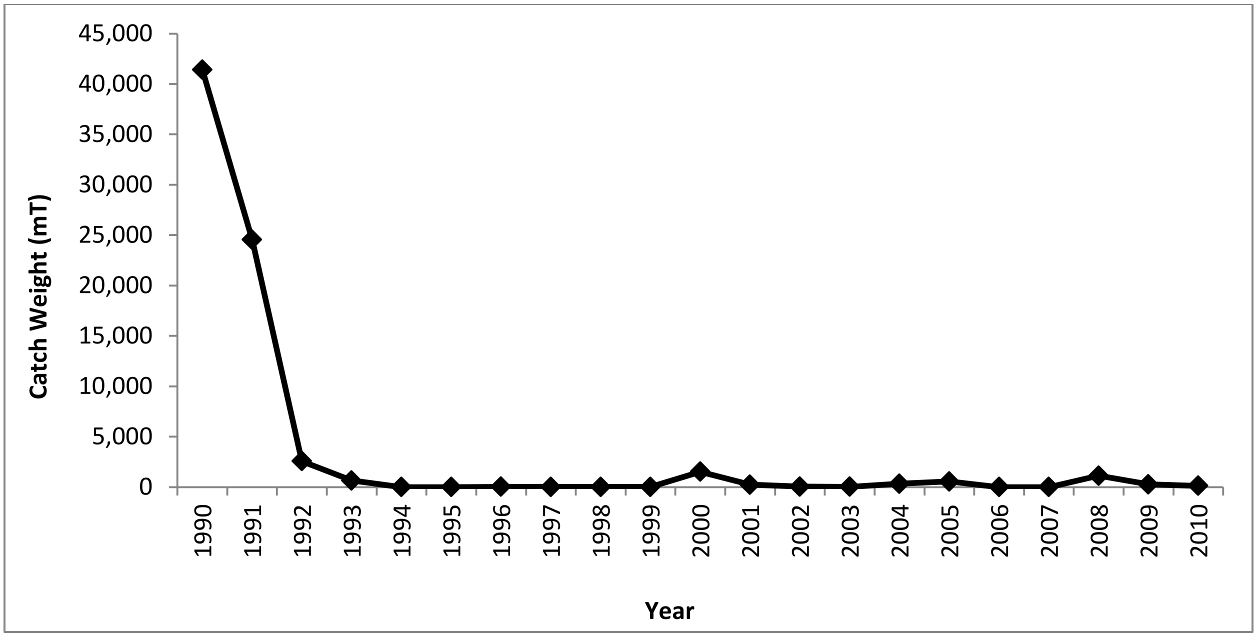
Source: DFO Commercial Fisheries Catch Data (1990-2010).

Figure 4.9 Harvest of All Species from 1990 to 2010 within Study Area UAs.



Source: DFO Commercial Fisheries Catch Data (1990-2010).

Figure 4.10 Snow Crab and Northern Shrimp Harvest from 1990 to 2010 within the Study Area UAs.



Source: DFO Commercial Fisheries Catch Data (1990-2010).

Figure 4.11 Groundfish Harvest from 1990 to 2010 within the Study Area UAs.

At present, snow crab harvesting (fixed gear) in this area tends to be focused in areas along the shelf break and slope. Northern shrimp trawling (mobile gear) overlaps some of these areas, but these two gears have a potential to conflict with each other, and thus crab and shrimp do not typically overlap in time or location. Shrimp harvesting tends to extend into deeper water in the Study Area, along the northeastern slope of Jeanne d'Arc Basin.

4.3.3.2 Study Area Catch Analysis 2005 to 2010

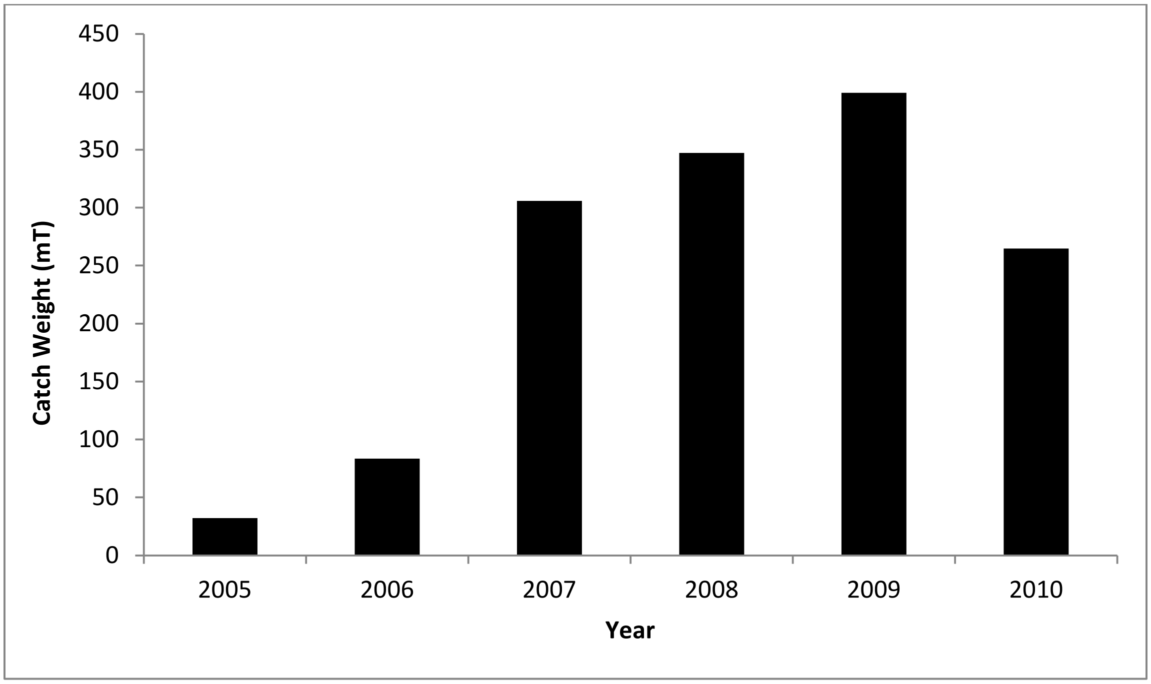
The average annual Canadian-landed harvest by species, 2005 to 2010 from within the Study Area shown below (Table 4.5) is based on the geo-referenced DFO datasets. The domestic harvest in the Study Area has been dominated by snow crab throughout this period, in terms of both quantity and value.

Table 4.5 Average Study Area Harvest by Species, May to December 2005 to 2010.

Species	Quantity (mt)	% of Total	Value ($)	% of Total
Snow Crab	235	98.4	738,983	99.4
Northern Shrimp	4	1.6	4,643	0.6
Totals	239	100.0	743,625	100.0

Source: DFO Commercial Fisheries Catch Data (2005-2010).

The total quantity of the harvest increased dramatically between 2006 and 2007, mainly the result of increased snow crab catches in the Study Area, and declined in 2010 to around 265 mt per year (Figure 4.12). Catches may maintain around 250-300 mt or decrease somewhat as a result of slightly increased snow crab quotas (discussed below) but significant reductions in shrimp quotas.



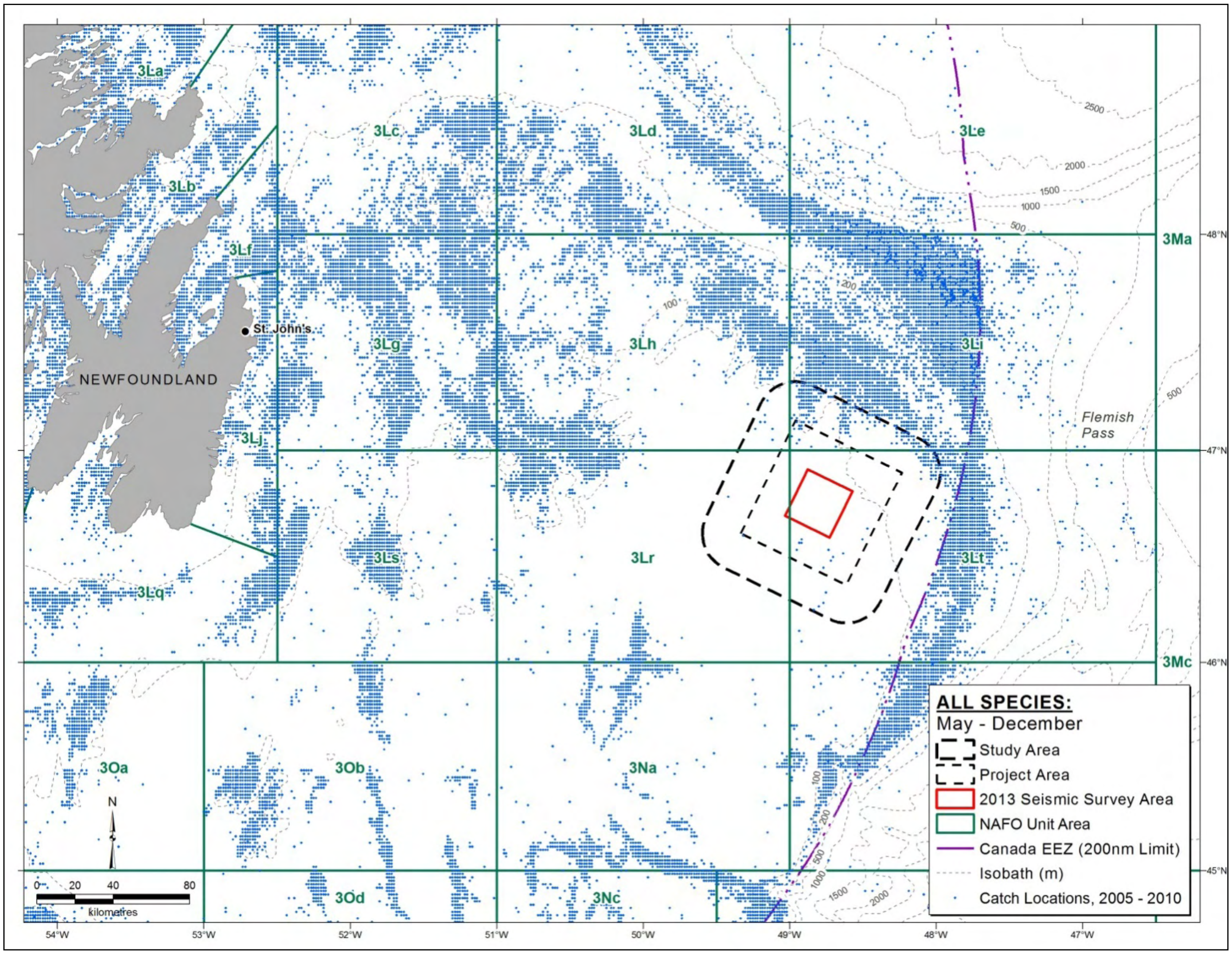
Source: DFO Commercial Fisheries Catch Data (2005-2010).

Figure 4.12 Harvest of All Species within the Study Area, May to December 2005 to 2010.

4.3.3.3 Harvesting Locations

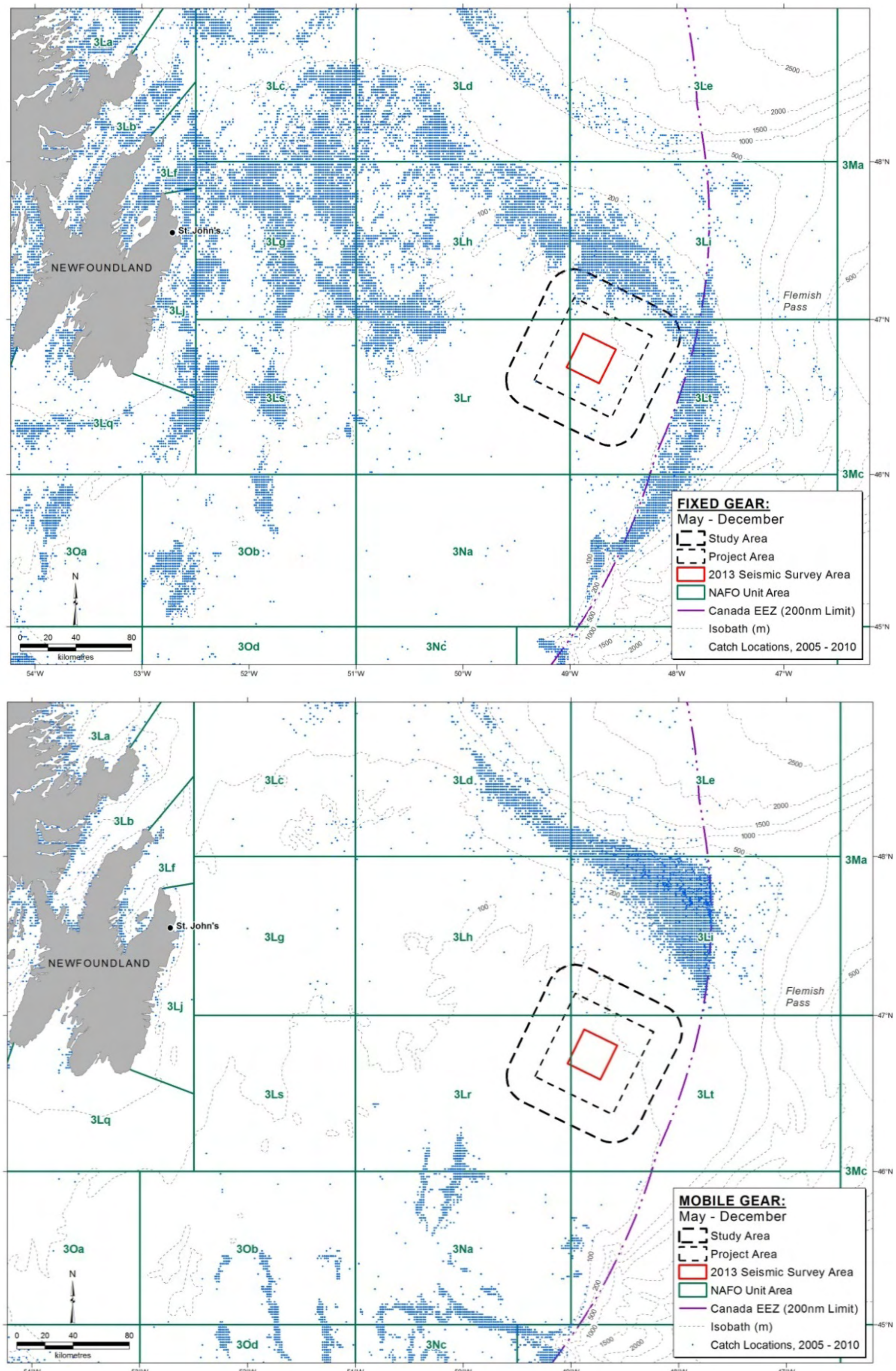
The following maps (Figures 4.13 and 4.14) show DFO dataset geo-referenced fish harvesting locations in relation to the Study Area for May to December, 2005 to 2010, combined. As Figure 4.13 illustrates, most of the domestic fish harvesting in the general area is concentrated outside of the Study Area between the 100 m and 1,000 m contours of the eastern Grand Banks, inside and to a lesser extent, outside the 200-Nm EEZ. The harvesting locations tend to be quite consistent from year to year, and this has been the case for most of the last decade.

In terms of average yearly catch weight, snow crab consisted of the entirety of the domestic harvest in the Study Area using fixed gear, while northern shrimp made up the entirety using mobile gear between May and December, 2005 to 2010 (see Table 4.6 and Figure 4.14).



Source: DFO Commercial Fisheries Catch Data (2005-2010).

Figure 4.13 All Species Harvesting Locations, May to December from 2005 to 2010 Combined.



Source: DFO Commercial Fisheries Catch Data (2005-2010).

Figure 4.14 Fixed (top) and Mobile (bottom) Gear Harvest Locations, May to December from 2005 to 2010 Combined.

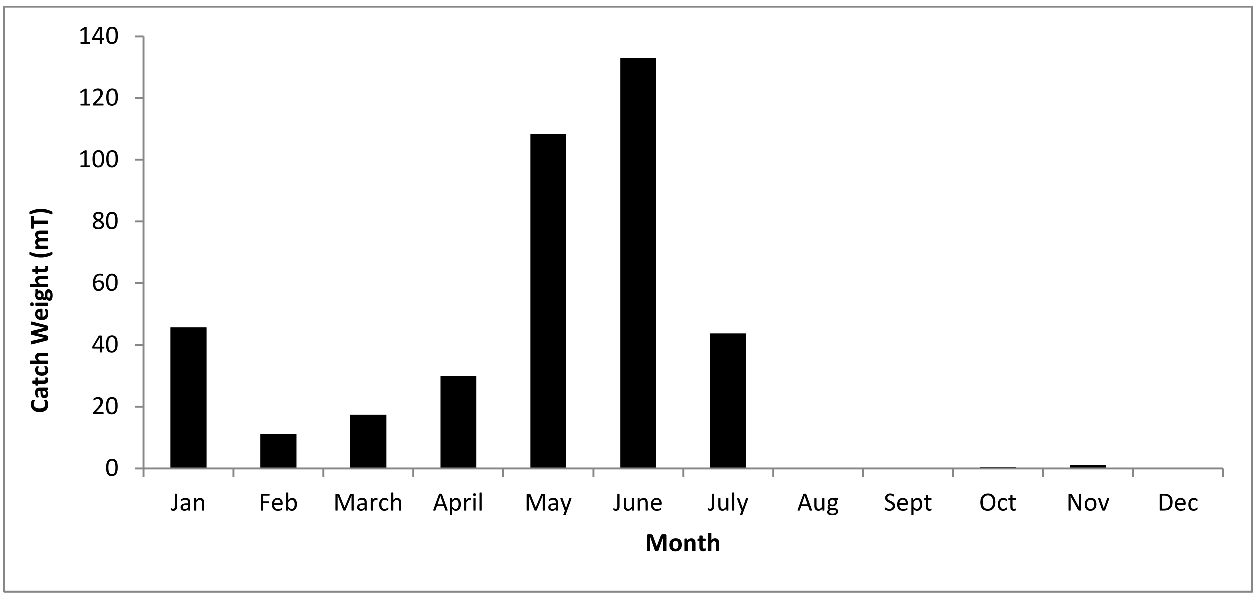
Table 4.6 Average Study Area Harvest by Species for Fixed and Mobile Gear, May to December, 2005 to 2010 Combined.

Species	Fixed Gear (mt)	% of Total	Mobile Gear (mt)	% of Total
Snow Crab	235	100.0	0	0
Northern Shrimp	0	0	4	100.0
Totals	235	100.0	4	100.0

Source: DFO Commercial Fisheries Catch Data (2005-2010).

4.3.3.4 Harvest Timing

The times that commercial species are harvested may change, depending on seasons and regulations set by DFO, the harvesting strategies of fishing enterprises, or on the availability of the resource itself. Figure 4.15 shows the 2005 to 2010 catch by month (averaged) from the Study Area; May and June were the most productive months during this period, followed by January and July, accounting for just over 62 and 23% of the annual catch, respectively.



Source: DFO Commercial Fisheries Catch Data (2005-2010).

Figure 4.15 Average Monthly Domestic Harvest, All Species, 2005 to 2010 Combined.

4.3.4 Principal Species Fisheries

As noted above, the domestic harvest within the Study Area is dominated by snow crab, with a minor component of northern shrimp. With decreasing shrimp quotas the relative importance of the species may change somewhat in the next few years. This subsection describes these two fisheries.

4.3.4.1 Snow Crab

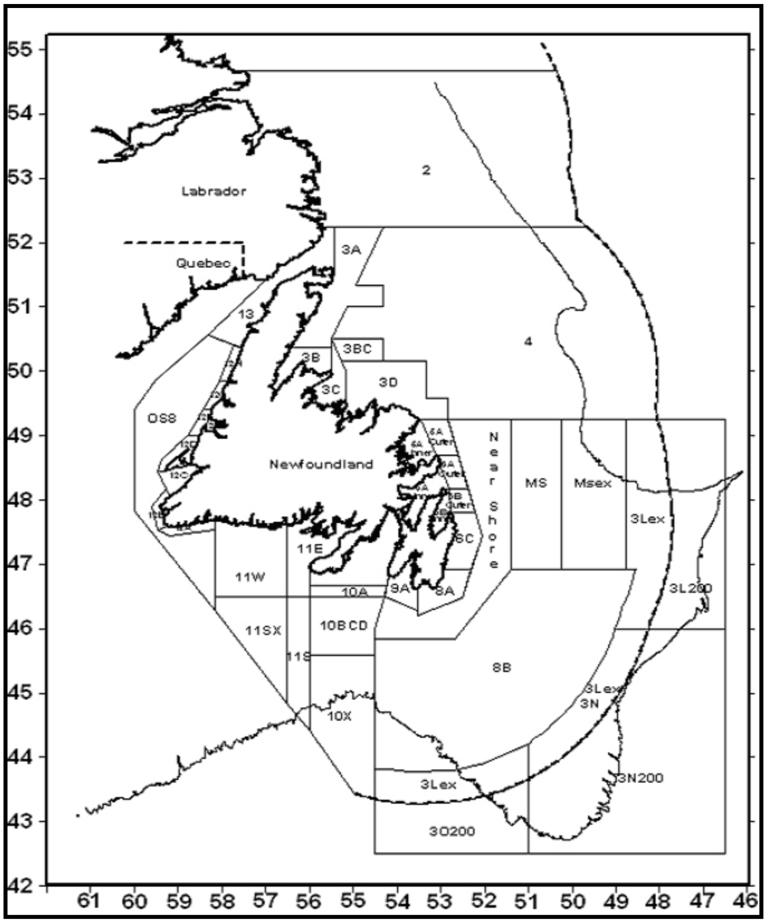
Snow crab was the most significant species harvested within the Study Area in terms of average quantity and value (Table 4.4), accounting for an average of 235 mt (98.4% of total harvest) between May and December from 2005 to 2010. The season is defined each year, but typically runs from April to July or August. The 2013 snow crab season is set to open on April 1st (R. Dunphy, Hibernia Management & Development Co. Ltd. – ExxonMobil Canada Properties Environmental Lead, pers. comm., 2013).

Over the past decade, the Newfoundland and Labrador snow crab fishery has gone through a number of fluctuations, with changes in both quantity and value in many Crab Fishing Areas (CFAs). Landed prices have been lower in recent years compared to the late 1990s and early 2000s.

A recent DFO snow crab science advisory report (DFO 2012b) notes that "[Division 3LNO Offshore] landings, mostly in Div. 3L, decreased from 24,500 t in 2007 to 22,000 t in 2009 but since increased to 26,000 t. Effort increased slightly in 2011 following a 2008-2010 decrease. Both the trap and trawl survey exploitable biomass indices increased in 2009. However, the trawl survey index decreased by 34% since 2009, while the trap survey index increased by 21%. Opposing survey trends create an uncertainty about the exploitable biomass…Recruitment has recently peaked and will likely decrease in the short term." The report further states that "…long-term recruitment prospects are unfavourable due to a warming oceanographic regime."

The Fisheries Resource Conservation Council's 2005 Strategic Conservation Framework for Atlantic Snow Crab (FRCC 2005) describes the general conduct of the offshore sector: "Vessels fishing up to and beyond 200 miles from the coast conduct voyages up to four and five days and greater depending on the vessel's holding system. Typically these vessels leave the traps for shorter periods, sometimes only a few hours, prior to retrieving the catch. Given that snow crab must be live at the time of landing and processing, the duration of fishing trips is limited, although some vessels are now able to keep crab live on board in tanks permitting them to extend the length of their trips." Quotas have been established by DFO in all management areas, the different fleets have trap and trip limits, and fish specified CFAs. Since the mid-2000s, electronic vessel monitoring systems (VMS) are required on all offshore vessels to ensure compliance (DFO 2012b). A new evergreen multi-year Integrated Fisheries Management Plan (IFMP) was implemented by DFO in 2012, which – in addition to continued sustainability management measures – introduced the mandatory use of biodegradable twine in crab traps in 2013 in an effort to reduce ghost fishing by lost traps (DFO 2012c).

Figure 4.16 shows the regulatory fishing areas for snow crab. The Study Area overlaps with portions of CFAs Msex (mid-shore extended), 3Lex (from 170 miles to 200 miles from shore) and 8B (southern Avalon, outside of 50 miles). The quotas for these CFAs (within the 200 nm-EEZ) remained the same for 2011 and 2012: Msex (3,780 t), 3Lex (2,822 t), and 8B (650 t); overall crab quotas have been stable for the Study Area region, while there have been significant declines in quota and catch rates north of the Study Area in NAFO Divisions 3K and 2J (R. Dunphy, Hibernia Management & Development Co. Ltd. – ExxonMobil Canada Properties Environmental Lead, pers. comm., 2013). Quotas for 2013 have not yet been listed by DFO for snow crab.



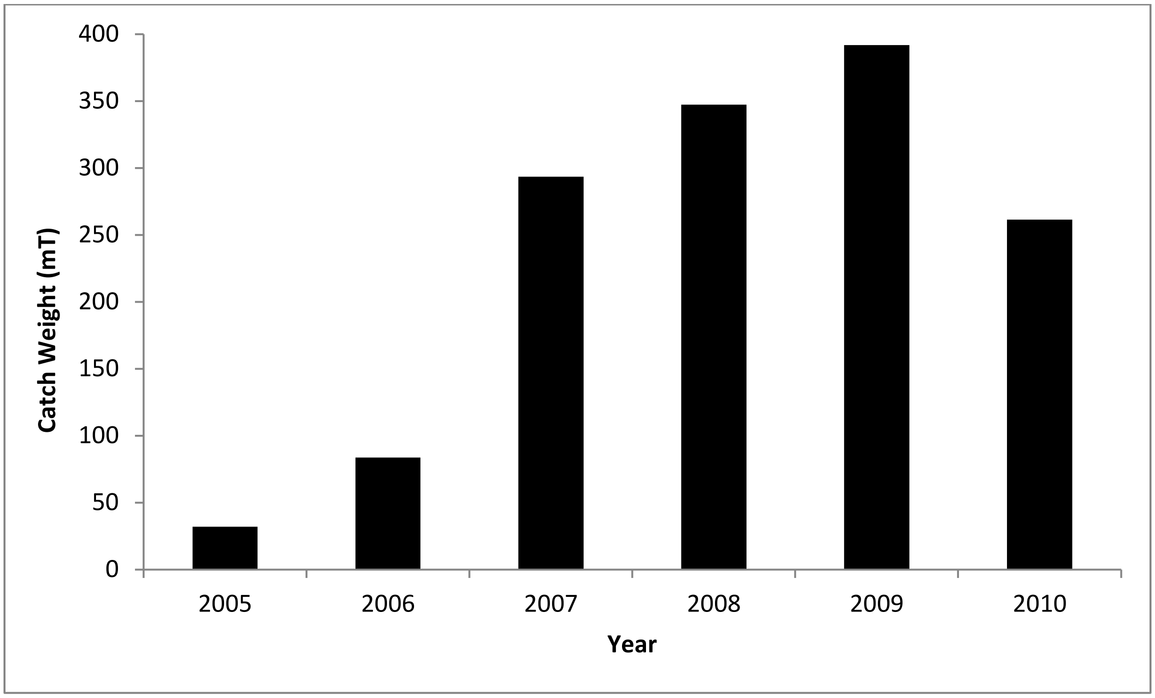
Source: DFO (2013).

Figure 4.16 Snow Crab Fishing Areas.

Figure 4.17 shows the aggregated annual snow crab quantities of harvest from the Study Area for May to December 2005 to 2010. Annual snow crab harvest levels increased between 2005 and 2009 from 32 to 392 mt, and decreased in 2010 down to 261 mt. As quotas and catch-rates have remained stable in recent years, catches are anticipated to remain at this level. Figure 4.18 shows the proportional and non-proportional aggregated harvesting locations for this species (May to December, 2005 to 2010) in relation to the Study Area. This fishery is focused along the slope edge of Jeanne d'Arc Basin, beyond the 100 m isobath in the north-eastern region of the Study Area. The area proposed for 2013 activities does not overlap with the domestic snow crab harvesting locations indicated in Figure 4.18.

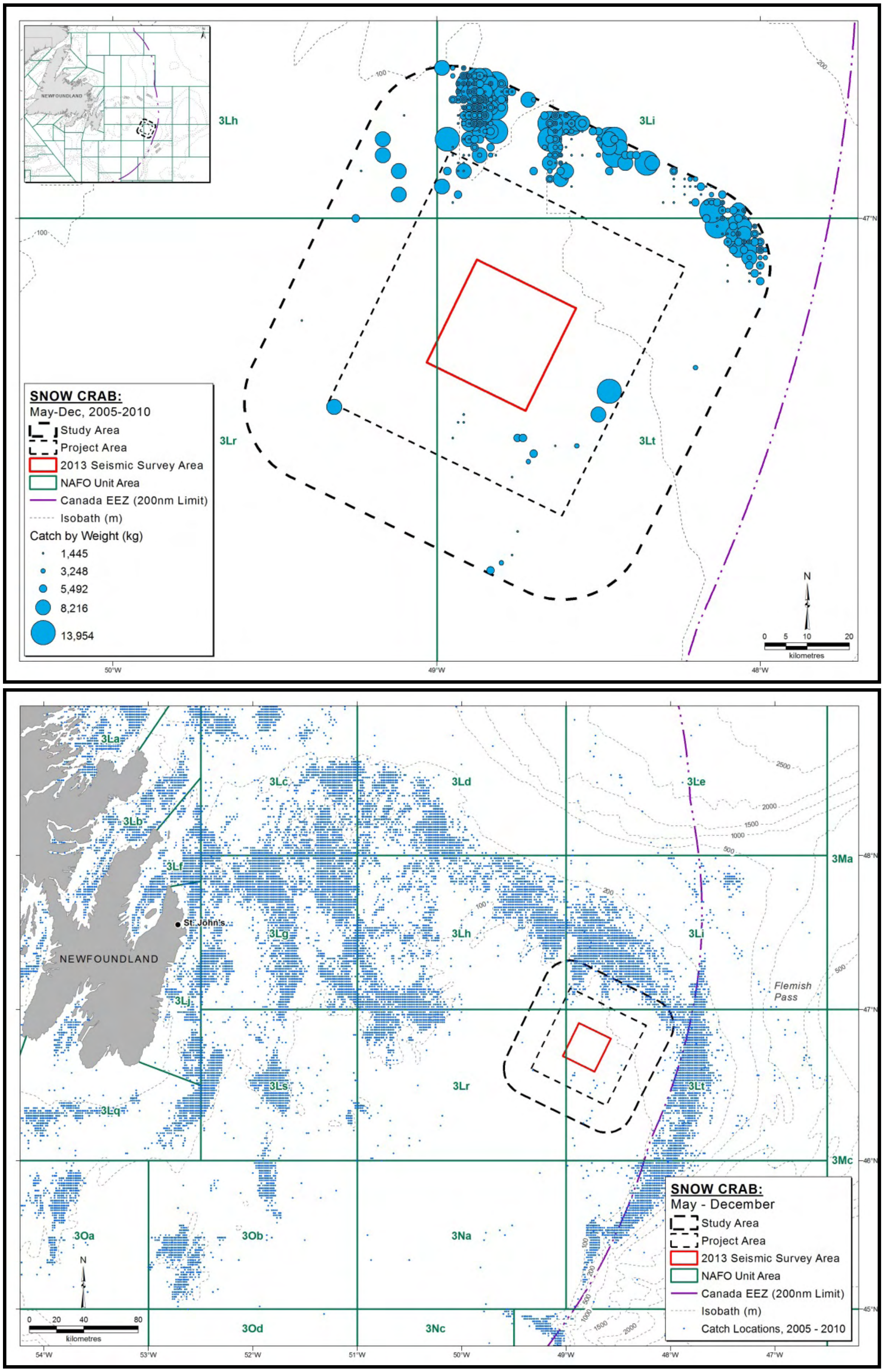
This fixed gear fishery poses more potential than mobile gear fisheries for seismic /fishing gear conflicts in those areas where the two marine activities might overlap in time and space. If OBCs are used in the proposed 2013 seismic survey, the potential for conflict with snow crab fishing gear may increase if in the same area at the same time as the OBCs are temporarily deployed. However, as no snow crab harvest has been reported within the proposed 2013 Seismic Survey Area from 2005 through 2010, the likelihood of gear conflict is probably low.

Figure 4.19 shows the average snow crab harvest by month, 2005-2010, and indicates that the harvest has occurred between April and July in the Study Area. In 2012, the Msex, 3Lex, and 8B seasons closed on 31 July.



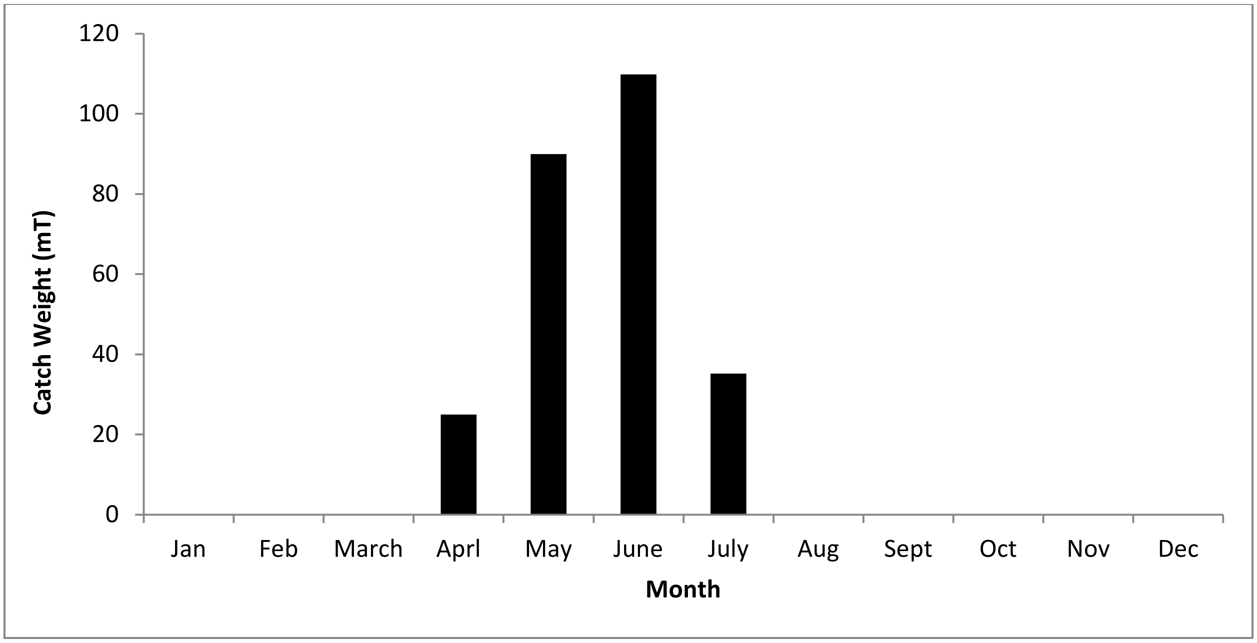
Source: DFO Commercial Fisheries Catch Data (2005-2010).

Figure 4.17 Yearly Snow Crab Harvest, May to December 2005 to 2010.



Source: DFO Commercial Fisheries Catch Data (2005-2010).

Figure 4.18 Proportional (within Study Area only; top) and Non-proportional (bottom) Snow Crab Harvesting Locations, May to December, 2005 to 2010 Combined.



Source: DFO Commercial Fisheries Catch Data (2005-2010).

Figure 4.19 Average Monthly Snow Crab Harvest, 2005 to 2010.

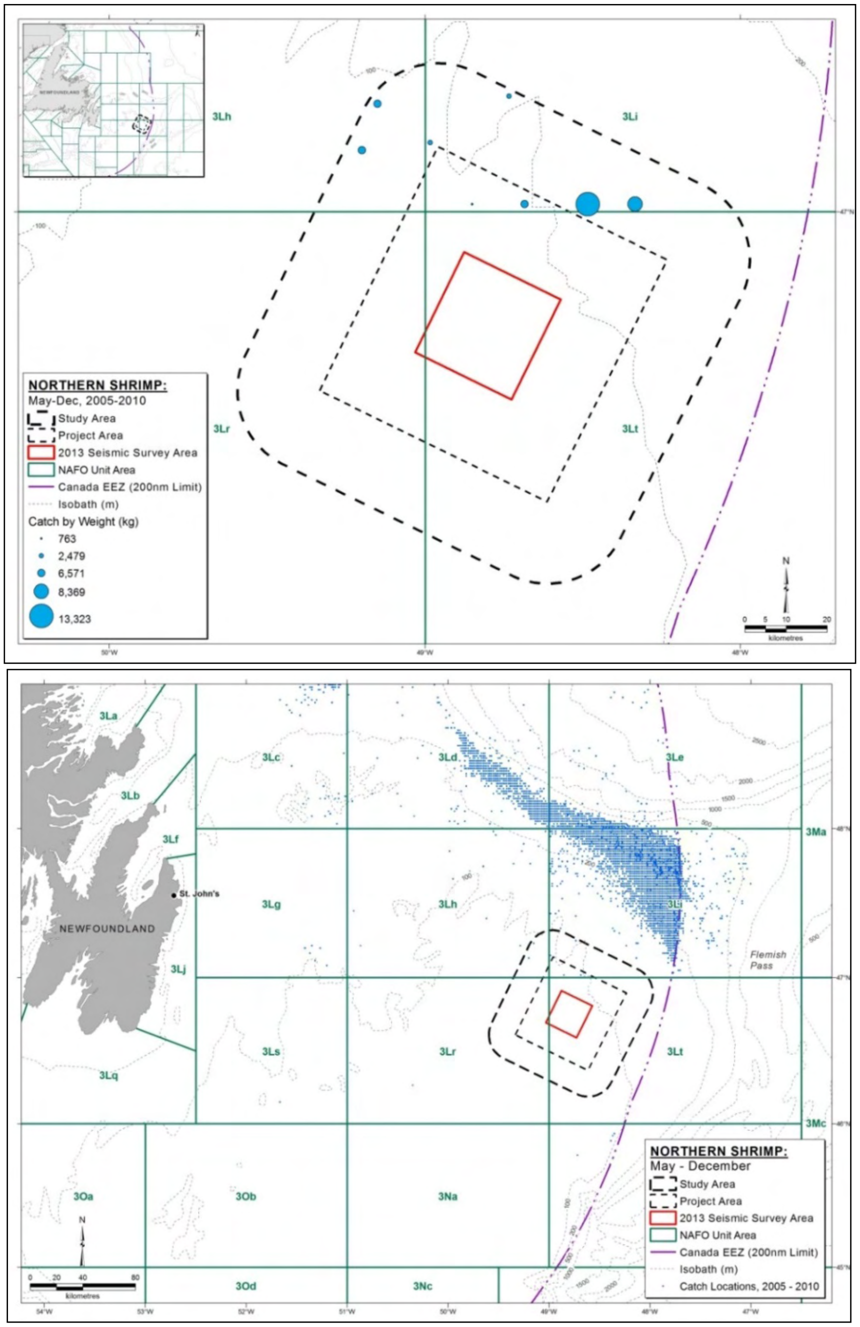
4.3.4.2 Northern Shrimp

Figure 4.20 shows proportional and non-proportional domestic harvesting locations for northern shrimp for May to December, 2005 to 2010, aggregated. This fishery occurred in the north-eastern portion of the Study Area, outside of the proposed 2013 Seismic Survey Area. The majority of shrimp harvesting occurs north and northeast of the Study Area, between the 200 and 500 m isobaths. Northern shrimp trawls are mobile gear, and pose a relatively low potential for conflict with seismic gear if in the same area at the same time. As no northern shrimp catches have been reported in recent years within the proposed 2013 Seismic Survey Area, the likelihood of gear conflict is probably low, even if OBCs are used.

Figure 4.21 shows the aggregated annual quantity of the northern shrimp harvest taken from the Study Area from May to December 2005 to 2010. Northern shrimp harvest has been sporadic in the Study Area during this time, with no reported harvests in 2005, 2006 and 2008 and variable levels of harvest in the remaining years. Because of increasing scientific concerns about the status of the resource, catch allowances have been cut in this area since 2009/10 so a decrease in catch is expected, potentially for the next several years. As discussed above, the overall quota for NAFO Division 3L has been reduced considerably, and may drop further in future years. The 2013 quota for SFA 7 (Figure 4.22) is 7,162 mt (DFO 2012d), down from 10,000 t in 2011. The offshore fleet's 2013 quota allocation is 1,377 t (DFO 2012d). In accordance with NAFO recommendations, Canadian harvesters are currently permitted to fish their quota in the entire 3L Division, while harvesting outside of Canadian waters requires obtaining a Schedule from Conservation and Protection and appending this to relevant licences (DFO 2012d). The northern shrimp operates on a calendar year, and is set to open on 1 April 2013 (R. Dunphy, Hibernia

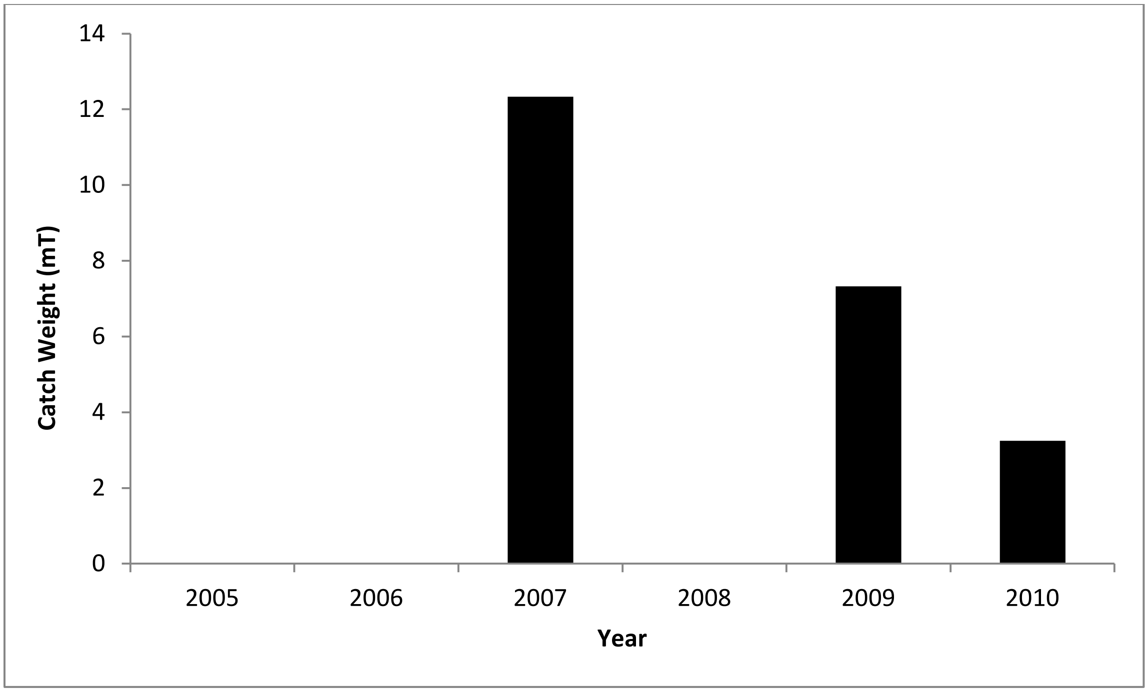
Management & Development Co. Ltd. – ExxonMobil Canada Properties Environmental Lead, pers. comm., 2013).

Figure 4.23 shows the northern shrimp harvest by month (averaged) from the Study Area, for the period 2005 to 2010. Harvest for northern shrimp occurs mainly in the winter months (January to February), with lesser amounts in the summer and fall.



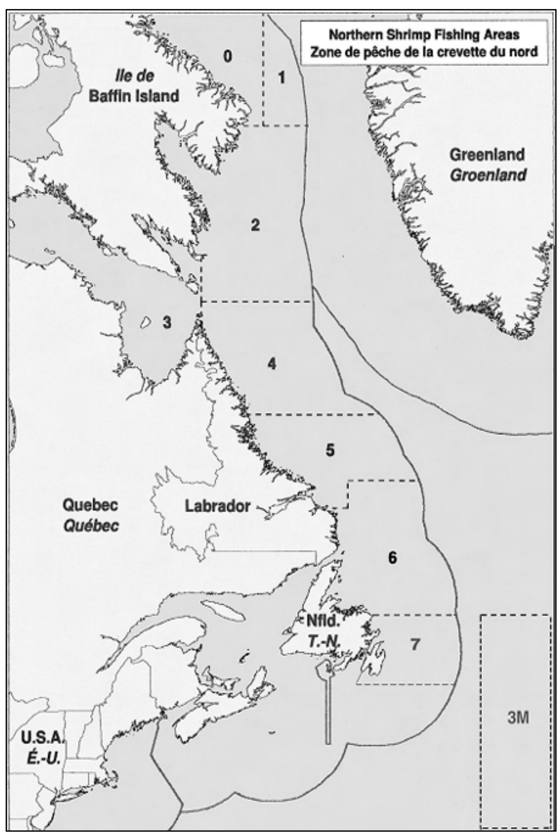
Source: DFO Commercial Fisheries Catch Data (2005-2010).

Figure 4.20 Proportional (within Study Area only; top) and Non-proportional (bottom) Northern Shrimp Harvesting Locations, May to December, 2005 to 2010.



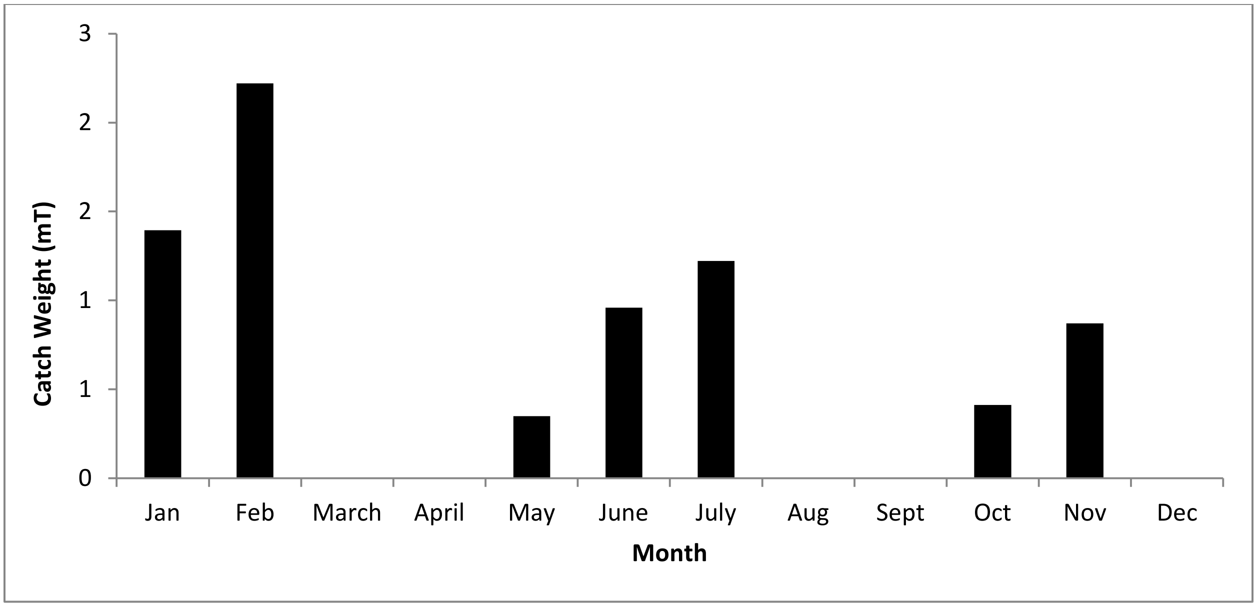
Source: DFO Commercial Fisheries Catch Data (2005-2010).

Figure 4.21 Annual Northern Shrimp Harvest from May to December 2005 to 2010.



Source: DFO (2013).

Figure 4.22 Northern Shrimp Fishing Areas.



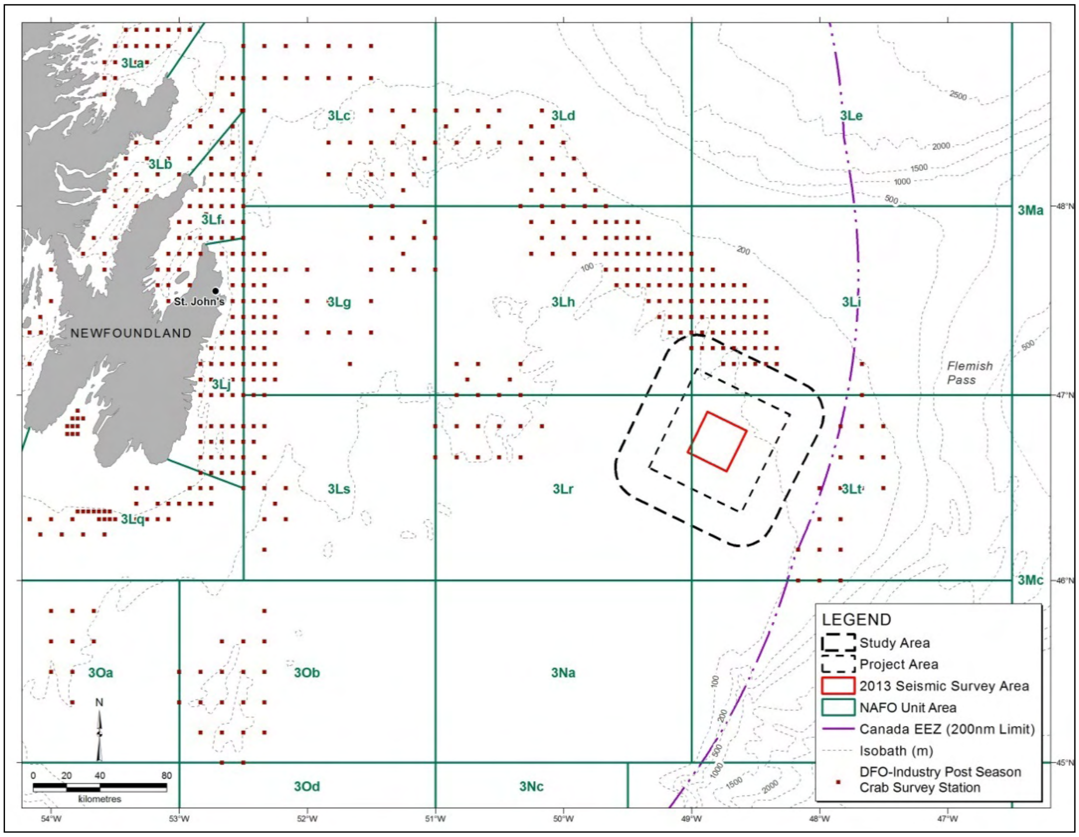
Source: DFO Commercial Fisheries Catch Data (2005-2010).

Figure 4.23 Average Monthly Northern Shrimp Harvesting, 2005 to 2010.

4.3.5 Industry and DFO Science Surveys

Fisheries research surveys conducted by DFO, and sometimes by the fishing industry, are important to the commercial fisheries to determine stock status, as well as for scientific investigation. In any year, there may be overlap between the Study Area and DFO research surveys in NAFO Division 3L, depending on the timing in a particular year. Typically, DFO conducts a spring survey in sections of 3LNOPs (April to July), and a fall survey of 2HJ3KLMNO (September or October to December). The fall survey may employ two vessels. The deeper waters of 3L (slope areas) are typically surveyed in October, and the shallower areas in November or December. There is also an annual spring acoustic survey for capelin in NAFO Division 3L. Schedules of the 2013 DFO multispecies science surveys are presently available as of October 22, 2012 (*RV Needler*), March 1 and 6, 2013 (*RV Vladykov and Teleost*, respectively) (G. Sheppard, DFO, pers. comm., 2013).

Members of the FFAW have been involved in an industry survey for crab in various offshore harvesting locations over the past few years, such as the snow crab DFO-industry collaborative post-season trap survey. This survey is conducted every year. It starts on September 1 and may continue until November before it is completed. The set locations are determined by DFO and do not change from year to year. Only eight of the stations fall within HMDC's Study Area. Research stations are shown in Figure 4.24.



Source: DFO 2013.

Figure 4.24 DFO-Industry Post-season Crab Survey Locations, 2013.

4.3.6 Concluding Summary of Commercial Fisheries in Study Area

While the species discussed in this section have been commercially harvested in the Study Area to varying degrees, there have been few reported harvests from 2005 to 2010 within the Project Area and none within the proposed 2013 Seismic Survey Area. The probability of interaction with fishers, fishing gear, and/or harvests during the proposed 2013 seismic survey is low. The proposed 2013 seismic survey will likewise pose little to no potential conflict with post-season crab surveys, as there are no survey locations within the Project or proposed 2013 Seismic Survey Areas. Interactions with commercial fisheries will be addressed in the Fishery VEC section (Section 5.6.2).

4.4 Seabirds

4.4.1 Seabird Surveys in the Study Area

Seabird surveys in the Study Area and surrounding areas have been conducted by the Canadian Wildlife Service (CWS) and oil industry related seabird monitoring programs. Prior to 2000, seabird surveys were sparse on the Orphan Basin, northern Grand Banks and Flemish Cap. Original baseline information has been collected by the CWS through PIROP (Programme intégré de recherches sur les oiseaux pélagiques). These data have been published for 1969-1983 (Brown 1986) and up to the early 1990s

(Lock et al. 1994). Since the late 1990s, additional seabird observations have been collected on the NE Grand Banks by the offshore oil and gas industry from drill platforms and supply vessels (Baillie et al. 2005; Burke et al. 2005; Fifield et al. 2009). From 2005 to 2008, seabird surveys were conducted from vessels conducting seismic surveys on the northern Grand Banks as part of the marine bird monitoring and mitigation programs required by C-NLOPB (Abgrall et al. 2008a, 2009). These surveys were conducted in the months of May to November. The CWS also initiated the Eastern Canadian Seabirds at Sea (ECSAS) surveys of Newfoundland and Nova Scotia waters. The Environmental Studies Research Funds (ESRF) combined with CWS to fund a 3.5 year project focused on improving the knowledge of seabirds at sea on the northern Grand Banks and other areas of oil industry activity in eastern Canada (Fifield et al. 2009). A total of 76 surveys conducted in this time span include many from the Grand Banks and Orphan Basin. Monthly surveys were conducted including the NE Grand Banks production area from 2006 to 2009.

The results from all of the above surveys have been used to describe the abundance, diversity and spatial distribution of seabirds in the Study Area. The predicted monthly occurrences for each species expected to occur regularly in the Study Area are provided in Table 4.7.

Table 4.7 Predicted Monthly Abundances of Seabird Species Occurring in the Study Area.

Common Name	Scientific Name	Monthly Abundance											
		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Procellariidae													
Northern Fulmar	*Fulmarus glacialis*	C	C	C	C	C	C	C	C	C	C	C	C
Great Shearwater	*Puffinus gravis*					U	C	C	C	C	C	S	
Sooty Shearwater	*Puffinus griseus*					S	S-U	S-U	S-U	S-U	S-U	S	
Manx Shearwater	*Puffinus puffinus*					S	S	S	S	S	S		
Hydrobatidae													
Leach's Storm-Petrel	*Oceanodroma leucorhoa*				U-C	C	C	C	C	C	C	S	
Wilson's Storm-Petrel	*Oceanites oceanicus*						S	S	S	S			
Sulidae													
Northern Gannet	*Morus bassanus*				S	S	S	S	S	S	S		
Phalaropodinae (Scolopacidae)													
Red Phalarope	*Phalaropus fulicarius*					S	S	S	S	S	S		
Red-necked Phalarope	*Phalaropus lobatus*					S	S	S	S	S			
Herring Gull	*Larus argentatus*	U	U	U	U	U	S	S	S	S	S	S	S
Iceland Gull	*Larus glaucoides*	S	S	S	S						S	S	S

Common Name	Scientific Name	Monthly Abundance											
		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Lesser Black-backed Gull	*Larus fuscus*					VS	VS	VS	VS	VS	VS	VS	VS
Glaucous Gull	*Larus hyperboreus*	S	S	S	S						S	S	S
Great Black-backed Gull	*Larus marinus*	U	U	U	U	U	S	S	U	U	U	U	U
Ivory Gull	*Pagophila eburnea*	VS?	VS?	VS?	VS?								
Black-legged Kittiwake	*Rissa tridactyla*	C	C	C	C	C	S	S	S	U	C	C	C
Arctic Tern	*Sterna paradisaea*					S	S	S	S	S			
Stercorariidae													
Great Skua	*Stercorarius skua*					S	S	S	S	S	S		
South Polar Skua	*Stercorarius maccormicki*					S	S	S	S	S	S		
Pomarine Jaeger	*Stercorarius pomarinus*				S	S	S	S	S	S	S		
Parasitic Jaeger	*Stercorarius parasiticus*					S	S	S	S	S	S		
Long-tailed Jaeger	*Stercorarius longicaudus*					S	S	S	S	S			
Alcidae													
Dovekie	*Alle alle*	C	C	C	C	U	VS	VS	VS	S	C	C	C
Common Murre	*Uria aalge*	S-U	S-U	S-U	S-U	S	S	S	S	S	S-U	S-U	S-U
Thick-billed Murre	*Uria lomvia*	U-C	U-C	U-C	U-C	S-U	S-U	S-U	S-U	U-C	U-C	U-C	U-C
Razorbill	*Alca torda*				S	S	S	S	S	S	S	S	
Atlantic Puffin	*Fratercula arctica*				S	S	S	S	S	S-U	S-U	S-U	

Sources: Brown (1986); Lock et al. (1994); Baillie et al. (2005); Moulton et al. (2005, 2006); Lang et al. (2006); Lang (2007); Lang and Moulton (2008); Abgrall et al. (2008a, 2008b, 2009.)

Notes: C = Common, present daily in moderate to high numbers; U = Uncommon, present daily in small numbers; S = Scarce, present, regular in very small numbers; VS = Very Scarce, very few individuals or absent. Blank spaces indicate not expected to occur in that month. Predicted monthly occurrences derived from 2004, 2005, 2006, 2007 and 2008 monitoring studies in the Orphan Basin and Jeanne d'Arc Basin and extrapolation of marine bird distribution at sea in eastern Canada in Brown (1986); Lock et al. (1994) and Fifield et al. (2009)

4.4.2 Breeding Seabirds in Eastern Newfoundland

Hundreds of thousands of pairs of seabirds nesting on the Avalon Peninsula reflect the richness of the offshore regions off southeastern Newfoundland. The seabird breeding colonies on Baccalieu Island, the Witless Bay Islands and Cape St. Mary's are among the largest in Atlantic Canada. More than 4.6 million pairs nest at these three locations alone (Table 4.8; Figure 4.25). This includes the largest Atlantic Canada colonies of Leach's Storm-Petrel (3,336,000 pairs on Baccalieu Island), Black-legged Kittiwake (23,606 pairs on Witless Bay Islands), Thick-billed Murre (1,000 pairs at Cape St. Mary's) and Atlantic Puffin (216,000 pairs on Witless Bay Islands). These birds and along with non-breeding seabirds feed on the Grand Banks during the nesting season from May to September. In addition, Funk Island, 150 km northwest of the Grand Banks supports the largest colony of Common Murre (412,524 pairs) in Atlantic Canada (Chardine et al. 2003). Many of these birds could reach the Study Area in the non-breeding season.

There are nine significant seabird nesting sites on the SE coast of Newfoundland from Cape Freels to the Burin Peninsula. Each meets the criteria for an Important Bird Area (IBA) (Figure 4.25). IBA is a site that provides essential habitat for one or more species of breeding or non-breeding birds. These sites may contain threatened species, endemic species, species representative of a biome, or highly exceptional concentrations of birds (www.ibacanada.com).

Table 4.8 Numbers of Pairs of Marine Birds Nesting at Marine Bird Colonies in Eastern Newfoundland.

Species	Wadham Islands	Funk Island	Cape Freels and Cabot Island	Baccalieu Island	Witless Bay Islands	Cape St. Mary's	Middle Lawn Island	Corbin Island	Green Island
Northern Fulmar	-	46[A]	-	12[A]	22[A,F]	Present[A]	-	-	-
Manx Shearwater	-	-	-	-	-	-	13[K]	-	-
Leach's Storm-Petrel	1,038[D]	-	250[J]	3,336,000[J]	667,086[H,I,J]	-	13,879[H]	100,000[J]	103,833[M]
Northern Gannet		9,837[b]		1,712[B]	-	14,789[L]	-	-	-
Herring Gull	-	500[J]	-	Present[A]	4,638[e,j]	Present[J]	20[J]	5,000[J]	Present[mM]
Great Black-backed Gull	Present[D]	100[J]	-	Present[A]	166[E,J]	Present[J]	6[J]	25[J]	-
Black-legged Kittiwake	-	810[J]	-	12,975[J]	23,606[F,J]	10,000[J]	-	50[J]	-
Arctic and Common Terns	376[J]	-	250[J]	-	-	-	-	-	-
Common Murre	-	412,524[C]	2,600[J]	4,000[J]	83,001[F,J]	15,484[J]	-	-	-
Thick-billed Murre		250[J]	-	181[J]	600[J]	1,000[J]	-	-	-
Razorbill	273[D]	200[J]	25[J]	100[J]	676[F,J]	100[J]	-	-	-
Black Guillemot	25[J]	1[J]	-	100[J]	20+[J]	Present[J]	-	-	-
Atlantic Puffin	6,190[D]	2,000[J]	20[J]	30,000[J]	272,729[F,G,J]	-	-	-	-
TOTALS	7,902	426,268	3,145	3,385,080	1,052,546	32,256	13,918	105,075	103,833

Sources: [A] Stenhouse and Montevecchi (1999); [B] Chardine (2000); [C] Chardine et al. (2003); [D] Robertson and Elliot (2002); [E] Robertson et al. (2001); [F] Robertson et al. (2004); [G] Rodway et al. (2003); [H] Robertson et al. (2002); [I] Stenhouse et al. (2000); [J] Cairns et al. (1989); [K] Robertson (2002); [L] CWS (unpubl. Data); [M] Russell (2008).

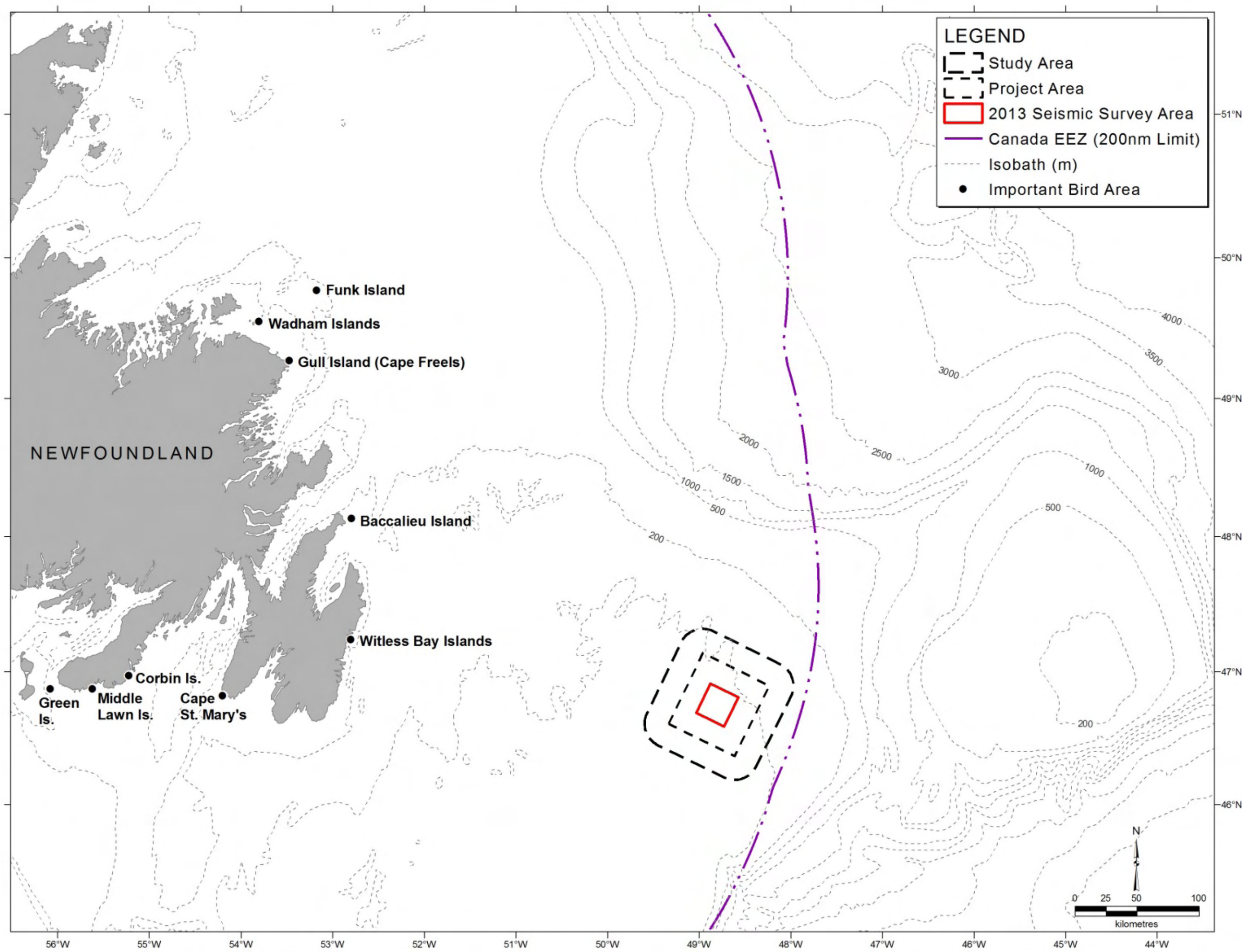


Figure 4.25 Locations of Seabird Nesting Colonies at Important Bird Areas (IBAs) Most Proximate to the Study Area.

In addition to local breeding birds, there are many non-breeding seabirds on the Grand Banks during the summer months. A significant portion of the world's population of Great Shearwater is thought to migrate to the Grand Banks and eastern Newfoundland to moult and feed during the summer months after completion of nesting in the southern hemisphere (Lock et al. 1994). Depending on the species, seabirds require two to four years to become sexually mature. Many non-breeding sub-adult seabirds, notably Northern Fulmars and Black-legged Kittiwakes are present on the Grand Banks and Flemish Cap year round. During the non-breeding season large numbers of Arctic breeding Thick-billed Murre, Dovekie, Northern Fulmar and Black-legged Kittiwake migrate to eastern Newfoundland, including the Grand Banks and Flemish Cap to spend the winter.

The Ivory Gull was listed as an *endangered* species by COSEWIC in April 2006 and is listed as *endangered* under *SARA* Schedule 1. Ivory Gull is likely of less than annual occurrence in the Project Area. See Section 4.6 for more detail.

4.4.3 Seasonal Occurrence and Abundance of Seabirds

The world range and seasonal occurrence and abundance of seabirds occurring regularly in the Study Area are described below. Table 4.7 summarizes the predicted abundance status for each species monthly. The table uses four categories to define a relative abundance of seabirds species observed:

1. *Common* = occurring daily in moderate to high numbers,
2. *Uncommon* = occurring regularly in small numbers,
3. *Scarce* = a few individuals occurring, and
4. *Very Scarce* = very few individuals.

A species world population estimate is considered when assessing relative abundance; for example, Great Shearwater is far more numerous on a world wide scale compared to a predator like the Great Skua. Information was derived from Brown (1986), Lock et al. (1994), Baillie et al. (2005), Lang et al. (2006), Moulton et al. (2006), Abgrall et al. (2007), Lang (2007), Abgrall (2008a), and Fifield et al. (2009).

Descriptions of seasonal distribution and abundance of seabirds is provided in summary form in the following sections. These are based on Husky's seismic study area which encompasses the smaller HMDC seismic Study Area (for additional detail see appended LGL 2012, especially Section 4.4.3).

4.4.3.1 Procellariidae (fulmars and shearwaters)

Northern Fulmar is common in the Study Area year round. The Northern Fulmar breeds in the N Atlantic, N Pacific, and Arctic oceans. In the Atlantic, it winters south to North Carolina and southern Europe (Brown 1986; Lock et al. 1994). Through band recoveries, it is known that most individuals in Newfoundland waters are from Arctic breeding colonies. Adults and sub-adult birds are present in the winter with sub-adults remaining through the summer. About 80 pairs breed in eastern Newfoundland (Stenhouse and Montevecchi 1999; Robertson et al. 2004). Fulmars were found to be most numerous during spring and autumn 1999 to 2002 on the NE Grand Banks, based on observations from drill rigs (Baillie et al. 2005). Results from the Jeanne d'Arc Basin 2005, 2006 and 2008 show an average of 5.06 birds/km^2 for July and August 2006, an average of 1.24 birds/km^2 late May to September 2008, and 14.72 birds/km^2 in October and early November in 2005.

The CWS ECSAS survey data from 2006-2009 in the Study Area show Northern Fulmar was present during all seasons (spring, summer and winter) surveyed (Fifield et al. 2009). Northern Fulmar is expected to be common year round in the Study Area.

Great Shearwater migrate north from breeding islands in the S Atlantic and arrive in the northern hemisphere during summer. A large percentage of the world population of Great Shearwaters is thought to moult their flight feathers during the summer month while in Newfoundland waters (Brown 1986; Lock et al. 1994). Seismic monitoring on the Jeanne d'Arc Basin showed Great Shearwater were common in summer with a mean weekly density of 5.06 birds/km^2 from 9 July to 16 August 2006 (Appendix 4 in LGL 2012 appended).

Sooty Shearwater follows movements similar to Great Shearwater but is scarce to uncommon during May to early November on the Study Area. Manx Shearwater breeds in the N Atlantic in relatively small world wide numbers compared to Great Shearwater. It is expected to be scarce in the Study Area during May to October.

4.4.3.2 Hydrobatidae (storm-petrels)

Leach's Storm-Petrel is common in offshore waters of Newfoundland from April to early November. Very large numbers nest in eastern Newfoundland with more than 3,300,000 pairs breeding on Baccalieu Island (Table 4.8). Adults range far from nesting sites on multiday foraging trips during the breeding season. Non-breeding sub-adults stay at sea during the breeding season. Leach's Storm-Petrel is widespread in Newfoundland waters. Densities of Leach's Storm-Petrels during seismic surveys on the Jeanne d'Arc Basin averaged of 0.60 birds/km^2 during the survey period 9 July to 16 August 2006 (Appendix 4 in LGL 2012 appended).

The Wilson's Storm-Petrel migrates north from breeding islands in the S Atlantic to the N Atlantic in the summer months. Newfoundland is at the northern edge of its range. It is expected to be scarce in the Study Area from June to September.

4.4.3.3 Sulidae (gannets)

More than 26,000 pairs of Northern Gannets nest on three colonies in eastern Newfoundland (Table 4.8). Gannets are common near shore and scarce beyond 100 km from shore. The Study Area is beyond the range of most Northern Gannets. It is expected to be scarce visitor from April to October within the Study Area.

4.4.3.4 Phalaropodinae (phalaropes)

The Red Phalarope and Red-necked Phalarope both breed in the Arctic to sub-Arctic regions of N America and Eurasia. They winter at sea mostly in the southern hemisphere. They migrate and feed offshore, including Newfoundland waters during their spring and autumn migrations. Phalaropes seek out areas of upwelling and convergence where rich sources of zooplankton are found. Small numbers of migrant Red Phalaropes and Red-necked Phalaropes have been observed in the Orphan Basin and northern Grand Banks during monitoring surveys on geophysical survey vessels, 2005-2008 (Abgrall et al. 2008a, 2009) in the Study Area during spring and fall migration. Phalaropes are expected to be very scarce in the Study Area during May to October.

4.4.3.5 Laridae (gulls and terns)

Great Black-backed, Herring, Glaucous, Iceland and Lesser Black-backed Gull

Great Black-backed Gull, Herring Gull, Iceland Gull, Glaucous Gull and Lesser Black-backed Gull occur in the Study Area. Great Black-backed Gull and Herring Gull are widespread nesters on the N Atlantic including Newfoundland and Labrador. Glaucous Gull and Iceland Gull breed in Subarctic and Arctic latitudes. They are winter visitors to Newfoundland. Lesser Black-backed Gull is a European gull increasing in numbers as a migrant and wintering species in eastern N America.

Great Black-backed Gull is usually the most numerous of the large gulls found in the offshore regions of Newfoundland. On drilling platforms on the NE Grand Banks during 1999 to 2002, Great Black-backed Gull was common from September to February and nearly absent from March to August (Baillie et al. 2005). A similar pattern was observed by environmental observers on offshore installations on the Terra Nova oil field from 1999 to 2009 (Suncor, unpubl. data). The ECSAS survey data from 2006-2009 in the Study Area show 'large gulls' were present during all seasons (spring, summer, fall and winter) surveyed (Fifield et al. 2009). Herring Gulls were present in consistent numbers throughout the year but in lower numbers than Great Black-backed Gulls. Results from seismic monitoring programs in Jeanne d'Arc Basin between May and October showed that large gulls were most numerous from mid-August to October (Appendix 4 in LGL 2012).

Black-legged Kittiwake

Black-legged Kittiwake is an abundant species in the N Atlantic Ocean. It is a pelagic gull that goes to land only during the nesting season. Non-breeding sub-adults remain at sea for the first year of life. Black-legged Kittiwake is expected to be present within the Study Area year round, and most numerous during the non-breeding season (August to May). Black-legged Kittiwake is present in all months of the year on the Grand Banks. Observations from the drilling platforms on the NE Grand Banks during 1999 to 2002 showed Black-legged Kittiwakes were present in October to May, but were most prevalent during November to December (Baillie et al. 2005). It was among the most numerous species observed by environmental observers on offshore installations on the Terra Nova oil field during the winter months (Suncor, unpubl. data). In the Jeanne d'Arc Basin, highest densities were observed in October and November vs. summer months (Appendix 4 in LGL 2012 appended).

Ivory Gull

Concerns over reduced numbers of Ivory Gulls at known breeding colonies in the Canadian Arctic have resulted in COSEWIC listing it as *endangered*. This species is discussed further in Section 4.6.

4.4.3.6 Stercorariidae (skuas and jaegers)

Great Skua and South Polar Skua

These two skua species occur regularly but in very low densities in offshore waters of Newfoundland during the May to October period. The Great Skua breeds in the northern hemisphere, in Iceland and northwestern Europe. The South Polar Skua breeds in the southern hemisphere from November to March and migrates to the northern hemisphere where it is present May to October. Identifying skuas to species is very difficult at sea. They usually occur where other marine birds are numerous, particularly along shelf edges.

Skuas occurred in such low densities that they were infrequently recorded during systematic surveys on during monitoring surveys on the Jeanne d'Arc Basin in 2005-2008 (Abgrall et al. 2008a, 2009). Skuas are expected to be scarce in the Study Area from May to October, or early November.

Pomarine Jaeger, Parasitic Jaeger and Long-tailed Jaeger

All three species of jaeger nest in the subarctic and Arctic in N America and Eurasia. They winter at sea in the Pacific and Atlantic oceans. Pomarine and Parasitic Jaegers winter mainly south of 35°N, while Long-tailed Jaegers winter mainly south of the equator. The three species of jaeger are relatively easy to identify in adult plumage but difficult in sub-adult plumages. Adults migrate through Newfoundland waters in spring and late summer and fall, while sub-adults migrate only part way to the breeding grounds and are present in Newfoundland waters all summer. Like skuas, they are kleptoparasites, preying chiefly on Black-legged Kittiwakes and Arctic Terns. The Long-tailed Jaegers also often hunt for fish and invertebrates on their own. Because of the low densities of jaegers they are infrequently recorded on systematic surveys. All three jaeger species were observed in low densities during monitoring programs on the Jeanne d'Arc Basin in 2005, 2006 and 2008 (Appendix 4 in LGL 2012 appended) (Abgrall et al. 2008a, 2009). Jaegers are expected to be scarce in the Study Area from May to October or early November.

Arctic Tern

Arctic Tern is the only species of tern expected in offshore waters of Newfoundland. It breeds in sub-Arctic to Arctic regions of N America and Eurasia. It winters at sea in the southern hemisphere. It migrates in small numbers through the Study Area from May to September. During Husky's seismic program (9 July to 16 August 2006) a total of 10 Arctic Terns and 15 unidentified terns (probably Arctic) were observed during systematic and incidental observations (Abgrall et al. 2008a).

4.4.3.7 Alcidae (Dovekie, murres, Black Guillemot, Razorbill and Atlantic Puffin)

There are six species of alcids breeding in the N Atlantic. All of these except for Dovekie nest in large numbers in eastern Newfoundland (Table 4.8). Dovekies nest mainly in Greenland. Dovekie, Common

Murre, Thick-billed Murre and Atlantic Puffin occur in the Study Area during part of the year. Black Guillemot and Razorbills are more coastal and are expected to be rare within the Study Area.

Dovekie

Dovekie breeds in the N Atlantic, primarily in Greenland and east Nova Zemlya, Jan Mayen and Franz Josef Land in northern Russia. This species winters at sea south to 35°N. The Dovekie is a very abundant bird, with a world population estimated at 30 million (Brown 1986). A large percentage of the Greenland-breeding Dovekies winter in the western Atlantic, mainly off Newfoundland (Brown 1986). The predicted status in the Study Area is common from October to April, uncommon during the end of spring migration in May and at the beginning of fall migration in September, and very scarce during the summer months (June to August; LGL 2012; Fifield et al. 2009).

Murres

The two species of murre, Common and Thick-billed, are often difficult to identify with certainty at sea so are often grouped as "murres" during offshore seabird surveys. Common Murre is an abundant breeding species in eastern Newfoundland with just over a half million pairs nesting (Table 4.8). These birds spend the winter from eastern Newfoundland south to Massachusetts. Thick-billed Murre is an uncommon breeder in eastern Newfoundland. However, Newfoundland waters are an important wintering area for many of the two million pairs breeding in Arctic Canada and Greenland.

Global location sensors deployed on ten Common Murre during the breeding season at Funk Island showed the birds were present on the Grand Banks year round particularly at the shelf edge (Hedd et al. 2011). All ten birds were present on the Jeanne d'Arc Basin area in November and December. The predicted status of Common Murre in the Study Area is scarce to uncommon October to April and scarce from May to August. The predicted status of Thick-billed Murre in the Study Area is uncommon to common October to April and scarce from May to August.

Other Alcids

Atlantic Puffins winter off southern Newfoundland and Nova Scotia and they occur in low densities as far offshore as the Study Area. Non-breeding sub-adults occur throughout the summer whereas adults and juveniles can occur in late summer and fall. As expected, very low densities of puffins were recorded during surveys conducted from mid-May to late September in the Jeanne d'Arc basin (Appendix 4 in LGL 2012 appended). Densities of Atlantic Puffins increased in October and November in Jeanne d'Arc Basin (Appendix 4 in LGL 2012). Within the Study Area, Atlantic Puffin is expected to be scarce during the breeding season (April to August) and scarce to uncommon during the post-breeding season September to November. Razorbills tend to occur closer to shore than the murres. Very few were recorded during monitoring programs on the Jeanne d'Arc Basin in 2005-2008 between mid-May and early-November (Appendix 4 in LGL 2012). Razorbill is expected to be very scarce in the Study Area during April to November and absent during December to March. Black Guillemot is common near shore in Newfoundland and Labrador but would not be expected as far offshore as the Study Area.

4.4.4 Prey and Foraging Habits

Marine birds in the Study Area consume a variety of prey ranging from small fish to zooplankton. Different foraging methods include plunge diving from a height of 30 m into the water, feeding on the surface, and sitting on the water then diving. Table 4.9 summarizes the feeding habits of birds expected to occur in the Study Area.

Table 4.9 Foraging Strategy and Prey of Seabirds in the Study Area.

Species	Prey	Foraging Strategy	Time with Head Under Water	Depth (m)
Procellariidae				
Northern Fulmar	Fish, cephalopods, crustaceans, zooplankton, offal	Surface feeding	Brief	1-2
Great Shearwater	Fish, cephalopods, crustaceans, zooplankton, offal	Shallow plunging, surface feeding	Brief	Usually < 2, recorded maximum of 18.
Sooty Shearwater	Fish, cephalopods, crustaceans, zooplankton, offal	Shallow plunging, surface feeding	Brief	Usually <10, maximum recorded 60.
Manx Shearwater	Fish, cephalopods, crustaceans, zooplankton, offal	Shallow plunging, surface feeding	Brief	1-10
Hydrobatidae				
Wilson's Storm-Petrel	Crustaceans, zooplankton	Surface feeding	Brief	<0.5
Leach's Storm-Petrel	Crustaceans, zooplankton	Surface feeding	Brief	<0.5
Sulidae				
Northern Gannet	Fish, cephalopods	Deep plunge diving	Brief	10
Phalaropodinae				
Red Phalarope	Zooplankton, crustaceans	Surface feeding	Brief	0
Red-necked Phalarope	Zooplankton, crustaceans	Surface feeding	Brief	0
Laridae				
Great Skua	Fish, cephalopods, offal	Kleptoparasitism	Brief	< 0.5
South Polar Skua	Fish, cephalopods, offal	Kleptoparasitism	Brief	< 0.5
Pomarine Jaeger	Fish	Kleptoparasitism	Brief	< 0.5
Parasitic Jaeger	Fish	Kleptoparasitism	Brief	< 0.5
Long-tailed Jaeger	Fish, crustaceans	Kleptoparasitism, surface feeding	Brief	< 0.5
Herring Gull	Fish, crustaceans,	Surface feeding,	Brief	< 0.5

Species	Prey	Foraging Strategy	Time with Head Under Water	Depth (m)
	offal	shallow plunging		
Iceland Gull	Fish, crustaceans, offal	Surface feeding, shallow plunging	Brief	< 0.5
Glaucous Gull	Fish, crustaceans, offal	Surface feeding, shallow plunging	Brief	< 0.5
Great Black-backed Gull	Fish, crustaceans, offal	Surface feeding, shallow plunging	Brief	< 0.5
Ivory Gull	Fish, crustaceans, offal	Surface feeding, shallow plunging	Brief	< 0.5
Black-legged Kittiwake	Fish, crustaceans, offal	Surface feeding, shallow plunging	Brief	< 0.5
Arctic Tern	Fish, crustaceans, zooplankton	Surface feeding, shallow plunging	Brief	< 0.5
Alcidae				
Dovekie	Crustaceans, zooplankton, fish	Pursuit diving	Prolonged	Max 30, average is < 30
Common Murre	Fish, crustaceans, zooplankton	Pursuit diving	Prolonged	Max 100 , average 20-50
Thick-billed Murre	Fish, crustaceans, zooplankton	Pursuit diving	Prolonged	Max 100 , average 20-60
Razorbill	Fish, crustaceans, zooplankton	Pursuit diving	Prolonged	Max 120, average 25
Atlantic Puffin	Fish, crustaceans, zooplankton	Pursuit diving	Prolonged	Max 60, average < 60

Sources: Cramp and Simmons (1983); Nettleship and Birkhead (1985); Lock et al. (1994); Gaston and Jones (1998), Ronconi et al. (2010a, b).

4.4.4.1 Procellariidae (fulmar and shearwaters)

Northern Fulmar and the three species of shearwaters that are expected to occur in the Study Area feed on a variety of invertebrates, fish and zooplankton at or very near the surface. Capelin is an important food source for shearwaters. They secure their prey by swimming on the surface and picking at items on the surface, or dipping head under the water. Shearwaters are also capable of diving a short distance under the surface, probably no more than a metre on average. They may do this flying low over the water and then plunging into the water with enough force to get them below the surface for a few seconds or dive from a sitting position.

4.4.4.2 Sulidae (Northern Gannet)

Northern Gannet feeds on cephalopods and small fish such as capelin, mackerel, herring and Atlantic saury. They secure prey in spectacular fashion by plunging from a height of up to 30 m into the water reaching depths of 10 m. They pop back to the surface within a few seconds of entering the water.

4.4.4.3 Phalaropodinae (phalaropes)

Red-necked and Red Phalaropes eat zooplankton at the surface of the water. They secure food by swimming and rapidly picking at the surface of the water. The head probably rarely goes beneath surface.

4.4.4.4 Hydrobatidae (storm-petrels)

Leach's and Wilson's Storm-Petrel feed on small crustaceans, various small invertebrates and zooplankton. These storm-petrels usually feed while on the wing picking small food items from the surface of the water.

4.4.4.5 Laridae (skuas, jaegers, gulls, terns)

Skuas and jaegers feed by chasing other species of birds until they drop food they are carrying or disgorge the contents of their stomachs. This method of securing food is called kleptoparasitism. Long-tailed Jaeger, the smallest member of this group, also feeds on small invertebrates and fish, which is caught by dipping to the surface of the water while remaining on the wing.

The large gulls, Herring, Great Black-backed, Glaucous and Iceland Gull, are opportunists eating a variety of food items from small fish at the surface, to carrion, and refuse and offal from fishing and other ships at sea. They find this food at the surface and may plunge their head under water to grab food just below the surface but the entire body is rarely submerged.

Ivory Gull often feed from the wing over water, dip feeding for small fish and invertebrates on the surface. They occasionally plunge dive so that the entire body may be submerged momentarily. They also swim and pick at the surface of the water and walk on ice to scavenge animal remains.

Black-legged Kittiwakes feed on a variety of invertebrates and small fish. Capelin is an important part of their diet when available. They feed by locating prey from the wing then dropping to the water surface and plunge diving. The body may be submerged very briefly. They also swim and pick at small invertebrates near the surface.

Arctic Tern feed on small fish and invertebrate that they catch from the wing with a shallow plunge dive. The entire bird rarely goes beneath the surface. They rarely rest on the water.

4.4.4.6 Alcidae (Dovekie, murres, Razorbill and Atlantic Puffin)

This group of birds is different than the other seabirds of the Study Area. They spend considerable time resting on the water and dive deep into the water column for food. Dovekie feed on zooplankton including larval fish. They can dive down to 30 m and remain under water up to 41 seconds, but average dives are somewhat shallower and shorter in duration (Gaston and Jones 1998). Common Murre and Thick-billed Murre have been recorded diving to 100 m but 20-60 m is thought to be average.

Dives have been timed up to 202 seconds but 60 seconds is closer to average (Gaston and Jones 1998). Razorbill has been recorded diving to 120 m but 25 m is thought to be more typical with time under water about 35 seconds (Gaston and Jones 1998). Black Guillemot usually feeds in water <30 m in depth but in deep water has been recording diving to 50 m with a maximum 147 seconds under water. Average depth and duration of dives is expected to be less (Gaston and Jones 1998). Atlantic Puffin will dive to 60 m but 10 to 45 m is thought to be typical. Maximum length of time recorded under water is 115 seconds but a more typical dive would be about 30 seconds.

4.4.5 Concluding Summary of Seabirds in Study Area

The northeast Grand Banks is an important feeding, migratory and over-wintering area for seabirds. At least 26 species of seabirds occur in the HMDC Study Area.

The groups of seabirds potentially most sensitive to seismic survey activities are probably the storm petrels and the alcids. The former because they have a tendency to strand on lighted vessels at night particularly in times of low visibility, and the latter because they spend more time underwater than the other species. These interactions are addressed in the effects section (Section 5.6.3). Storm petrels are likely the most common bird species in the Study Area during the proposed time frame of the Project. Murres occur in very high numbers in the Study Area but are relatively scarce during the timeframe of the proposed surveys. Other alcids may occur there but not in large numbers since many of them are found closer inshore.

4.5 Marine Mammals and Sea Turtles

4.5.1 Marine Mammals

Much of the information on marine mammal occurrence and abundance in the Study Area is based upon the results of marine mammal monitoring for seismic surveys in Jeanne d'Arc basin and adjacent areas (e.g., Moulton et al. 2005, 2006; Abgrall et al. 2008a,b; 2009). There are also sighting data (incidental and systematic) compiled by DFO. Recent exploration and drilling EAs and their amendments for Jeanne d'Arc Basin (LGL 2008a, 2011a, 2012), and the northern Grand Banks (LGL 2011b) have provide up to date information on marine mammals. The following "biological background" overview of marine mammal species likely to occur in the Study Area summarizes relevant information with particular focus on spatial and temporal distribution and life history parameters.

A large database of cetacean sightings in Newfoundland and Labrador waters has been compiled by DFO in St. John's (J. Lawson, DFO Research Scientist, pers. comm.) and has been made available for the purposes of describing cetacean sightings within the Study Area. These data can be used to indicate what species have occurred in the region, but cannot typically provide fine-scale descriptions or predictions of abundance or distribution. The DFO database also includes marine mammal sightings collected as part of seismic monitoring programs.

As noted by DFO, a number of *caveats* should be considered when using the DFO cetacean sighting data, and include:

1. The sighting data have not yet been completely error-checked;
2. The quality of some of the sighting data is unknown;
3. Most data have been gathered from platforms of opportunity that were vessel-based. The inherent problems with negative or positive reactions by cetaceans to the approach of such vessels have not yet been factored into the data;
4. Sighting effort has not been quantified (i.e., the numbers cannot be used to estimate true species density or abundance for an area);
5. Both older and some more recent survey data have yet to be entered into this database. These other data will represent only a very small portion of the total data;
6. Numbers sighted have not been verified (especially in light of the significant differences in detectability among species);
7. For completeness, these data represent an amalgamation of sightings from a variety of years and seasons. Effort (and number of sightings) is not necessarily consistent among months, years, and areas. There are large gaps between years. Thus seasonal, depth, and distribution information should be interpreted with caution; and
8. Many sightings could not be identified to species, but are listed to the smallest taxonomic group possible.

4.5.1.1 Overview of Marine Mammals

A total of 20 marine mammals, including 17 cetacean and three seal species are known or expected to occur in the Study Area (Table 4.10). Several cetaceans are considered at risk by COSEWIC and listed under the *SARA*. Those species listed under Schedule 1 of *SARA* are described in Section 4.6.

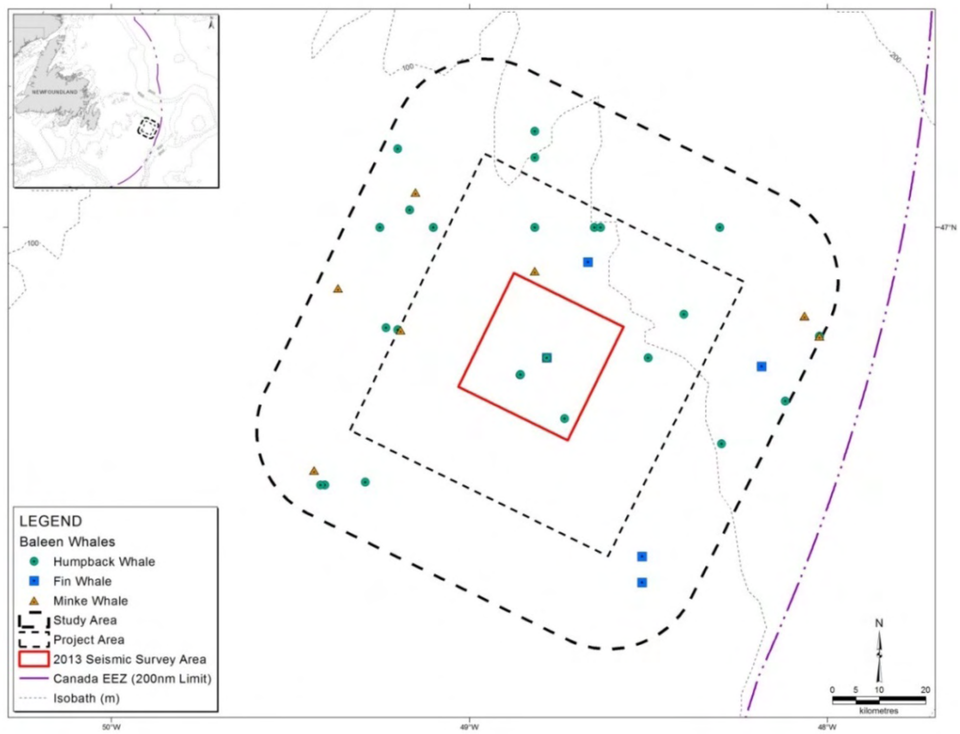
A summary of the prey of marine mammals that occur in the Study Area is summarized in Table 4.14 in LGL (2008a). For most species of marine mammals there are no reliable population estimates for Atlantic Canada; most estimates are based on data collected in northeastern U.S. waters. Thus, Waring et al. (2011) was reviewed to acquire updated population estimates for cetaceans considered a part of the Western N Atlantic stock.

The summary of sightings below combines the data sources described above as well as historical and new sightings from commercial whaling, fisheries observers, MMOs aboard seismic vessels, and the general public. Within the Study Area, sighting dates ranged from 1961 to 2009 and included baleen whales (Figure 4.26), large toothed whales (Figure 4.27), and dolphins and porpoises (Figure 4.28). These data are summarized in Table 4.11.

Table 4.10 Marine Mammals Known or Expected to Occur in the Study Area.

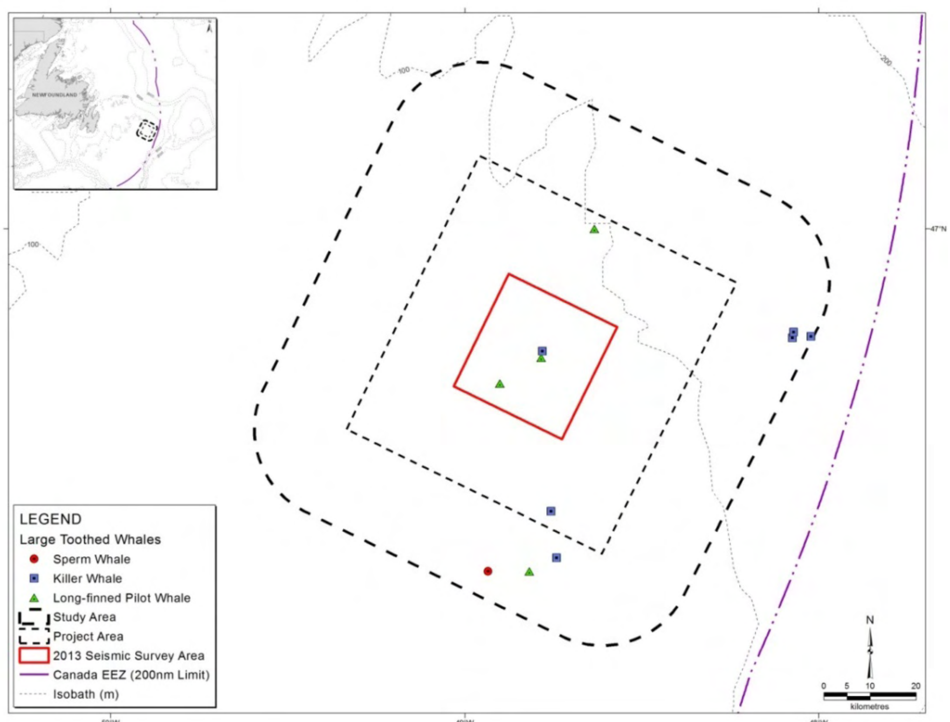
Common Name	Study Area: Occurrence	Study Area: Season	Habitat	SARA Status [a]	COSEWIC Status [b]
Baleen Whales (Mysticetes)					
Blue whale (*Balaenoptera musculus*)	Rare	Year-round but mostly spring to summer	Coastal, pelagic	Schedule 1: E	E
North Atlantic right whale (*Eubalaena glacialis*)	Extremely Rare	Summer?	Coastal, shelf	Schedule 1: E	E
Fin whale (*B. physalus*)	Common	Year-round but mostly summer	Pelagic, slope	Schedule 1: SC	SC
Sei whale (*B. borealis*)	Uncommon	May - Sept.	Pelagic, offshore	NS	DD
Humpback whale (*Megaptera novaeangliae*)	Common	Year-round but mostly May - Oct.	Coastal, banks	Schedule 3: SC	NAR
Minke whale (*B. acutorostrata*)	Common	Year-round but mostly May - Oct.	Shelf, banks, coastal	NS	NAR
Toothed Whales (Odontocetes)					
Sperm whale (*Physeter macrocephalus*)	Uncommon to Common	Year-round but mostly summer	Pelagic, slope, canyons	NS	NAR; LPC
Northern bottlenose whale (*Hyperoodon ampullatus*)[c]	Uncommon	Year-round?	Pelagic, slope, canyons	NS	SC
Sowerby's beaked whale (*Mesoplodon bidens*)	Rare	Summer?	Pelagic, deep slope, canyons	Schedule 1: SC	SC
Killer whale (*Orcinus orca*)	Rare	Year-round but mostly June-Oct.	Widely distributed	NS	SC
Long-finned pilot whale (*Globicephala melas*)	Common	May - Sept.	Mostly pelagic	NS	NAR
Atlantic white-sided dolphin (*Lagenorhynchus acutus*)	Common	Year-round but mostly June-Oct.	Shelf, slope	NS	NAR
Short-beaked common dolphin (*Delphinus delphis*)	Common	Summer-fall	Nearshore, pelagic	NS	NAR
White-beaked dolphin (*L. albirostris*)	Uncommon	Year-round but mosty June-Sept.	Shelf	NS	NAR
Common bottlenose dolphin (*Tursiops truncatus*)	Rare	Summer?	Shelf, coastal, pelagic (occasionally)	NS	NAR
Striped dolphin (*Stenella coeruleoalba*)	Uncommon	Summer?	Offshore convergence zones and upwellings	NS	NAR
Harbour porpoise (*Phocoena phocoena*)	Uncommon	Year-round but mostly spring to fall	Shelf, coastal, pelagic (occasionally)	Schedule 2: T	SC
True Seals (Phocids)					
Harp seal (*Pagophilus groenlandicus*)	Common	Year-round	Pack ice and pelagic	NS	NC; MPC
Hooded seal (*Cystophora cristata*)	Common	Year-round	Pack ice and pelagic	NS	NAR; MPC
Grey seal (*Halichoerus grypus*)	Rare	Year-round	Coastal and continental shelf	NS	NAR

Notes: E=Endangered, T=Threatened, SC=Special Concern, NAR=Not at Risk, NC=Not Considered, DD=Data Deficient, NS=No Status, LPC=Low Priority Candidate, MPC=Medium Priority Candidate. ? indicates uncertainty.
[a] www.sararegistry.gc.ca/default_e.cfm, accessed November 2012.
[b] www.cosewic.gc.ca/eng/sct5/index_e.cfm, accessed November 2012.
[c] Davis Strait population.



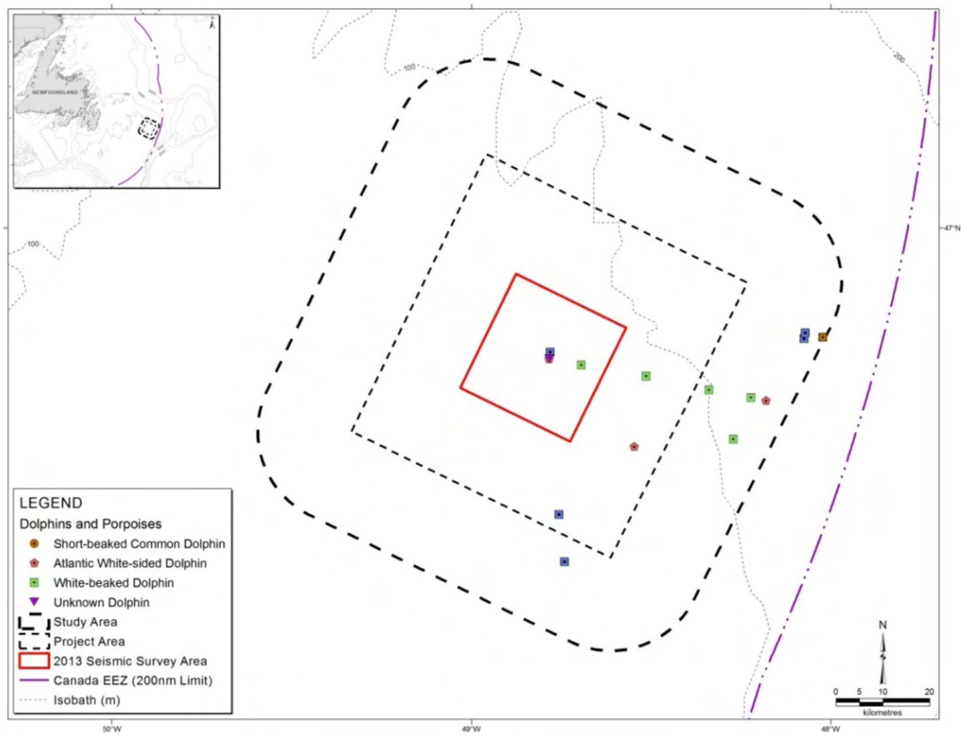
Source: Based on DFO sightings database.

Figure 4.26 Baleen Whale Sightings in the Study Area.



Source: Based on DFO sightings database.

Figure 4.27 Large Toothed Whale Sightings in the Study Area.



Source: Based on DFO sightings database.

Figure 4.28 Dolphin and Porpoise Sightings in the Study Area.

Table 4.11 Cetacean Sightings within the Study Area, 1961 to 2009.

Species	Number of Sightings	Minimum Number of Individuals	Months Observed
Mysticetes			
Humpback Whale	85	279	March-Dec
Fin Whale	6	14	June-July; Sept
Minke Whale	13	20	May-Oct; Dec
Large Odontocetes			
Sperm Whale	1	1	Aug
Killer Whale	6	26	May-June; Aug; Oct-Nov
Long-finned Pilot Whale	6	24	March; July; Sept
Delphinids			
Short-beaked Common Dolphin	1	90	March
Atlantic White-sided Dolphin	3	19	July-Aug
White-beaked Dolphin	5	34	Aug
Unidentified Cetaceans			
Unidentified Dolphin	2	21	Aug
Unidentified Cetacean	17	24	June-Oct

Source: Based on DFO sightings database.

4.5.1.2 Baleen Whales (Mysticetes)

Six species of baleen whales occur in the Study Area, four of which are considered regular visitors (Table 4.10). Blue whales are considered rare and N Atlantic right whales are considered extremely rare in the Study Area; these species are described in Section 4.6 on Species at Risk. Although some individual baleen whales may be present in offshore waters of NL year-round, most baleen whale species presumably migrate to lower latitudes during winter months.

Fin Whale

The Atlantic population of fin whale is currently designated as *special concern* under Schedule 1 of *SARA* and by COSEWIC (Table 4.10). Fin whales are distributed throughout the world's oceans, but are most common in temperate and Polar Regions (Jefferson et al. 2008). Fin whales were heavily targeted by commercial whalers in Newfoundland and Labrador, and the current estimate for the western N Atlantic stock is 3,985 individuals (CV=0.24; Waring et al. 2011). Fin whales continue to regularly occur in Newfoundland and Labrador waters, particularly during summer months. Based on the DFO cetacean sightings database, fin whales have been sighted in the Study Area (Figure 4.26) from June to September (Table 4.11). Fin whales were also sighted during a recent Statoil/Husky seismic monitoring program in Jeanne d'Arc Basin (Abgrall et al. 2009).

Humpback Whale

The humpback whale is cosmopolitan in distribution and is most common over the continental shelf and in coastal areas (Jefferson et al. 2008). There are an estimated 11,570 individuals in the N Atlantic (Stevick et al. 2003). Based on aerial surveys conducted off the south and northeast coast of Newfoundland, an estimated 1,427 humpback whales occur there (Table 6 *in* Lawson and Gosselin 2009). In eastern Canada, humpback whales are considered *special concern* on Schedule 3 of the *SARA* and are considered *not at risk* by COSEWIC. Humpback whales migrate annually from high-latitude summer foraging areas to Caribbean breeding grounds in the winter. Primary feeding areas in the N Atlantic have been described using genetic and individual identification data as the Gulf of Maine eastern Canada, west Greenland, and the NE Atlantic (Stevick et al. 2006). Humpback whales are common over the banks and nearshore areas of Newfoundland and Labrador from June through September, sometimes forming large aggregations to feed primarily on spawning capelin, sand lance, and krill. Humpbacks are the most commonly recorded mysticetes on the Grand Banks, with sightings occurring year-round (Tables 4.10 and 4.11), but predominantly during summer. In the Study Area they have been reported from March to December (Table 4.11).

Sei Whale

Sei whale distribution is poorly known, but it occurs in all oceans and appears to prefer mid latitude temperate waters (Jefferson et al. 2008). In the Canadian Atlantic, sei whales have no status under *SARA* and are considered *data deficient* by COSEWIC. Two stocks of sei whales are currently considered to occur in eastern Canada, on the Scotian Shelf and in the Labrador Sea, although there is limited evidence supporting the definition of the Labrador Sea stock (COSEWIC 2003a). The best estimate of abundance for the Nova Scotia stock of sei whales is 386 (CV=0.85; Waring et al. 2011). Satellite telemetry data showed that sei whales migrated from the southeast N Atlantic to the Labrador Sea, suggesting a productive feeding ground for sei whales in that area (Olsen et al. 2009; Prieto et al. 2010). Sei whales were regularly sighted in the Orphan Basin during the Chevron seismic monitoring programs in 2004 and 2005 (6 and 15 sightings, respectively; Moulton et al. 2005, 2006), and one sei whale sighting was recorded in Jeanne d'Arc Basin during the Statoil/Husky seismic monitoring program in 2008 (Abgrall et al. 2009). Based on the DFO cetacean sightings database, no sei whale sightings have been reported in the Study Area (Figure 4.26; Table 4.11). Sei whales appear to prefer offshore, pelagic, deep areas that are often associated with the shelf edge, and feed primarily on copepods (COSEWIC 2003a).

Minke Whale

The smallest of the baleen whales, minke whales have a cosmopolitan distribution and use polar, temperate, and tropical regions (Jefferson et al. 2008). Minke whales have no status under *SARA* and are considered *not at risk* in the Atlantic by COSEWIC. There are four populations recognized in the N Atlantic based on feeding areas, including the Canadian east coast, west Greenland, central N Atlantic, and NE Atlantic stocks (Donovan 1991). However, DNA data suggest that there may be as few as two different stocks in the N Atlantic (Anderwald et al. 2011). There are an estimated 8,987 individuals (CV=0.32) in the Canadian east coast stock, which ranges from the continental shelf of the northeastern United States to the eastern half of Davis Strait (Waring et al. 2011). Minke whales are common over the banks and coastal regions of Newfoundland and Labrador from early spring to fall, arriving as early as April and remaining as late as October and November. Within the Study Area, minke whales were the second most commonly recorded mysticetes in the DFO sightings database, with sightings predominantly recorded during May-October and December (Figure 4.26; Table 4.11). Thirty-one sightings of minke whales were recorded in Jeanne d'Arc Basin during the Statoil/Husky seismic monitoring program in 2008 (Abgrall et al. 2009). Minke whales tend to forage in continental shelf waters on small schooling fish like capelin and sand lance, making relatively short duration dives (Stewart and Leatherwood 1985).

4.5.1.3 Toothed Whales (Odontocetes)

Eleven species of toothed whales may occur in the Study Area (see Table 4.10), ranging from the largest of odontocetes, the sperm whale, to the one of the smallest, the harbour porpoise. Many of these species might be present in the Study Area only seasonally, but there is generally little information on the distribution and abundance of these species.

Sperm Whale

The sperm whale is most common in tropical and temperate waters, but is widely distributed and occurs from the edge of the polar pack ice to the equator (Jefferson et al. 2008). Sperm whales have no status under *SARA* and are designated *not at risk* by COSEWIC. They are currently considered a *low priority candidate* *species* by COSEWIC. Whitehead (2002) estimated a total of 13,190 sperm whales for the Iceland-Faroes area, the area north of it, and the east coast of N America combined, but Waring et al. (2011) reported an estimate of 4,804 animals (CV=0.38) for the N Atlantic. Since males tend to range further north (Whitehead 2003), any sperm whales encountered in the Study Area are more likely to be single males. However, mixed groups with females and juveniles have occasionally been observed in higher latitudes, and males can still form large same-sex aggregations (Whitehead and Weilgart 2000; Whitehead 2003). Sperm whales appear to prefer deep waters off the continental shelf, particularly areas with high secondary productivity, steep slopes, and canyons that may concentrate their primary prey of large-bodied squid (Jaquet and Whitehead 1996; Waring et al. 2001). Sperm whales are deep divers, routinely diving to hundreds of metres, sometimes to depths over 1,000 m and remaining submerged up to an hour (Whitehead and Weilgart 2000). Sperm whales were regularly sighted in the deep waters of Orphan Basin during the summers of 2004-2007 (Moulton et al. 2005, 2006; Abgrall et al. 2008b) but were not observed in the shallower waters of Jeanne d'Arc Basin in 2005-2008 (Lang et al. 2006; Lang and Moulton 2008; Abgrall et al. 2008a, 2009). There was one sighting of a sperm whale reported in the DFO cetacean sightings database that occurred in the Study Area in August (Figure 4.27; Table 4.11).

Northern Bottlenose Whale

The distribution of northern bottlenose whales is restricted to the N Atlantic, primarily in deep, offshore areas with two regions of concentration: The Gully and adjacent submarine canyons on the eastern Scotian Shelf, and Davis Strait off northern Labrador (Reeves et al. 1993). Throughout their range, northern bottlenose whales were harvested extensively during industrial whaling, which likely greatly reduced total numbers (COSEWIC 2002a; DFO 2011a). The total abundance of northern bottlenose whales in the N Atlantic is unknown, but ~163 individuals comprise the Scotian Shelf population (Whitehead and Wimmer 2005). There is no abundance estimate for Davis Strait, and few sightings were made during recent surveys (DFO 2011a). Although the Scotian Shelf population is designated *endangered* under Schedule 1 of *SARA* and by COSEWIC, the Davis Strait population has no status under *SARA* and is considered *special concern* by COSEWIC. The proposed recovery target for northern bottlenose whales is to increase population size and maintain the current distribution (DFO 2011a). Although the stock origin of northern bottlenose whales off Newfoundland and Labrador is unknown (DFO 2011a), it is expected that any whales in the Study Area would belong to the Davis Strait population. This population is considered to occur in that area year-round, with mating and births occurring between April and June, with a peak in April (COSEWIC 2002a; DFO 2011a). Occurring primarily in deep waters over canyons and the shelf edge, northern bottlenose whales routinely dive to depths over 800 m and remain submerged for over an hour (Hooker and Baird 1999). Foraging apparently occurs at depth, primarily on deep-water squid and fish (COSEWIC 2002a; DFO 2011a). Northern bottlenose whales may occur at low densities, but year-round, throughout the deep, offshore waters of the Orphan Basin and the Flemish Pass area. Based on the DFO cetacean sightings database, there have been no sightings of northern bottlenose whales in the Study Area (Figure 4.27; Table 4.11). This species is not expected to occur in the shelf waters of the Study Area.

Sowerby's Beaked Whale

The Sowerby's beaked whale is a small beaked whale found only in the N Atlantic, primarily in deep, offshore temperate to subarctic waters (COSEWIC 2006a). Designated as *special concern* (Schedule 1) under *SARA* and by COSEWIC, it is unclear if Sowerby's beaked whales are uncommon or poorly surveyed due to their deep-diving behaviour, small size, and offshore habitat. It is the most northerly distributed of the *Mesoplodon* spp., with all but one record occurring in the NW Atlantic between New England and Labrador (MacLeod 2000; MacLeod et al. 2006). There are an unknown number of Sowerby's beaked whales in the N Atlantic, but they are occasionally encountered offshore of eastern Newfoundland and Labrador. They are most often observed in deep water, along the shelf edge and slope. Based on analysis of stomach contents, their main prey type appears to be mid to deep water fish, with squid making up a small portion of the diet (MacLeod et al. 2003; Pereira et al. 2011). Despite the paucity of confirmed sightings, Sowerby's beaked whales may occur in low densities offshore of the Study Area. There were no records in the DFO cetacean sightings database for the Study Area (Figure 4.27; Table 4.11).

Killer Whale

Killer whales have a cosmopolitan distribution and occur in all oceans from polar pack ice to the equator, but they appear to be most common in coastal areas of higher latitudes (Jefferson et al. 2008). Killer whales offshore of eastern Newfoundland are likely members of the eastern Arctic or Atlantic populations, which were recently categorized as *special concern* by COSEWIC but have no status under *SARA*. An unknown number of killer whales occur in the NW Atlantic, but at least 63 individuals have been identified in Newfoundland and Labrador (Lawson et al. 2007). Killer whale movements are generally related to the distribution and abundance of their primary prey, which can include fish, other marine mammals, seabirds, and cephalopods (Ford et al. 2000). In Newfoundland and Labrador, killer whales have been observed approaching, attacking, and/or consuming other cetaceans, seals, seabirds and several species of fish; however, it is not known if there is any prey specialization among killer whale groups or individuals (Lawson et al. 2007). Stable isotope analysis of samples from seven killer whales suggests that killer whales off Newfoundland and Labrador mainly feed on fish, although one individual was found to have fed mostly on baleen whales (Matthews and Ferguson 2011). Observed group sizes range from one to 60 individuals, averaging 5.1 whales (Lawson et al. 2007). Although they occur at relatively low densities, killer whales are considered year-round residents of NL (Lien et al. 1988; Lawson et al. 2007). Sightings seem to be increasing in recent years, but it is unclear if this is due to increasing abundance or observer effort. There were six killer whale sightings in the Study Area (Figure 4.27); sightings in the DFO cetacean sightings database occurred sporadically from May through November (Table 4.11). Four sightings of killer whales were recorded in Jeanne d'Arc Basin during the Statoil/Husky seismic monitoring program in 2008 (Abgrall et al. 2009).

Long-finned Pilot Whale

The long-finned pilot whale is widespread in the N Atlantic and considered an abundant year-round resident of Newfoundland and Labrador (Nelson and Lien 1996). Long-finned pilot whales have no status under *SARA* and are considered *not at risk* by COSEWIC (Table 4.10). An estimated 12,619 individuals (CV=0.37) occur in the NW Atlantic (Waring et al. 2011). Long-finned pilot whales were tied with sperm whales for the most commonly recorded toothed whale in the DFO cetacean database, occurring in the Study Area in March, July and September (Figure 4.27; Table 4.11). Pilot whales studied near Nova Scotia had an average group size of 20 individuals, but groups ranged in size from 2 to 135 animals (Ottensmeyer and Whitehead 2003). Group sizes recorded in the Study Area ranged from 24 or more (Table 4.11). Pilot whale distribution is linked with areas of high relief, the shelf break, or slope, and they often exhibit inshore-offshore movements coinciding with movements of their prey (Jefferson et al. 2008).

Atlantic White-sided Dolphin

Atlantic white-sided dolphins occur in temperate and sub-Arctic regions of the N Atlantic (Jefferson et al. 2008). This species has no status under *SARA* and is considered *not at risk* by COSEWIC (Table 4.10). There may be at least three distinct stocks in the N Atlantic, including the Gulf of Maine, Gulf of St. Lawrence, and Labrador Sea areas, which combined are estimated to total ~63,368 animals (CV=0.27) in the NW Atlantic (Waring et al. 2011). However, their abundance off Newfoundland and Labrador is unknown. Atlantic white-sided dolphins occur regularly from spring to fall in offshore areas of Newfoundland, but less is known of their winter distribution. Sightings in the N Atlantic seem to coincide with the 100 m depth contour and areas of high relief. There were three sightings in the DFO cetacean sightings database in July-August in the Study Area (Figure 4.28; Table 4.11).

Short-beaked Common Dolphin

The short-beaked common dolphin is an oceanic species that is widely distributed in temperate to tropical waters of the Atlantic (and Pacific) Ocean (Jefferson et al. 2008). This species has no status under *SARA* and is considered *not at risk* by COSEWIC (Table 4.10). An estimated 120,743 individuals (CV=0.23) occur in the NW Atlantic (Waring et al. 2011). One sightings of this species was recorded in the Study Area in March in the DFO database (Figure 4.28; Table 4.11).

White-beaked Dolphin

White-beaked dolphins have a more northerly distribution than most dolphin species, occurring in cold temperate and sub-Arctic waters of the N Atlantic (Jefferson et al. 2008). This species has no status under *SARA* and is considered *not at risk* by COSEWIC (Table 4.10). Waring et al. (2011) estimated a total of 2,003 individuals (CV=0.94) in the NW Atlantic, but it is unknown how many occur off northeastern Newfoundland. Sightings of white-beaked dolphins are considered uncommon in the Study Area. There were five sightings recorded in the Study Area in shelf August based on the DFO cetacean database (Figure 4.28; Table 4.11). White-beaked dolphins are thought to remain at high latitudes year-round and are generally observed in continental shelf and slope areas, although they also occur in shallow coastal areas (Lien et al. 1997). They typically occur in groups of less than 30 animals, but group sizes up to the low hundreds have also been reported (Lien et al. 1997).

Common Bottlenose Dolphin

This species is very widely distributed and is found most commonly in coastal and continental shelf waters of tropical and temperate regions (Jefferson et al. 2008). Bottlenose dolphins have no status under *SARA* and are considered *not at risk* by COSEWIC (Table 4.10). An estimated 81,588 individuals (CV=0.17) occur in the NW Atlantic (Waring et al. 2011). It is considered rare in the Study Area; there were no sightings of bottlenose dolphins in the DFO cetacean database for the area (Figure 4.28; Table 4.11). However, one sighting of 15 individuals was made to the north of the Study Area in Orphan Basin in September 2005 during the Chevron seismic monitoring program (Moulton et al. 2006).

Striped Dolphin

The striped dolphin preferred habitat seems to be deep water along the edge and seaward of the continental shelf, particularly in areas with warm currents (Baird et al. 1993). This species has no status under *SARA* and is considered *not at risk* by COSEWIC (Table 4.10). Offshore waters of Newfoundland are thought to be at the northern limit of its range. An estimated 94,462 individuals (CV=0.40) occur in the NW Atlantic (Waring et al. 2011). Although this species could occur in the Study Area, there were no sightings of striped dolphins recorded in the Study Area based on the DFO cetacean database (Figure 4.28; Table 4.11).

Harbour Porpoise

Harbour porpoises occur in continental shelf regions of the northern hemisphere, including from Baffin Island to New England in the NW Atlantic (Jefferson et al. 2008). There are at least three populations recognized in the NW Atlantic: eastern Newfoundland and Labrador, the Gulf of St. Lawrence, and the Gulf of Maine/Bay of Fundy (Palka et al. 1996). There are currently no range-wide population estimates for eastern Canada, largely due to a lack of any estimates for the Newfoundland and Labrador sub-population (COSEWIC 2006b). In the Atlantic, harbour porpoises are considered *threatened* (Schedule 2) on *SARA* and of *special concern* by COSEWIC. Limited information is available regarding distribution and movements of harbour porpoises in NL. Data on harbour porpoises incidentally caught in groundfish gillnets suggest that they occur around the entire island of Newfoundland and in southern Labrador (Lawson et al. 2004). Bycatch data also indicate that harbour porpoises occur as far north as Nain, and in deep water (>2,000 m) in the Newfoundland Basin and Labrador Sea (Stenson and Reddin 1990 *in* COSEWIC 2006b; Stenson et al. 2011). In general, harbour porpoises are primarily observed over continental shelves and in areas with coastal fronts or upwelling that concentrate small schooling fish, although sightings also occasionally occur in deeper waters (Read 1999). Harbour porpoises typically occur singly or in small groups of up to three individuals, occasionally occurring in larger groups (COSEWIC 2006b). There were no harbour porpoise sightings in the Study Area in the DFO cetacean sightings database (Figure 4.28; Table 4.11).

4.5.1.4 True Seals (Phocids)

Three species of seals including harp, hooded, and perhaps grey seals occur in the Study Area (Table 4.10). None of these species are designated under *SARA* or by COSEWIC.

Harp Seal

Harp seals are widespread in the N Atlantic and Arctic Ocean, ranging from northern Hudson Bay and Baffin Island to the western N Atlantic and the Gulf of St. Lawrence; vagrants have been reported as far south as Virginia (Scheffer 1958; Rice 1998). The total NW Atlantic population is estimated at 6.85 million seals in 2009 (Hammill and Stenson 2010). Harp seals are common during late winter/early spring off NE Newfoundland and southern Labrador where they congregate to breed and pup on the pack ice; the majority of the NW Atlantic population uses this region while the small remainder uses the Gulf of St. Lawrence (Lavigne and Kovacs 1988). Large concentrations are found on the sea ice off north-eastern Newfoundland where they moult during April and May (DFO 2010c). During the summer, the majority of harp seals migrate to Arctic and Greenland waters, but some harp seals remain in southern waters (DFO 2010c). Offshore areas of southern Labrador and eastern Newfoundland appear to be major wintering areas (Stenson and Sjare 1997; Lacoste and Stenson 2000).

Hooded Seal

Hooded seals are found in the N Atlantic, ranging from Nova Scotia to the high Arctic in Canada (Jefferson et al. 2008). There are an estimated 593,500 individuals in the Canadian Atlantic, the majority of which (~535,800 animals) whelp and breed in the pack ice off NE Newfoundland/southern Labrador in late winter-early spring (Hammill and Stenson 2006). Four primary pupping and mating areas occur in the N Atlantic and include northeast Newfoundland/southern Labrador, the Gulf of St. Lawrence, Davis Strait, and NE Greenland (Jefferson et al. 2008). Hooded seals fitted with transmitters in the Gulf of St. Lawrence in March started their migration to Greenland in May by traveling through Cabot Strait or the Strait of Belle Isle (Bajzak et al. 2009). Hooded seals aggregate in eastern Greenland to moult during early summer before dispersing to Davis Strait or the Greenland Sea for late summer and fall (see Hammill and Stenson 2006). Less is known about winter distribution, although there have been winter sightings on the Grand Banks and in the Study Area; recent telemetry data suggests that hooded seals move along the continental shelf edge after leaving Greenland moulting grounds to Davis Strait and Baffin Bay followed by southerly migrations into the Labrador Sea during winter (Andersen et al. 2009).

Grey Seal

Grey seals inhabit cold temperate to sub-Arctic regions of the N Atlantic, ranging in Canada from Nova Scotia to Labrador (Jefferson et al. 2008). An estimated 348,900 grey seals occur in the NW Atlantic (Thomas et al. 2011). The majority breeds during the winter on Sable Island, south of Nova Scotia, but pups are also born in the Gulf of St. Lawrence, and along the coast of Nova Scotia (DFO 2010d). An unknown number range into eastern Newfoundland. Grey seals are considered rare in the Study Area.

4.5.2 Concluding Summary of Marine Mammals in Study Area

Three species each of baleen whales, large toothed whales, dolphins, and seals have been reported in the Study Area. However, another 17 species of marine mammals could occur there at least sporadically and in low numbers, including several *SARA* Schedule 1 species. Potential interactions between the Project and marine mammals are discussed in Section 5.6.4.

4.5.3 Sea Turtles

Sea turtles regularly occur on the Grand Banks and adjacent waters; three species could potentially occur within the Study Area. Table 4.12 provides a summary of habitat, occurrence and status in the Project Area for leatherback (*Dermochelys coriacea*), loggerhead (*Caretta caretta*), and Kemp's Ridley sea turtles (*Lepidochelys kempii*). Of these species, the leatherback sea turtle is designated as *endangered* under COSEWIC and *SARA* (see Section 4.6 on Species at Risk for profile) and the loggerhead sea turtle is designated as *endangered* under COSEWIC but has no status under the *SARA*. Kemp's Ridley sea turtle has no status under *SARA* and has not been considered by COSEWIC.

Table 4.12 Sea Turtles Potentially Occurring in the Study Area.

Species	Project Area		*SARA* Status[a]	COSEWIC Status[b]	Activities	Habitat
	Occurrence	Timing				
Leatherback sea turtle	Rare	June to Nov	Schedule 1: E	E	Feeding	Open water, bays
Loggerhead sea turtle	Very rare	Summer	NS	E	Feeding	Open water
Kemp's Ridley sea turtle	Very rare	Summer	NS	NC	Feeding	Open water

[a] Species designation under the *Species at Risk Act*; E = Endangered, NS = No Status.
[b] Species designation by COSEWIC; E = Endangered, NC = Not Considered.

4.5.3.1 Loggerhead Sea Turtle

Although the loggerhead sea turtle is the most common sea turtle in N American waters (Spotila 2004), it was recently designated as *endangered* by COSEWIC (2010). Its distribution is largely constrained by water temperature and it does not generally occur where the water temperature is below 15°C (O'Boyle 2001; Brazner and McMillan 2008), which limits its northern range. Loggerheads can migrate considerable distances between near-equatorial nesting areas and temperate foraging areas, some moving with the Gulf Stream into eastern Canada waters during the summer and fall (Hawkes et al. 2007). While foraging at sea, loggerheads likely consume gelatinous zooplankton and squid (Spotila 2004); there is no diet information available for Canadian waters (DFO 2010e). Information to date indicates a seasonal population of juvenile loggerheads in Atlantic Canada (COSEWIC 2010). Loggerheads may be seen in the open seas during migration and foraging (e.g., Mansfield et al. 2009). Although they have not been reported in the Study Area, juvenile loggerhead turtles tagged in U.S. waters were recorded just south of the Study Area (Mansfield et al. 2009). Most loggerhead records offshore Newfoundland have occurred in deeper waters south of the Grand Banks, and sightings have extended as far east as the Flemish Cap (Figures 6 and 7 *in* COSEWIC 2010).

4.5.3.2 Kemp's Ridley Sea Turtle

The Kemp's Ridley sea turtle is more restricted in distribution, primarily occurring only in the Gulf of Mexico, but some juveniles sometimes feed along the U.S. east coast and rarely range into eastern Canada waters (Spotila 2004). Movements outside of the Gulf of Mexico likely occur during summer and in coastal areas. Juveniles have been sighted along the southern Newfoundland coast, in St. Mary's Bay, and off of Nova Scotia (Ernst et al. 1994), but there are no known reports in the Study Area.

4.5.4 Concluding Summary of Sea Turtles in Study Area

Of the three species of sea turtle that could occur in the Study Area, leatherback sea turtles are the most likely species to occur there, albeit in small numbers. The leatherback is listed on *SARA* Schedule 1 as *endangered* and is described in the following section on Species at Risk. Potential interactions between the Project and sea turtles are discussed in Section 5.6.4.

4.6 Species at Risk

A number of species are listed under the *Species at Risk Act* (*SARA*) on Schedules 1 to 3. However, only those designated as *endangered* or *threatened* on Schedule 1 (the official list of wildlife Species at Risk in Canada) have immediate legal implications. Two cetacean species/populations, one sea turtle species, one seabird species, and three fish species/populations are legally protected under *SARA* and have potential to occur in the Study Area (Table 4.13). Atlantic wolffish, the Atlantic population of fin whales and Sowerby's beaked whale are designated as *special concern* on Schedule 1 (Table 4.13). Schedules 2 and 3 of *SARA* identify species that were designated "at risk" by COSEWIC prior to October 1999 and must be reassessed using revised criteria before they can be considered for addition to Schedule 1. Species that potentially occur in the Study Area and are considered as *endangered*, *threatened* or species of *special concern* by COSEWIC but which have not received specific legal protection (i.e., proscribed penalties and legal requirement for recovery strategies and plans) under *SARA* are also listed in Table 4.13. These species are included since they may be designated under *SARA* in the future.

Under *SARA*, a 'recovery strategy' and corresponding 'action plan' must be prepared for *endangered*, *threatened*, and *extirpated* species. A 'management plan' must be prepared for species considered as *special concern*. Final recovery strategies have been prepared for five of the seven species currently designated as either *endangered* or *threatened* under Schedule 1 and potentially occurring in the Study Area: (1) the leatherback sea turtle (ALTRT 2006); (2) the spotted wolffish (Kulka et al. 2008), (3) the northern wolffish (Kulka et al. 2008), (4) the blue whale (Beauchamp et al. 2009), and (5) the North Atlantic right whale (Brown et al. (2009). A management plan has also been prepared for the Atlantic wolffish (Kulka et al. 2008), currently designated as *special concern* on Schedule 1.

HMDC will monitor *SARA* issues through the Canadian Association of Petroleum Producers (CAPP), the law gazettes, the Internet and communication with DFO and EC, and will adaptively manage any issues that may arise in the future. The company will comply with relevant regulations pertaining to *SARA* Recovery Strategies and Action Plans.

HMDC acknowledges the rarity of the Species at Risk and will continue to exercise due caution to minimize effects on them during all of its operations. HMDC also acknowledges the possibility of other marine species being designated as *endangered* or *threatened* on Schedule 1 during the course of the Project. Due caution will also be extended to any other species added to Schedule 1 during the life of this Project.

Species profiles of fish, birds, marine mammals, and sea turtles listed on Schedule 1 as *endangered* or *threatened* and any related special or sensitive habitat in the Study Area are described in the following sections.

Table 4.13 *SARA*- and COSEWIC-listed Marine Species that May Occur in the Study Area.

SPECIES		*SARA*[a]			COSEWIC[b]		
Common Name	**Scientific Name**	**Endangered**	**Threatened**	**Special Concern**	**Endangered**	**Threatened**	**Special Concern**
Marine Mammals							
Blue whale (Atlantic population)	*Balaenoptera musculus*	Schedule 1			X		
North Atlantic right whale	*Eubalaena glacialis*	Schedule 1			X		
Fin whale (Atlantic population)	*Balaenoptera physalus*			Schedule 1			X
Sowerby's beaked whale	*Mesoplodon bidens*			Schedule 1			X
Harbour porpoise	*Phocoena phocoena*		Schedule 2				X
Humpback whale	*Megaptera novaeangliae*			Schedule 3			
Sea Turtles							
Leatherback sea turtle	*Dermochelys coriacea*	Schedule 1			X		
Loggerhead sea turtle	*Caretta caretta*				X		
Fishes							
White shark (Atlantic population)	*Carcharodon carcharias*	Schedule 1			X		
Northern wolffish	*Anarhichas denticulatus*		Schedule 1			X	
Spotted wolffish	*Anarhichas minor*		Schedule 1			X	
Atlantic wolffish	*Anarhichas lupus*			Schedule 1			X
Atlantic cod	*Gadus morhua*			Schedule 3			
Atlantic cod (NL[c] population)	*Gadus morhua*				X		
Cusk	*Brosme brosme*				X		
Porbeagle shark	*Lamna nasus*				X		
Roundnose grenadier	*Coryphaenoides rupestris*				X		
Shortfin mako shark	*Isurus oxyrinchus*					X	
Atlantic salmon (South Newfoundland population)	*Salmo salar*					X	
American plaice (NL population)	*Hippoglossoides platessoides*					X	
Acadian redfish (Atlantic population)	*Sebastes fasciatus*					X	
Deepwater redfish (Northern population)	*Sebastes mentella*					X	
Blue shark (Atlantic population)	*Prionace glauca*						X
Basking shark	*Cetorhinus maximus*						X

SPECIES		*SARA*[a]			COSEWIC[b]		
Common Name	**Scientific Name**	**Endangered**	**Threatened**	**Special Concern**	**Endangered**	**Threatened**	**Special Concern**
(Atlantic population)							
Roughhead grenadier	*Macrourus berglax*						X
Spiny dogfish (Atlantic population)	*Squalus acanthis*						X
Thorny skate	*Amblyraja radiata*						X
Seabirds							
Ivory Gull	*Pagophila eburnea*	Schedule 1			X		

Sources: [a]*SARA* website (http://www.sararegistry.gc.ca/default_e.cfm) (as of 1 March 2013); [b] COSEWIC website (http://www.cosewic.gc.ca/index.htm) (as of 1 March 2013); [c] Newfoundland and Labrador. COSEWIC candidate species not included in this table.

4.6.1 Profiles of *SARA*-listed Species

Only those marine species that are listed under Schedule 1 of the *SARA* as either *endangered* or *threatened* are profiled in this section.

4.6.1.1 Fish

For the Study Area, only three fish species are listed as either *endangered* or *threatened* under Schedule 1 of the *SARA*. Profiles of these three species are provided in this section. Some of the other fish species/populations that are included in Table 4.13 (i.e., Atlantic cod, roughhead grenadier, American plaice and redfishes) are profiled in Section 4.2.4 of the appended EA (LGL 2012).

White Shark

The white shark is known worldwide for its large size, predatory nature and reputation for attacking humans. Worldwide, this species is rare but does occur with some predictability in certain areas. The white shark is widely distributed in sub-polar to tropical seas of both hemispheres, but it is most frequently observed and captured in inshore waters over the continental shelves of the western N Atlantic, Mediterranean Sea, southern Africa, southern Australia, New Zealand, and the eastern N Pacific. The species is not found in cold polar waters (*SARA* website accessed January 2012).

Off Atlantic Canada, the white shark has been recorded from the NE Newfoundland Shelf, the Strait of Belle Isle, the St. Pierre Bank, Sable Island Bank, the Forchu Misaine Bank, in St. Margaret's Bay, off Cape La Have, in Passamaquoddy Bay, in the Bay of Fundy, in the Northumberland Strait, and in the Laurentian Channel as far inland as the Portneuf River Estuary. The species is highly mobile, and individuals in Atlantic Canada are likely seasonal migrants belonging to a widespread NW Atlantic population. It occurs in both inshore and offshore waters, ranging in depth from just below the surface to just above the bottom, down to a depth of at least 1,280 m (*SARA* website accessed January 2012).

In reproduction, the female produces eggs which remain in her body until they are ready to hatch. When the young emerge, they are born live. Gestation period is unknown, but may be about 14 months. Litter size varies, with an average of seven pups. Length at birth is assumed to be between 109 and 165 cm.

Possible white shark pupping areas on the west and east coasts of N America include off southern California and the Mid-Atlantic Bight, respectively (*SARA* website accessed January 2012).

White sharks are top level predators with a wide prey base feeding primarily on many types of fish, and marine mammals, as well as squid, molluscs, crustaceans, marine birds, and reptiles. There has, however, been one recorded occurrence of an orca preying on a white shark (*SARA* website accessed January 2012).

White sharks were not caught in DFO RV surveys conducted in the Study Area during 2007 to 2011.

Northern Wolffish

The northern wolffish is a deepwater fish of cold northern seas that has been caught at depths ranging from 38 to 1,504 m, with observed densest concentrations between 500 and 1,000 m at water temperatures of 2 to 5°C. During 1980-1984, this species was most concentrated on the NE Newfoundland and Labrador shelf and banks, the southwest and southeast slopes of the Grand Banks, and along the Laurentian Channel. Between 1995 and 2003, the area occupied and density within the area was considerably reduced. These wolffish are known to inhabit a wide range of bottom substrate types, including mud, sand, pebbles, small rock and hard bottom, with highest concentrations observed over sand and shell hash in the fall, and coarse sand in the spring. Unlike other wolffish species, both juvenile and adult stages of this species have been found a considerable distance above the bottom, as indicated by diet (Kulka et al. 2008).

Prey of northern wolffish are primarily bathypelagic (>200 m depth) biota such as ctenophores and medusa, but also include mesopelagic biota (<200 m depth) and benthic invertebrates. Pelagic fish represent the largest percentage of stomach contents on the basis of volume. Tagging studies have suggested limited migratory behaviour by these wolffish. Northern wolffish typically spawn late in the year on rocky bottom. Cohesive masses of fertilized eggs are laid in crevices but are unattached to the substrate. Pelagic larvae hatch after an undetermined egg incubation time, and typically feed on crustaceans, fish larvae and fish eggs (Kulka et al. 2008).

During DFO RV surveys conducted in the Study Area in 2007-2011, one northern wolffish was caught, during a spring survey (2007). This single northern wolffish catch was located in the southeastern portion of the Study Area (see Figure 4.6 in Section 4.2.5 of this EA).

Spotted Wolffish

The life history of the spotted wolffish is very similar to that of the northern wolffish except that it seldom inhabits the deepest areas used by the northern wolffish. Although spotted wolffish have been caught at depths ranging from 56 to 1,046 m, the observed densest concentrations occur between 200 and 750 m at water temperatures of 1.5 to 5°C. During 1980-1984, spotted wolffish were most concentrated on the northeast Newfoundland and Labrador shelf and banks, the southwest and southeast slopes of the Grand Banks, along the Laurentian Channel, and in the Gulf of St. Lawrence. Between 1995 and 2003, the area occupied and density within the area was considerably reduced. As with northern wolffish, spotted wolffish also inhabit a wide range of bottom substrate types, including mud, sand, pebbles, small rock and hard bottom, with highest concentrations observed over sand and shell hash in the fall, and coarse sand in the spring (Kulka et al. 2008).

Prey of spotted wolffish are primarily benthic (>75%), typically including echinoderms, crustaceans, and molluscs associated with both sandy and hard bottom substrates. Fish also constitutes part of the spotted wolffish diet (<25%). Tagging studies indicate the spotted wolffish migrations are local and limited. Spotted wolfish reproduction includes internal fertilization. In Newfoundland and Labrador waters, this typically occurs in July and August on stony bottom. Cohesive masses of eggs are deposited in crevices, remaining unattached to the substrate. After an undetermined incubation time, pelagic larvae hatch and start to feed on crustaceans, fish larvae and fish eggs within a few days of hatching (Kulka et al. 2008).

During DFO RV surveys conducted in the Study Area in 2007-2011, two spotted wolffish were caught, during both spring (2007) and fall (2008) survey times. Both spotted wolffish catches were in the northeastern portion of the Study Area (see Figure 4.6 in Section 4.2.5 of this EA).

4.6.1.2 Seabirds

The Ivory Gull is the only seabird listed as either *endangered* or *threatened* under Schedule 1 of the *SARA* that could potentially occur in the Study Area.

Ivory Gull

The Ivory Gull has a circumpolar breeding distribution and is associated with pack ice throughout the year. In Canada, the Ivory Gull breeds exclusively in Nunavut. Breeding colonies occur on southeastern Ellesmere Island, eastern Devon Island and northern Baffin Island. In Canadian waters, Ivory Gulls occur among the pack ice of the Davis Strait, the Labrador Sea, Strait of Belle Isle, and northern Gulf of St. Lawrence. The Ivory Gull is listed as *endangered* on Schedule 1 of *SARA*, designated as *endangered* by COSEWIC, and considered *near threatened* on the Red List of Threatened Species (Table 4.14; IUCN 2009).

In comparison to most gulls, Ivory Gulls have reduced reproductive output, in that they usually only lay one to two eggs (Haney and MacDonald 1995). They depart from colonies immediately following breeding (~mid-August) for offshore foraging areas associated with the ice edge of permanent, multi-year pack ice. At sea, the Ivory Gull is a surface-feeder where its main prey includes small fish and macrozooplankton. It is also an opportunistic scavenger of carrion found on ice and marine mammals killed by large predators (Haney and MacDonald 1995). Currently, the Canadian breeding population is estimated at 500 to 600 individuals (COSEWIC 2006c). Surveys conducted during 2002 to 2005 indicate a total decline of 80% and an annual decline of 8.4% over the last 18 years. If this decline continues at a steady rate, the breeding population will decrease by a further 62% over the next decade, to approximately 190 individuals. A survey conducted in March 2004 within the pack ice off the coast of Newfoundland and Labrador observed a substantial decrease in Ivory Gull observations as compared to 1978 results (COSEWIC 2006c). The numbers of Ivory Gulls observed per 10-minute watch period were 0.69 and

0.02 individuals for 1978 and 2004, respectively (COSEWIC 2006c). Considering that changes to the breeding environment have been minimal, causes for the observed decline are likely related to factors occurring during migration or on the wintering grounds (Stenhouse 2004). During heavy ice winters, the Ivory Gull may occasionally reach the southern Orphan Basin and northern Grand Banks near the Study Area, late in the winter or early spring when sea ice reaches the maximum southern extremity. The thirty-year median of ice concentration shows ice extending into the northern edge of the Grand Banks east to 48°W during late February to late March. The total of 21 Ivory Gulls reported from drill platforms on the NE Grand Banks during 1999 to 2002, seems improbable, especially considering that most sightings were reported during ice-free periods. Ivory Gull is reported regularly along the coast of Labrador and the tip of the Great Northern Peninsula of Newfoundland in winter. There are occasional sightings of Ivory Gulls south along the east coast of Newfoundland. It is expected to be very rare in the Study Area.

4.6.1.3 Marine Mammals

Only two marine mammal species are listed as either *endangered* or *threatened* under Schedule 1 of the *SARA*. Profiles of these two species are provided in this section. Some of the other marine mammal species/populations that are included in Table 4.13 are profiled in Section 4.5.

Blue Whale

The blue whale has a cosmopolitan distribution, but tends to be more frequently observed in deep water than in coastal environments (Jefferson et al. 2008). Blue whales became severely depleted during industrial whaling and still occur at relatively low densities in the N Atlantic. The Atlantic population of blue whales is considered *endangered* on *SARA* Schedule 1, and by COSEWIC. A recently finalized recovery strategy for blue whales in the NW Atlantic is available with a long-term recovery goal to reach a total of 1,000 mature individuals through the achievement of three 5-year objectives (Beauchamp et al. 2009). No critical habitat was identified. Blue whales likely number in the low hundreds in the NW Atlantic and have been sighted only sporadically off the NE coast of Newfoundland (COSEWIC 2002b). There were no sightings of blue whales in the Study Area recorded in the DFO cetacean sightings database (Figure 4.26; Table 4.11). During a CSEM monitoring program in 2007, there were two sightings of blues whales in Orphan Basin north of the Study Area, both occurred in August and in water depths of 2,366 m and 2,551 m (Abgrall et al. 2008b). Blue whales feed primarily on krill and their distribution is often associated with areas of upwelling or shelf edges where their prey may concentrate. Blue whales are considered rare in the Study Area.

North Atlantic Right Whale

Research results suggest the existence of six major habitats or congregation areas for NW Atlantic right whales: the coastal waters of the southeastern United States; the Great South Channel; Georges Bank/Gulf of Maine; Cape Cod and Massachusetts Bays; the Bay of Fundy; and the Scotian Shelf (COSEWIC 2003b; Waring et al. 2009). The North Atlantic right whale is currently listed as *endangered* on Schedule 1 of *SARA* and by COSEWIC (Table 4.14; COSEWIC 2003b). Waring et al. (2009) suggest that the current best estimate of the minimum population size is 325 individuals. This species is considered extremely rare in the

Study Area. However, there have been some relatively recent sightings of small numbers of right whales off Iceland and Norway, and it is possible (although highly unlikely) that this species may occur in the Study Area. There are no sightings of this species listed in the DFO database (Figure 4.26; Table 4.11).

4.6.1.4 Sea Turtles

The leatherback turtle is the only sea turtle listed as either *endangered* or *threatened* under Schedule 1 of the *SARA* that could potentially occur in the Study Area. The other sea turtle species included in Table 4.13, the loggerhead, is profiled in Section 4.5.

Leatherback Turtle

The largest and most widely ranging of sea turtles, the leatherback sea turtle ranges from sub-polar and cool temperate foraging grounds to tropical and sub-tropical nesting areas in all of the world's oceans (Spotila 2004). There are an estimated 26,000 to 43,000 individuals globally (Dutton et al. 1999), but there is no current estimate of the number of leatherbacks using eastern Canada waters. Leatherback sea turtle is designated as *endangered* (Schedule 1) on *SARA* and by COSEWIC. In the recovery strategy for leatherback sea turtle in the Canadian Atlantic Ocean, the recovery goal is to "achieve the long-term viability of the leatherback turtle populations frequenting Atlantic Canadian waters" via six supporting objectives (ALTRT 2006). No critical habitat was designated in ALTRT (2006). Adult leatherbacks are considered regular summer visitors to eastern Newfoundland, with the northernmost records occurring off Labrador at nearly 54ºN; observations around Newfoundland and Labrador occur from June to November, but are most common in August and September (Goff and Lien 1988). Exhibiting wide-ranging oceanic movements, leatherbacks occur in pelagic regions of the N Atlantic to forage on gelatinous zooplankton (Hays et al. 2006). Most leatherbacks that occur in Atlantic Canadian waters are large sub-adults and adults, with a female-biased sex ratio among mature turtles (James et al. 2007). These turtles represent nesting populations in a minimum of 10 countries in South and Central America, and the Caribbean (James et al. 2007). DFO Newfoundland Region maintains a database of leatherback turtle sightings and entanglements in Newfoundland and Labrador (J. Lawson, DFO Research Scientist, pers. comm.); one leatherback turtle observation was recorded just southwest of the Study Area in August 2007 (LGL 2012). There was also a sighting of a leatherback turtle made in Jeanne d'Arc Basin during the Statoil/Husky seismic monitoring program in 2008 (Abgrall et al. 2009).

4.6.2 Concluding Summary of Species at Risk in Study Area

There are no known concentrations or critical habitat of *SARA* species in the HMDC Study Area. Seven *SARA* Schedule 1 species that may occur in the Study Area include:

- White shark—listed as *endangered*. We are aware of no reported sightings in the Study Area;
- Northern wolfish—listed as *threatened*. Mostly found in deeper water (500-1,000 m) than the Study Area (<200m);

- Spotted wolffish—listed as *threatened*. Mostly found in deeper water (200-750 m) than the Study Area;
- Blue whale—listed as *endangered*. Generally prefers deeper water than the Study Area and no sightings there in the DFO database;
- North Atlantic Right Whale—listed as *endangered*. Mostly found well to the south of the Study Area and no sightings in the DFO data base there;
- Leatherback turtle—listed as *endangered*;
- Ivory Gull—listed as endangered. We are aware of no credible sightings in the Study Area and they would be very rare there in the absence of ice.

Interactions with *SARA* species are discussed in Section 5.6.5.

4.7 Potentially Sensitive Areas

There are a variety of regulatory frameworks that deal directly or indirectly with sensitive areas in Newfoundland and Labrador. Marine fisheries are administered by DFO through the federal *Fisheries Act*. Management of marine mammals, including species at risk, is controlled by DFO under the *Marine Mammals Regulations* of the *Fisheries Act*. All species at risk are administered under the *Species at Risk Act* (2002) which lists the species and provides measures to protect those species. The *Oceans Act* Marine Protected Areas are established by DFO to protect and conserve important fish and marine mammal habitats, *endangered* marine species, unique features and areas of high biological productivity or biodiversity. Migratory birds, including species at risk, are solely or jointly managed (depending on the species) between Canada and the US through the CWS branch of Environment Canada. Current legislation and agreements regarding migratory birds include the Convention for the Protection of Migratory Birds (1916), *Migratory Birds Convention Act* and the North American Waterfowl Management Plan (CWS and United States Fish and Wildlife Services (USFWS) 1986; CWS, USFWS, and SEMARNAP 1998). Waterfowl are managed according to "flyways" denoting wintering and summering habitat connected by international migration corridors.

4.7.1 Special Areas

There are no designated special areas in the Project or Study areas. The Project Area is over 50 km from parts (the two Ecologically and Biologically Significant Areas (EBSAs) of Virgin Rocks and NE Newfoundland Shelf and Slope) of the Placentia Bay Grand Banks (PBGB) Large Ocean Management Area (LOMA), one of the marine regions established to form the planning basis for implementation of integrated-management plans by DFO (Figure 4.29). The LOMAs and EBSAs are described in detail in Section 4.7.1 of LGL (2012) (appended).

In April 2003, DFO announced that special conservation measures were required for the Bonavista Corridor, including the Bonavista Cod Box, located >188 km northwest of the Study Area (Figure 4.29).

In 2008 and 2009, the NAFO Scientific Council identified areas of significant coral and sponge concentrations within the NAFO Regulatory Area. Based on these identifications, areas for closure to fishing with bottom contact gear were delineated. Figure 4.30 shows the locations of these 11 areas, none of which occur either entirely or partially within the proposed HMDC Study Area. Two other closure areas occur at the boundary of the Study Area. Implementation date of the closures started on 1 January 2010 (NAFO website). Given the nature of seismic survey equipment, with the possible exception of OBC (if used), there should be no interaction with corals and sponges.

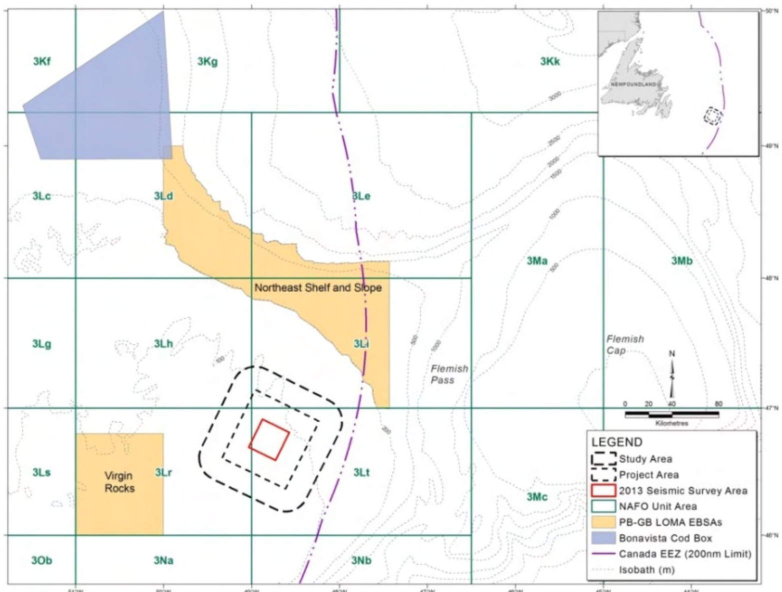


Figure 4.29 Locations of the PBGB LOMA EBSAs and Bonavista Cod Box Relative to the HMDC Project and Study Areas.

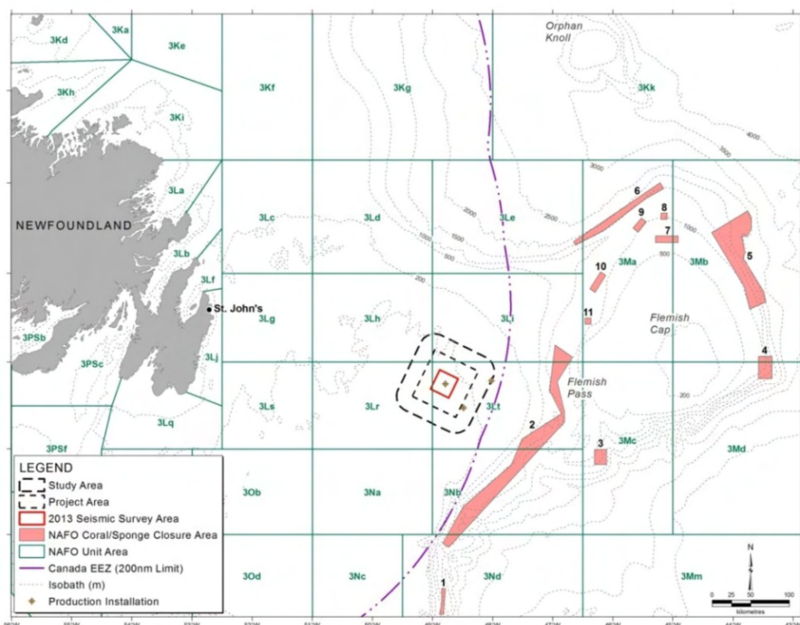


Figure 4.30 Locations of NAFO Coral/Sponge Closure Areas Relative to HMDC's Study and Project Areas.

4.7.2 Concluding Summary of Special Areas in Study Area

As there are no known special or sensitive areas in the HMDC Study Area or immediately adjacent to it, special areas are not discussed further in this EA.