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# 5.0 EFFECTS ASSESSMENT METHODS

The methods used to assess potential environmental effects of the WREP are described in this Chapter.

## 5.1 Types of Environmental Effects

The types of effects considered in this environmental assessment are:

- The environmental effects of the WREP on the environment
- The effects of the environment on the WREP

Environmental effects are defined in Section 2(1) of CEAA as:

> a) any change that the project may cause in the environment, including any change it may cause to a listed wildlife species, its critical habitat or the residences of individuals of that species, as those terms are defined in subsection 2(1) of the *Species at Risk Act*,
>
> b) any effect of any change referred to in paragraph (a) on
>
> (i) health and socio-economic conditions,
>
> (ii) physical and cultural heritage,
>
> (iii) the current use of lands and resources for traditional purposes by aboriginal persons, or
>
> (iv) any structure, site or thing that is of historical, archaeological, paleontological or architectural significance, or
>
> c) any change to the project that may be caused by the environment,
>
> whether any such change or effect occurs within or outside Canada.

An environmental effect is similarly defined in section 2(o) of the EPA as:

> a change in the present or future environment that would result from an undertaking;

The potential environmental effects of each phase of the WREP (Sections 2.6 to 2.15) have been evaluated for each of the selected Valued Ecosystem Components (VECs). The environmental effects analyses also include both direct and indirect effects. Cumulative environmental effects have been evaluated in accordance with the CEAA and its guidance documentation (Hegmann et al. 1999), as well as the EPA and its guidance documentation. As required by the Development Plan Guidelines (C-NLOPB 2006) and the CEAA, residual environmental effects, or those environmental effects remaining after the application of mitigation measures, are presented.

Socio-economic effects resulting from environmental effects are described herein for commercial fisheries.

The analyses of the effects of the environment, particularly the physical environment, on the WREP include the effects of oceanographic and climatic conditions, among other environmental factors, and the subsequent implications for WREP design.

## 5.2 Scope of the Environmental Assessment

The scope of the WREP includes surveys (geophysical, geotechnical, geohazard, VSP and environmental), construction, installation, commissioning, development drilling, operations and maintenance and decommissioning of the WHP and/or drilling centres and associated facilities.

The subsea development option, which includes the subsea drill centre, flowlines and the activities associated with that development option, has previously been assessed under the *Husky White Rose Development Project: New Drill Centre Construction and Operations Program Environmental Assessment Addendum* (LGL 2007a). The construction of the subsea drill centre for the West White Rose pool was one of the potential subsea drill centres assessed and compensated for in 2007. A fish habitat compensation agreement (Authorization No. 07-01-002) has been in place with DFO since 2007 to compensate for the excavation of up to five subsea drill centres sites, of which only two have been excavated to date (the NADC and SWRX).

The WHP development option will consist of construction of a CGS in Argentia, NL. The construction site is a brownfield location on the northeast portion of the Northside Peninsula, bordering Argentia Harbour. The topsides will be constructed at an existing fabrication facility and therefore are not considered part of this environmental assessment. The CGS will be constructed in the dry, in a de-watered graving dock. Upon completion of the CGS, the CGS will be floated to a deep-water mating site in Placentia Bay, where it will be mated with the topsides structure. The WHP will then be towed to and installed in the western portion of the White Rose field and tied back to the *SeaRose FPSO*. New subsea drill centres, using subsea drill centre technology, may be developed in conjunction with the WHP development option. The project to be assessed consists of the following components:

On-land and nearshore WREP components are related solely to the WHP development option. There will be no nearshore components associated with the subsea drill centre development option. Husky has identified the following key WREP-related activities in the Nearshore Project Area:

- Graving dock excavation. Associated activities may include graving dock side stability/reinforcement (e.g., sheet piles, bund wall, etc.) and site grading and levelling
- Site dewatering and disposal
- Use of The Pond for disposal of excavated soil material and dredged material
- CGS construction at the graving dock
- shoreline dredging
- Tow-out channel dredging

- Tow-out to the deep-water mating site
- Topsides mating and commissioning at the deep-water mating site
- Tow-out of the WHP to the White Rose field.
- Operation of support craft associated with the above activities, including but not limited to heavy lift vessels, construction vessels, supply vessels, helicopters, tow vessels and barges
- Associated surveys for all above activities, including: remotely-operated vehicle (ROV) surveys, diving programs, geotechnical programs, geophysical programs, geological programs, environmental surveys.

Husky has identified the following key WREP-related activities in the Offshore Project Area:

- Offshore site and clearance surveys
- Installation of the WHP/subsea drill centre at its offshore location (may include site preparation activities such as dredging, seafloor levelling, offshore solid ballasting, piles and mooring points,
- Subsea equipment and flowline installation to tieback to the *SeaRose FPSO*
- Flowline berm protection (i.e., rock piles and/or concrete mats)
- WHP/subsea drill centre commissioning
- Operation, production, maintenance, modifications, decommissioning and abandonment of the WHP/subsea drill centre
- Drilling operations (exploration and development drilling), from the WHP of up to 40 wells, or 16 wells from a mobile offshore drilling unit (MODU) through a subsea drill centre, including well testing, well completions and workovers and data logging
- Supporting activities, including diving programs, and operation of support craft associated with the above activities, including but not limited to dredging vessels, light intervention vessels, construction vessels, MODUs, WHP supply and standby vessels and helicopters
- Associated surveys for all above activities, including: ROV surveys, diving programs, geotechnical programs, geophysical programs (e.g., VSPs, geohazard/wellsite surveys), geological programs, environmental surveys (including iceberg surveys)
- Potential future activities, including excavation of up to two additional subsea drill centres and installation of infrastructure, including any associated surveys (e.g., VSP, geohazard/wellsite).

### 5.2.1 Factors to be Considered

This environmental assessment includes a consideration of the following factors:

(a) Purpose of and need for the project

(b) Alternatives to the project

(c) Alternative means of carrying out the project that are technically and economically feasible and the environmental effects of any such alternative means

(d) the environmental effects of the project, including those due to malfunctions or accidents that may occur in connection with the project and any cumulative environmental effects that are likely to result from the project in combination with other projects or activities that have been or will be carried out, and the significance of these effects

(e) measures, including contingency and compensation measures as appropriate, that are technically and economically feasible and that would mitigate any significant adverse environmental effects of the project

(f) the significance of adverse environmental effects following the employment of mitigative measures

(g) The need for, and the requirements of, any follow-up program in respect of the project

(h) The capacity of renewable resources that are likely to be significantly affected by the project to meet the needs of the present and those of the future

(i) Report on consultation undertaken by Husky with interested parties who may be affected by the project and comments that are received from interested parties and the general public respecting any matters described above.

### 5.2.2 Scope of the Factors to be Considered

This environmental assessment addresses the CEAA and EPA factors listed above, as well as the matters listed in the appropriate sections of the Development Plan Guidelines (C-NLOPB 2006), the Scoping Document (C-NLOPB 2012a), and issues and concerns identified and documented by Husky through public consultation, including consultation with regulators and key stakeholders.

With regard to the current use of land and resources by Aboriginal persons, as per the definition of environmental effect, these factors were not considered in the environmental assessment. The WREP nearshore and offshore Study Areas and Project Areas have not historically been identified as those with Aboriginal use or title. There are no land claims before the Government of Canada or the Government of Newfoundland and Labrador for these areas. Based on this assessment, there is no interaction with current use of land and resources by Aboriginal persons, and therefore, no effect.

The discussion of biological and physiological environments will consider the data available for the Project and Study Areas. Where data gaps exist, the environmental assessment will clearly identify the lack of available data.

## 5.3 Environmental Assessment Methods

This section describes the methodological approach used in the environmental assessment and scoping for the WREP. The methodological framework is based on Barnes et al. (2000) and guidance documents produced by the Canadian Environmental Assessment Agency (CEA Agency) (1994a, 1994b, 2007). The following discussion provides an overview of the approach as it was applied to the WREP.

### 5.3.1 Step 1 – Scoping Issues and Selecting Valued Environmental Components

To focus or "scope" an environmental assessment, it is standard practice to identify a concise list of those components of the environment that are "valued" (socially, economically, culturally and/or scientifically), and of interest when considering the potential environmental effects of a project. In this process, information from public, regulatory and stakeholder consultation is summarized and synthesized into a list of overall issues and concerns. The Scoping Document (C-NLOPB 2012a) for the environmental assessment of the WREP provides the scope of the WREP, the scope of the assessment and the factors to be considered in the assessment. It reflects the comprehensive public and regulatory consultation process and provides guidance for the scope of the environmental assessment.

The WREP study team conducted public and stakeholder consultation in preparation of the environmental assessment. A summary of the consultation process is provided in Chapter 6. Where those issues are related to the scope of the WREP under environmental assessment, they have been addressed in this environmental assessment. For the convenience of readers and reviewers, the location where each issue is addressed in the environmental assessment is provided in Chapter 6.

Each VEC has been selected based on the issues that have been raised throughout the consultation process and as reflected in the Scoping Document and based on the professional experience of the study team. The selected VECs comprehensively reflect the issues, while providing a focus for the environmental assessment so that environmental effects can be meaningfully evaluated. The VECs included in the assessment are as follows.

**Air Quality**

Air Quality has been selected as a VEC for the following reasons:

- Air quality has an intrinsic or natural value, in that it is needed to sustain life and maintain the health and well-being of humans, wildlife, vegetation and other biota
- The potential for interaction with WREP activities
- If not properly managed, release of air contaminants to the atmosphere from the WREP may be harmful to human health and other biological resources in the vicinity of the WREP

- GHG emissions can accumulate in the atmosphere and are believed to be a major factor in climate change.

**Fish and Fish Habitat**

Fish and Fish Habitat has been selected as a VEC for the following reasons:

- Provisions of the *Fisheries Act* (R.S.C. 1985, c. F-14) pertaining to the harmful alteration, disruption or destruction of fish habitat require that environmental effects to fish and fish habitat be fully evaluated
- The potential for interaction with the WREP
- Marine fish and fish habitat are ecologically, recreationally and commercially important.

The Fish and Fish Habitat VEC includes marine benthos, plankton, water, sediment and fish and shellfish that are not considered at risk species by SARA or the Committee on the Status of Endangered Wildlife in Canada (COSEWIC). These components are intrinsically related to one another and together they allow a holistic approach to the assessment of potential environmental effects in the marine environment.

**Marine Birds**

Marine Birds have been selected as a VEC for the following reasons:

- They are abundant in the Nearshore and Offshore Study Areas
- The potential for interaction with WREP activities
- They are sensitive to oiling
- They are protected under the *Migratory Birds Convention Act, 1994* (S.C. 1994, c. 22) (migratory birds)
- As high-level predators, marine birds can play an ecologically important role in indicating the health of the marine ecosystem.

The Marine Birds VEC includes species of birds that typically use the nearshore/coastal marine and offshore environments that are not considered at risk species by SARA or COSEWIC. The groups considered under the Marine Birds VEC are seaducks (eiders and other duck species), cormorants, fulmars and other shearwaters, storm-petrels, gannets, phalaropes, larids (jaegers, skuas, gulls and terns) and alcids (e.g., dovekie, murres and puffins).

### Marine Mammals and Sea Turtles

Marine Mammals and Sea Turtles have been selected as a VEC for the following reasons:

- Populations of marine mammals and some sea turtle species migrate to the Offshore Study Area primarily to forage for food
- The potential for interaction with WREP activities
- As high-level predators, marine mammals and sea turtles play an ecologically important role by serving as indicators of changes in the marine ecosystem.

The Marine Mammal and Sea Turtle VEC includes cetaceans (whales, dolphins and porpoises), pinnipeds (seals) and sea turtles that are not considered at risk species by SARA or COSEWIC.

### Species at Risk

Species at Risk has been selected as a VEC for the following reasons:

- Species at Risk and their habitat are legally protected under federal legislation (SARA) and/or have been assessed by COSEWIC
- Due to their nature, Species at Risk can be more vulnerable to human-induced changes in their habitat or population levels and therefore require special consideration with respect to mitigation strategies
- Several federally-listed and/or COSEWIC-assessed marine Species at Risk could potentially occur in the Study Areas.

### Commercial Fisheries

Commercial fisheries have been selected as a VEC due to their cultural and economic importance, and the potential for interactions with the WREP.

### Sensitive or Special Areas

Sensitive or Special Areas has been selected as a VEC primarily due to stakeholder and regulatory concerns about the vulnerability of sensitive or special areas to potential WREP-related environmental effects, including potential exposure to contaminants from operational discharges and accidental spills from the WREP.

Sensitive or Special Areas are often associated with rare or unique marine habitat features, habitat that supports sensitive life stages of valued marine resources, and/or critical habitat for species of special conservation status. As per the Scoping Document (C-NLOPB 2012a), Sensitive or Special Areas include:

- Important or essential habitat to support marine resources

- Areas identified through the Placentia Bay-Grand Banks Large Ocean Management Area (PBGB-LOMA) Integrated Management Plan Initiative.

In the nearshore, these Sensitive or Special Areas include capelin beaches, eelgrass beds, salt marshes and the Cape St. Mary's Seabird Ecological Reserve. Offshore Sensitive or Special Areas include the Northwest Atlantic Fisheries Organization (NAFO) proposed Southeast Shoal Vulnerable Marine Ecosystem (VME) and various canyon areas and seamount and knoll VMEs. In addition, Ecologically and Biologically Significant Areas (EBSAs) identified by DFO occur within the Offshore Study Area (i.e., Northeast Shelf and Slope; Virgin Rocks; Lily Canyon-Carson Canyon and Southeast Shoal and Tail of the Banks). The Bonavista Cod Box is also within the Offshore Study Area.

### 5.3.2 Step 2 – Establishing Boundaries

An important aspect of an environmental assessment is determining boundaries, as they help focus the scope of the environmental assessment and allow for a meaningful analysis of potential environmental effects associated with the WREP. The setting of boundaries also helps in determining the most effective use of available study resources.

#### 5.3.2.1 Spatial Boundaries

The spatial boundaries as described below have been defined based on predicted WREP-environment interactions, modelling results and a consideration of VEC-specific boundaries, as per the CEA Agency Operational Statement (2003b). In accordance with the Scoping Document, the following spatial boundaries have been used in this environmental assessment:

**Nearshore (applies to Wellhead Platform option only)**

- Project Area: The on-land and marine area within Port of Argentia Harbour and the deep-water topsides mating site in which all WREP activities and works are to occur. It is defined as the area within which WREP activities will occur (see Figure 5-1).

- Affected Area: The area which could potentially be affected by WREP works or activities within or beyond the Project Area. The Affected Area boundary varies with the component being considered (e.g., air emissions Affected Area and the fish and fish habitat Affected Area), the nature of the VEC and the sensitivity of different species within the VEC. The Affected Areas for several WREP activities have been determined by modelling (see the following supporting documents: Noise Modelling (JASCO 2012); Dredging Modelling (AMEC 2012a); Drill Cuttings Deposition Modelling (AMEC 2012b); SBM Whole Mud Spill Modelling (AMEC 2012c); and Oil Spill Modelling (SL Ross 2012)).

- Study Area: The Nearshore Study Area (see Figure 5-2) has been defined by modelling WREP-environment interactions, such as accidental events, and considers all WREP-environment interactions. This is the area within which significance will be determined for nearshore activities and it represents a compilation of the various nearshore Affected Areas for all WREP works, activities and accidental events.

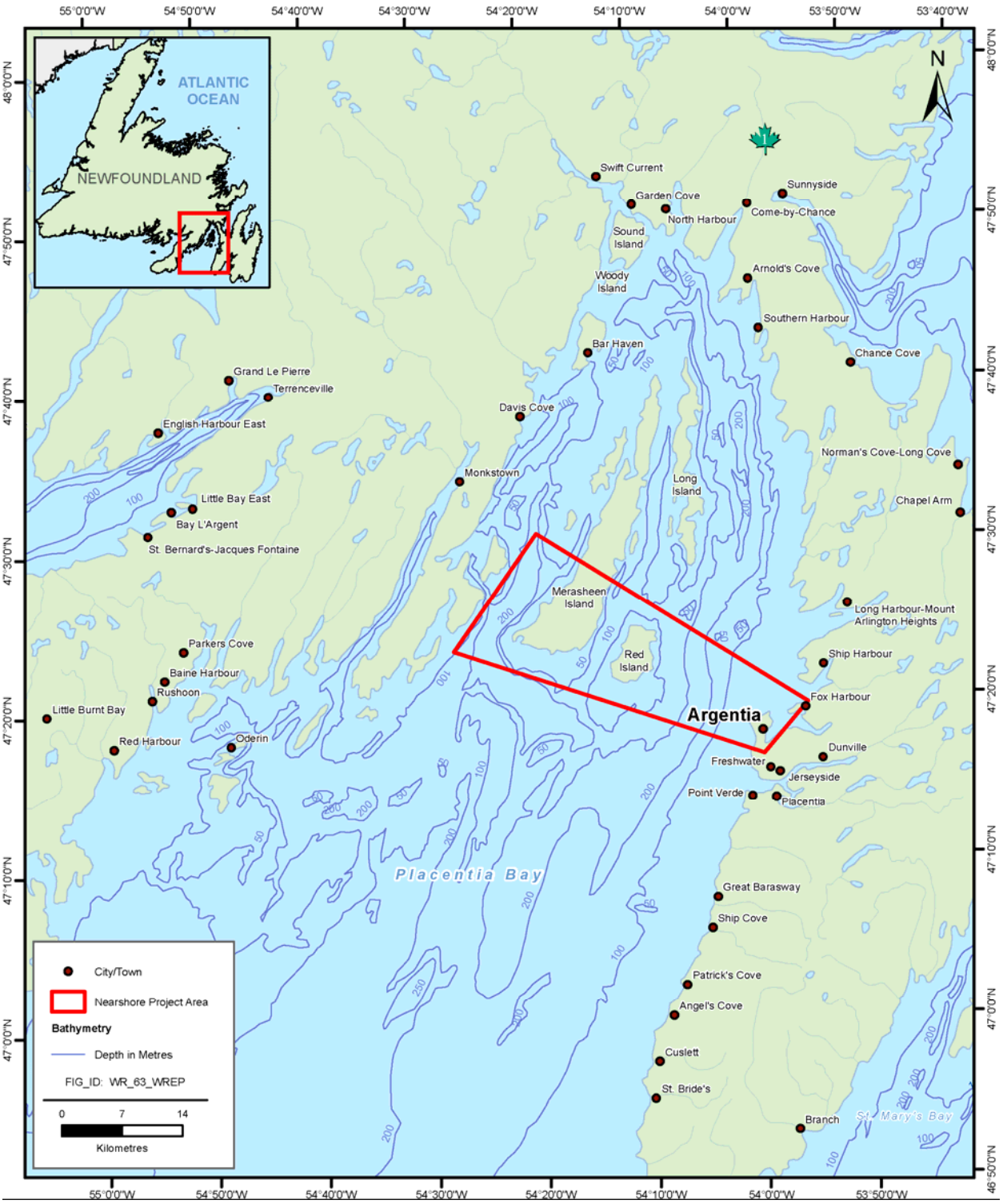



**Figure 5-1 Nearshore Project Area**

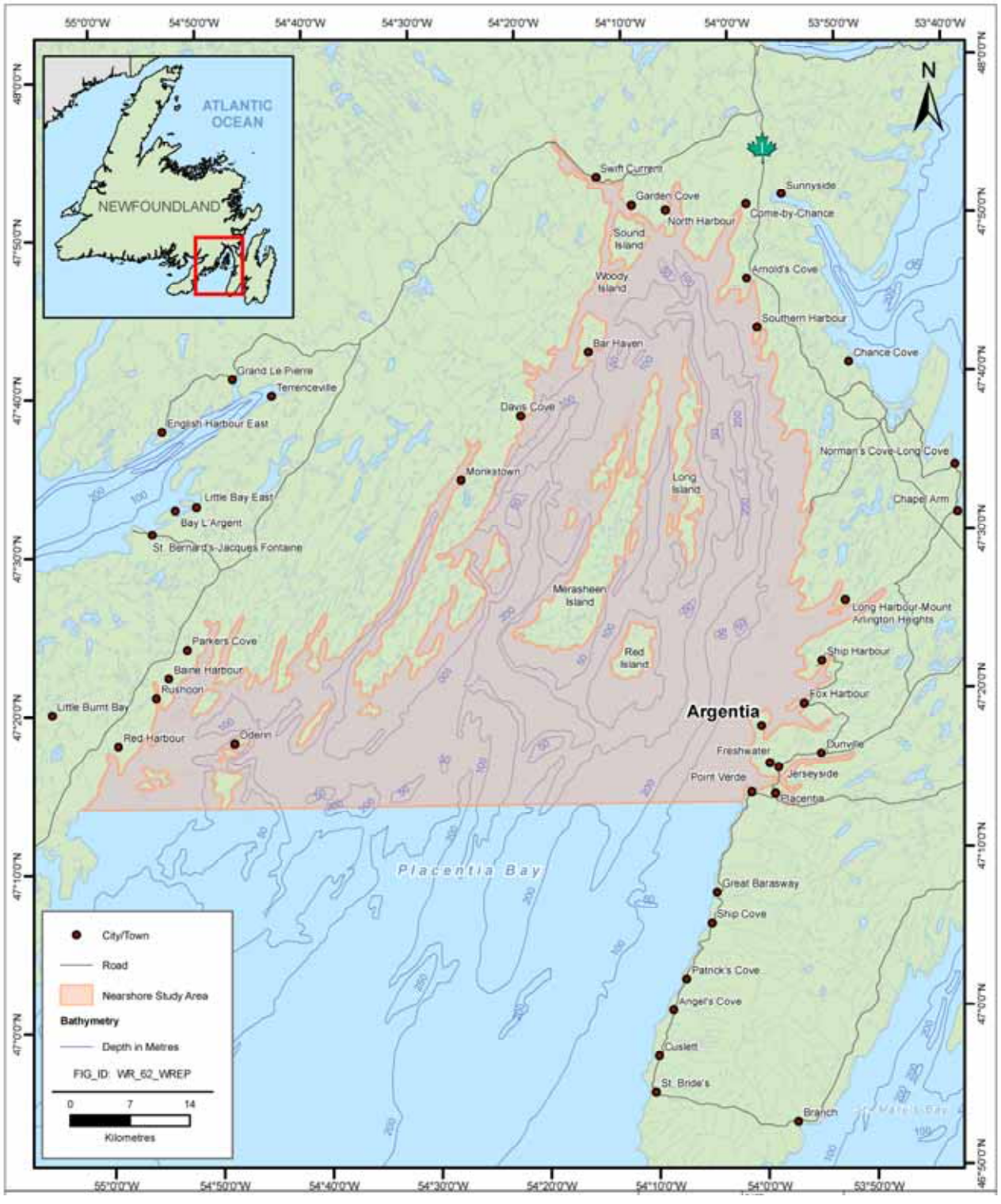



**Figure 5-2 Nearshore Study Area**

## Offshore

- Project Area: The marine area within which all offshore WREP works and activities are to occur (as defined in Chapter 2). The Offshore Project Area is defined by the existing White Rose field (see Figure 5-3).

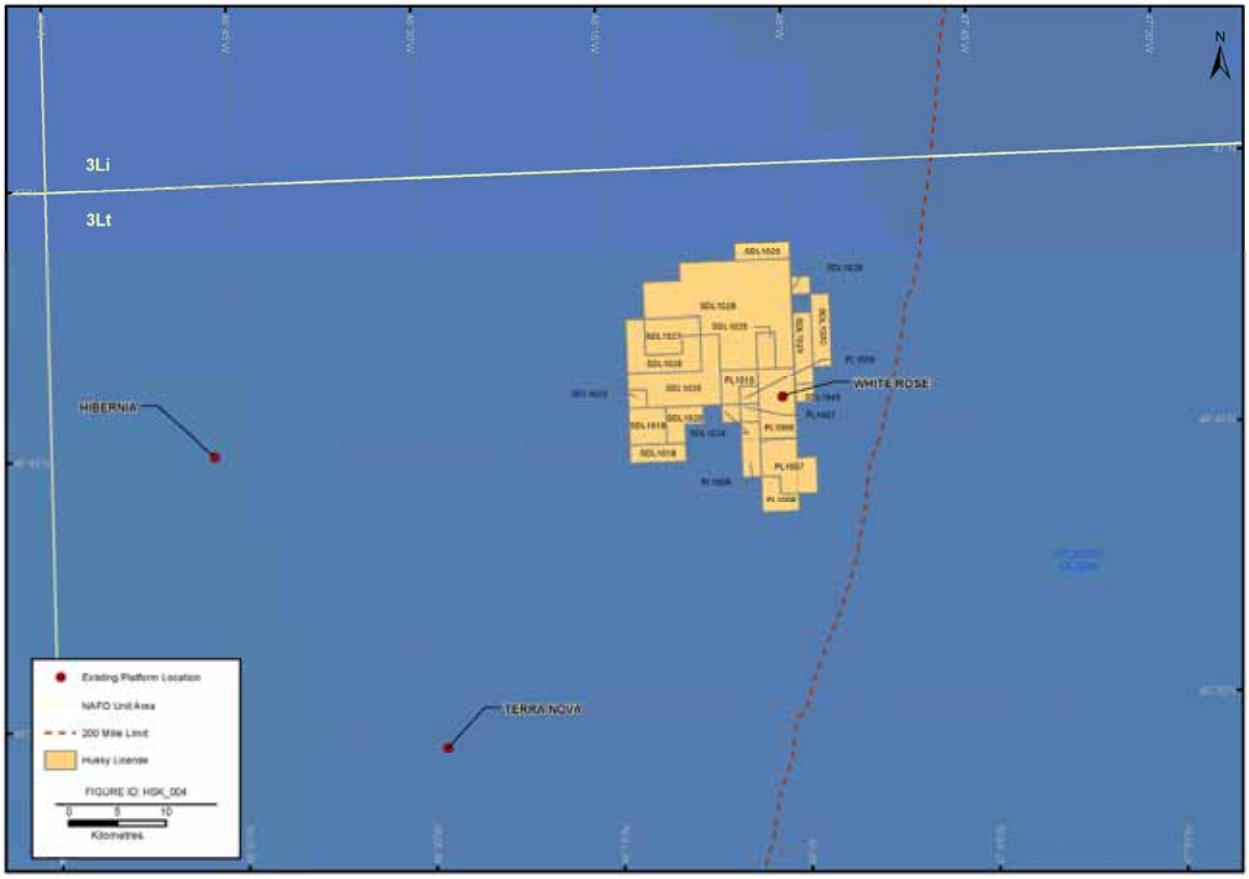



**Figure 5-3 Offshore Project Area**

- Affected Area: The area which could potentially be affected by WREP works or activities within or beyond the Project Area. The Affected Area boundary varies with the component being considered (e.g., drill cutting discharges Affected Area and air emissions Affected Area), the nature of the VEC and the sensitivity of different species within the VEC. The Affected Areas for several WREP activities have been determined by modelling (see the following Supporting Documents: Noise Modelling (JASCO 2012); Drill Cuttings Deposition Modelling (AMEC 2012b); SBM Whole Mud Spill Modelling (AMEC 2012c); and Oil Spill Modelling (SL Ross 2012))

- Study Area: The Offshore Study Area (see Figure 5-4) has been defined by modelling WREP environment interactions, such as accidental events and emissions and discharges, and considers all WREP-environment interactions. This is the area within which significance will be determined for offshore activities and it represents a compilation of the various offshore Affected Areas for all WREP works, activities and accidental events

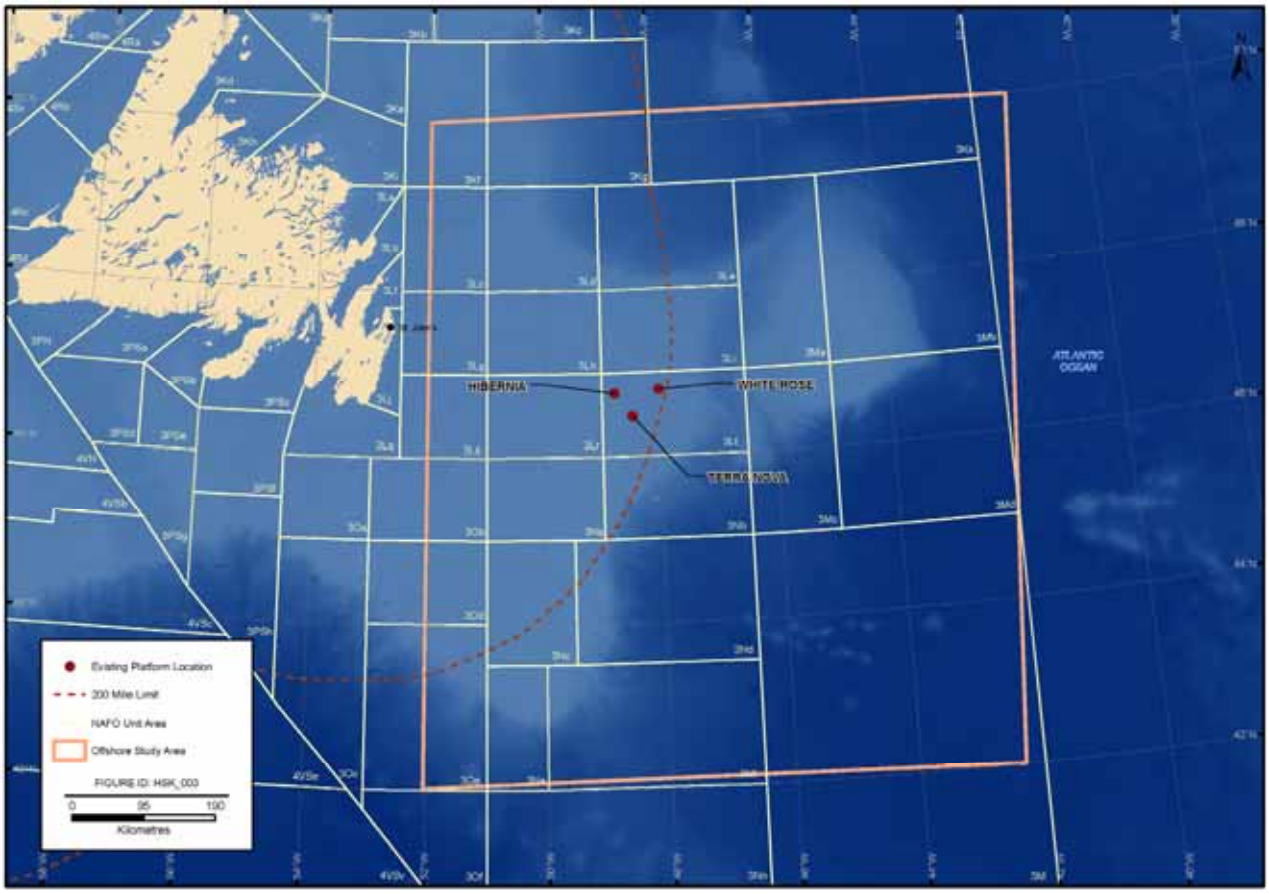



**Figure 5-4 Offshore Study Area**

### 5.3.2.2 Temporal Boundaries

The temporal boundaries of the environmental assessment reflect the construction period (applies only to the WHP option), the operating life of the WREP, through to decommissioning and abandonment of the WREP. The scheduling of physical works and activities associated with the WREP have been considered in relation to the sensitive life cycle phases of the VECs. Chapter 2 provides a description of the activities that will occur during the WREP phases.

**Nearshore (applies to Wellhead Platform option only)**

- In the case of the WHP development option, site preparation, graving dock construction, construction of CGS, dredging, topsides mating and tow out will occur over an estimated maximum 30 to 38 months from 2013 to 2016. Various activities will occur at all times of year until completion.

- In the case of the subsea drill centre development option, no nearshore activities will occur

**Offshore**

- In the case of the WHP development option, site preparation, installation of the WHP and initial production/maintenance will occur from 2016 to 2017. The WHP will be decommissioned and abandoned in accordance with standard practices at the end of its production life, which is anticipated to be 25 years.

- The subsea drill centre option is scheduled to begin construction in 2014, with first oil expected in 2015. Under this option, the wells will be plugged and abandoned at the end of its production life (anticipated to be 20 years), and the subsea infrastructure removed or abandoned in accordance with relevant regulations

#### 5.3.2.3 Administrative Boundaries

Administrative boundaries are the boundaries associated with resource management or socio-cultural boundaries (e.g., NAFO Division and Unit Areas designating fishing areas along Newfoundland and Labrador's coast and offshore area). Administrative boundaries are described for each VEC, as required.

### 5.3.3 Step 3 – Definition of Significance

Under CEAA, EPA and the C-NLOPB processes, determining the significance of environmental effects is central to decision-making. Significance definitions are developed for each VEC to provide the threshold for the significance of residual adverse environmental effects. These definitions have been established using information obtained through issues scoping, available information on the status and characteristics of each VEC and the experience of study team members. Significance thresholds indicate at which point the VEC would experience environmental effects of sufficient geographic extent, magnitude, duration, frequency and/or reversibility (each of these is described in more detail in Step 6 - Section 5.3.6), whereby its status or integrity is altered beyond an acceptable level even after application of the mitigation measures.

Significance definitions for each of the VECs are provided below.

**Air Quality**: A significant adverse residual environmental effect is one that degrades the quality of the air such that the maximum WREP-related ground-level concentration of the criteria air contaminants being assessed frequently exceeds stipulated air quality guidelines in the Nearshore or Offshore Study Areas. Frequently is defined as once per week for 1-hour standards and once per month for 24-hour standards.

**Fish and Fish Habitat**: A significant adverse residual environmental effect is one that affects fish and/or fish habitat, resulting in a decline in abundance or change in distribution of a population(s) over more than one generation within the Nearshore and/or Offshore Study Areas. Natural recruitment may not re-establish the population(s) to its original level within several generations or avoidance of the area becomes permanent.

For potential environmental effects on marine fish habitat, a significant adverse residual effect would be one that results in a harmful alteration, disruption or destruction of fish habitat that is so large and/or the fish and fish habitat is of such importance that it cannot be adequately compensated.

**Commercial Fisheries**: A significant adverse residual environmental effect has a measurable and sustained adverse effect on commercial fishing incomes.

**Marine Birds**: A significant adverse residual environmental effect is one that affects marine birds by causing a decline in abundance or change in distribution of a population(s) over more than one generation within the Nearshore and/or Offshore Study Areas. Natural recruitment may not re-establish the population(s) to its original level within several generations or avoidance of the area becomes permanent.

**Marine Mammals and Sea Turtles**: A significant adverse residual environmental effect is one that affects marine mammals or sea turtles by causing a decline in abundance or change in distribution of a population(s) over more than one generation within the Nearshore and/or Offshore Study Areas. Natural recruitment may not re-establish the population(s) to its original level within several generations or avoidance of the area becomes permanent.

**Species at Risk**: A significant, adverse environmental effect is one that, after application of feasible mitigation and consideration of reasonable WREP alternatives, will: jeopardize the achievement of self-sustaining population objectives or recovery goals; is not consistent with applicable allowable harm assessments; will result in permanent loss of critical habitat as defined in a species at risk recovery plan or action strategy; and/or where an incidental harm permit would not likely be issued. In the case of Species at Risk, the killing, harming, harassing, capturing, or taking of an individual that is listed as extirpated, endangered or threatened may be considered significant if a population is vulnerable to extinction.

**Sensitive or Special Areas**: A significant adverse residual environmental effect is one that alters the valued habitat of the identified Sensitive or Special Areas physically, chemically or biologically, in quality or extent, to such a degree that there is a decline in abundance of key species or species at risk or a change in community structure, beyond which natural recruitment (reproduction and immigration from unaffected areas) would not return the population or community to its former level within several generations.

A population, as considered above in the definitions of significance for each VEC, is those individuals occurring within the Nearshore and/or Offshore Study Areas.

### 5.3.4 Step 4 – Description of Existing Environment

A key step in an environmental assessment is the characterization of the environmental conditions within which a project will occur. In this environmental assessment, the existing environmental conditions for each VEC are presented, focusing on the Nearshore and Offshore Study Areas. Key data sources include results from fish habitat characterization surveys conducted by Husky in 2011 and 2012 in the Nearshore Area, environmental effects monitoring (EEM) programs conducted in the White Rose field (Husky 2003, 2004, 2005, 2007, 2009, 2011), primary literature, Newfoundland and Labrador offshore oil and gas environmental assessment reports and Environment Canada and DFO databases.

### 5.3.5 Step 5 – Identifying White Rose Extension Project-Valued Environmental Components Interactions and Existing Knowledge of Environmental Effects

To conduct an environmental assessment, it is necessary to understand how a project may affect the defined VECs by both direct and indirect means. The manner in which a project may affect the VECs is a function of the linkage, or pathway, from one to the other. The environmental effects of a project are a function of its activities, while the pathways are a function of several things, including project activities, ecological systems, and contaminant properties. Environmental effects and pathways have been identified and considered using the following criteria:

- Input from experts, stakeholders, and regulators
- Analyses of modelling studies of discharges and accidental events
- Results from the White Rose EEM programs on the Grand Banks (Husky 2003, 2004, 2005, 2007, 2009)
- Primary scientific literature
- Experience from previous environmental assessments, in particular environmental assessments for offshore oil development projects, including the original environmental assessment of the White Rose field (Husky Oil 2000, 2001) and drill centres (LGL 2007a), among others conducted by Husky in the Jeanne d'Arc Basin (LGL Limited 2005a, 2005b, 2006, 2007b, 2012, Jacques Whitford 2006a, 2006b).

This step involves identifying VEC-specific environmental effects resulting from interactions with the WREP, and a description of issues and concerns regarding key interactions. A WREP activity-environmental effects interaction matrix is used for each VEC, as shown in Table 5-1. The "Effect" as presented in Table 5-1 is specific to each VEC; an example of an "Effect" is "Change in Habitat Quantity".

**Table 5-1 Example Potential White Rose Extension Project-Valued Ecosystem Component Interactions Matrix**

| Potential Project Activities, Physical Works, Discharges and Emissions | Change in Habitat Quality | Change in Habitat Quantity | Potential Mortality |
|---|---|---|---|
| **Nearshore** | | | |
| ***Pre-construction and Installation*** | | | |
| Additional onshore surveys (e.g., topographic, geotechnical, environmental) | | | |
| Grading of site | | | |
| Construction of new temporary buildings and structures | | | |
| Upgrading/installation of infrastructure (e.g., site roads, buildings, cranes) | | | |
| Waste (domestic, construction, hazardous and sanitary ) | | | |
| Excavation and material disposal | | | |
| Lighting | | | |

| Potential Project Activities, Physical Works, Discharges and Emissions | Change in Habitat Quality | Change in Habitat Quantity | Potential Mortality |
|---|---|---|---|
| Chemical and fuel storage | | | |
| Bulk material handling (sand, cement, crushed rock, aggregate) | | | |
| Construction of graving dock (include sheet pile/driving, potential grouting) | | | |
| Dewater graving dock | | | |
| Air emissions | | | |
| Water Discharge from The Pond | | | |
| ***CGS Construction and Installation*** | | | |
| *Onshore (Argentia Construction Site)* | | | |
| Concrete production | | | |
| Back-up power generation | | | |
| Slip-forming | | | |
| Chemical and fuel storage | | | |
| Road transportation of materials, equipment, and personnel | | | |
| Water requirements (potable water, fire water and industrial water) | | | |
| Lighting | | | |
| Air Emissions | | | |
| Waste generated (domestic waste, construction waste, hazardous, sanitary waste) | | | |
| Bulk material handling (sand, cement, crushed rock, aggregate) | | | |
| *Marine (Argentia and Deep-water Mating Site)* | | | |
| Additional nearshore surveys (e.g., geotechnical, geophysical, environmental) | | | |
| Dredging | | | |
| CGS solid ballasting (which may include disposal of water containing fine material) | | | |
| CGS water ballasting and de-ballasting | | | |
| CGS towing to deep-water mating site | | | |
| Noise from topsides mating | | | |
| Lighting | | | |
| Air emissions | | | |
| Safety zone | | | |
| Additional hook-up and commissioning of topsides | | | |
| Operation of helicopters, supply, support, standby, mooring and tow vessels/barges/(ROVs) | | | |
| **Offshore** | | | |
| ***Wellhead Platform Installation/Commissioning*** | | | |
| Clearance surveys (e.g., sidescan sonar) prior to installation of WHP or pipelines/flowlines | | | |
| Tow-out/offshore installation | | | |
| Operation of helicopters and vessels/barges | | | |

| Potential Project Activities, Physical Works, Discharges and Emissions | Change in Habitat Quality | Change in Habitat Quantity | Potential Mortality |
|---|---|---|---|
| Diving activities/operation of ROVs | | | |
| Installation of flowlines and pipelines between WHP, subsea drill centre(s) and existing infrastructure | | | |
| Potential rock berms for flowline protection | | | |
| Installation of control and communications to *SeaRose FPSO* | | | |
| Additional hook-up, production testing and commissioning | | | |
| Lighting | | | |
| Air emissions | | | |
| Safety zone | | | |
| Hydrostatic test fluid (flowlines) | | | |
| Possible use of corrosion inhibitors or biocides (flowlines) [(A)] | | | |
| Water requirements (potable water, fire water and industrial water) | | | |
| Waste generated (domestic waste, construction waste, hazardous waste, sanitary waste) | | | |
| Drilling-associated seismic (VSPs and wellsite surveys) | | | |
| ***Subsea Drill Centre Excavation/Installation*** | | | |
| Dredging and disposal of dredge material | | | |
| Clearance surveys (e.g., sidescan sonar) prior to installation of pipelines/flowlines | | | |
| Operation of helicopters and supply, support, standby and tow vessels/barges | | | |
| Diving activities/operation of ROVs | | | |
| Lighting | | | |
| Air emissions | | | |
| Safety zone | | | |
| Installation of subsea equipment, flowlines and tie-in modules to existing subsea infrastructure | | | |
| Installation of control and communications to *SeaRose FPSO* | | | |
| Additional hook-up, production testing and commissioning | | | |
| Water requirements (potable water, fire water and industrial water) | | | |
| Waste generated (domestic waste, construction waste, hazardous waste, sanitary waste) | | | |
| Drilling-associated seismic (VSPs and wellsite surveys) | | | |
| ***Production/Operation and Maintenance*** | | | |
| Presence of structure | | | |
| Safety zone | | | |
| Noise from drilling from a MODU and WHP | | | |
| WBM (from either WHP or MODU) and SBM (from MODU only) cuttings [(B)] | | | |
| Maintenance activities | | | |

| Potential Project Activities, Physical Works, Discharges and Emissions | Change in Habitat Quality | Change in Habitat Quantity | Potential Mortality |
|---|---|---|---|
| Lighting | | | |
| Air emissions | | | |
| Power generation and flaring | | | |
| Welding and x-ray inspection | | | |
| Normal platform operational activities | | | |
| Chemical Use and management (e.g. BOP fluids, fuel, well treatment fluids, corrosion inhibitors [(B)]) | | | |
| Operation of seawater systems (cooling, firewater) | | | |
| Water requirements (potable water, fire water, cooling water, and industrial water) | | | |
| Waste generated (domestic waste, construction waste, hazardous, sanitary waste) | | | |
| Operation of helicopters, supply, support, standby and tow vessels/barges/ROVs | | | |
| Well interventions and workovers | | | |
| Surveys ( geotechnical, geophysical and environmental) | | | |
| Cementing and completing wells | | | |
| Operation of corrosion protection systems | | | |
| Oily water treatment [(C)] | | | |
| Vent and flare system [(D)] | | | |
| Diving activities/ Operation of ROVs | | | |
| ***Decommissioning and Abandonment*** | | | |
| Removal of WHP | | | |
| Plugging and Abandoning Wells | | | |
| Operation of Helicopters | | | |
| Operation of Vessels (supply/support/standby/tow vessels/barges/diving/ROVs) | | | |
| Lighting | | | |
| Air emissions | | | |
| Safety zone | | | |
| Surveys (geotechnical, geophysical and environmental) | | | |
| **Potential Future Activities** | | | |
| Surveys (e.g., geophysical, geological, geotechnical, environmental, ROV, diving) | | | |
| Excavation of drill centres (including disposal of dredge spoils) | | | |
| Noise from drilling from MODU at potential future drilling centres | | | |
| WBM and SBM Cuttings | | | |
| Hook-up and commissioning of drill centres | | | |
| Installation of Pipeline(s)/Flowline(s) and Testing from Drill Centres to FPSO, including Flowline Protection | | | |

| Potential Project Activities, Physical Works, Discharges and Emissions | Change in Habitat Quality | Change in Habitat Quantity | Potential Mortality |
|---|---|---|---|
| Chemical Use and management (e.g., BOP fluids, fuel, well treatment fluids, corrosion inhibitors [(B)]) | | | |
| **Accidental Events** | | | |
| Marine diesel fuel spill from support vessel | | | |
| Graving dock breach | | | |
| SBM whole mud spill | | | |
| Subsea hydrocarbon blowout | | | |
| Hydrocarbon surface spill | | | |
| Other spills (e.g., fuel, waste materials) | | | |
| Marine vessel incident (including collisions) (i.e., marine diesel fuel spill) | | | |
| **Cumulative Environmental Effects** | | | |
| Commercial fisheries (nearshore and offshore) | | | |
| Marine traffic (nearshore and offshore) | | | |
| White Rose Oilfield Development (including North Amethyst and South White Rose Extension) | | | |
| Terra Nova Development | | | |
| Hibernia Oil Development | | | |
| Hibernia Southern Extension Project | | | |
| Hebron Oil Development | | | |
| Offshore Exploration Seismic Activity | | | |
| Offshore Exploration Drilling Activity | | | |

(A) Husky will evaluate the use of biocides other than chlorine. The discharge from the hypochlorite system will be treated to meet a limit approved by the C-NLOPB's Chief Conservation Officer

(B) Water-based drilling fluids and cuttings will be discharged overboard. Husky will evaluate best available cuttings management technology and practices to identify a waste management strategy for spent non-aqueous fluid and non-aqueous fluid cuttings from the MODU. Synthetic-based mud cuttings will be re-injected into a dedicated well from the WHP, pending confirmation of a suitable disposal formation

(C) Water (including from open drains) will be treated prior to being discharged to the sea in accordance with OWTG (NEB et al. 2010)

(D) Small amounts of fuel gas will be used for flare pilots and may also be used to sweep the flare system piping

For the purposes of the environmental assessment, the construction phase for the WREP includes all activities at Argentia (associated with WHP option only)); and offshore installation (i.e., WHP tow-out, installation, hook-up and commissioning of either option). The operations and maintenance phase includes all activities occurring at the WHP or drill centre. Decommissioning and abandonment will include decommissioning of the WHP or drill centre at the offshore site. All activities associated with the WREP will be conducted within the Project Areas. As required by CEAA and the Scoping Document (C-NLOPB 2012a), the potential environmental effects of accidental events and cumulative environmental effects are also assessed. Potential accidental events, and other projects and activities that could result in potential environmental effects that act cumulatively with the WREP, are also identified in Table 5-1. Additional information on the assessment of cumulative environmental effects is provided in Section 5.3.7.

### 5.3.6 Step 6 – Environmental Effects Analysis and Mitigation

The next step in the environmental assessment process involves evaluating potential residual adverse environmental effects by WREP activity and phase. The evaluation of environmental effects, including cumulative environmental effects, involved:

- The potential interaction between WREP activities, for each WREP phase, and their environmental effects in combination with those of other past, present and likely future projects
- The mitigation strategies applicable to each of the interactions
- Evaluation criteria for characterizing the nature and extent of the environmental effects
- Significance of each environmental effect

Environmental effects assessment matrices have been used to summarize the analysis of environmental effects, including cumulative environmental effects, by WREP phase, and include accidental events (Table 5-2). This allows for a comprehensive analysis of all WREP-VEC interactions. Supporting discussion in the accompanying text highlights particularly important relationships, data or assessment analyses results.

**Table 5-2 Example Environmental Effects Assessment Matrix**

| WREP Activity | Potential Positive (P) or Negative (N) Environmental Effect | Mitigation Measure | Evaluation Criteria for Assessing Environmental Effects (A) | | | | | | Significance Rating | Level of Confidence |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | Magnitude | Geographic Extent | Frequency | Duration | Reversibility | Ecological / Socio-cultural / Economic Significance | | |
| **Nearshore** | | | | | | | | | | |
| | | | | | | | | | | |
| | | | | | | | | | | |
| **Offshore** | | | | | | | | | | |
| | | | | | | | | | | |
| | | | | | | | | | | |
| **Accidental Events** | | | | | | | | | | |
| | | | | | | | | | | |
| | | | | | | | | | | |

Key:
Magnitude:
N = Negligible (essentially no effect)
L = Low: <10 percent of the population or habitat in the Study Area will be affected
M = Medium: 11 to 25 percent of the population or habitat in the Study Area will be affected
H = High: >25 percent of the population or habitat in the Study Area will be affected

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

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

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

Reversibility (population level):
R = Reversible
I = Irreversible

Ecological/Socio-cultural / Economic Significance:
1 = Relatively pristine area not affected by human activity
2 = Evidence of existing adverse activity
3 = High level of existing adverse activity

Significance Rating:
S = Significant
NS = Not Significant
P = Positive

Level of Confidence:
L = Low level of confidence
M = Medium level of confidence
H = High level of confidence

(A) Where there is more than one potential environmental effect, the evaluation criteria rating is assigned to the environmental effect with the greatest potential for harm

The concept of classifying environmental effects simply means determining whether they are adverse or positive. The following includes some of the key factors that must be considered in determining adverse environmental effects, as per the CEA Agency's guidance (1994b):

- Loss of rare or endangered species
- Negative environmental effects on the health of biota
- Reduced biological diversity
- Loss or avoidance of critical/productive habitat
- Habitat fragmentation or interruption of movement corridors and migration routes
- Transformation of natural landscapes
- Chemical discharge
- Adverse effects on human health
- Loss or detrimental change in current use of lands and resources for traditional purposes
- Foreclosure of future resource use or production
- Negative environmental effects on human health or well-being.

Mitigation includes environmental design, environmental protection strategies, environmental management systems, compensation and measures specific to the avoidance, reduction or control of potential adverse environmental effects on a particular VEC. As required by CEAA, these measures must be technically and economically feasible. In the case of positive environmental effects, enhancement opportunities need to be considered. Depending on the anticipated environmental effects, mitigation and enhancement strategies have been optimized to reduce adverse environmental effects and enhance those that are positive. Therefore, the significance of an environmental effect is determined by taking the mitigative measures into consideration to determine the residual environmental effects.

The criteria used to characterize potential environmental effects for VECs are described below and are consistent with those outlined in CEAA guidance documents (CEA Agency 1994a, 1994b), in accordance with the Scoping Document. These criteria establish the framework for the assessment of environmental effects.

- Nature: the ultimate long-term trend of the environmental effect (e.g., positive, neutral or adverse)
- Magnitude: the amount or degree of change in a measurable parameter or variable relative to existing conditions
- Geographic Extent: the area over which the effect will occur

- Frequency: the number of times during the WREP or a specific WREP phase that an effect might occur (e.g., one time or multiple times)

- Duration: the period of time over which the effect will occur

- Reversibility: the likelihood that a VEC will recover from an environmental effect, including consideration of active management techniques (e.g., habitat reclamation works). This may be due to the removal of a WREP component/activity or due to the ability of a VEC to recover or habituate. As well, reversibility is considered on a population level for biological VECs. Therefore, although an environmental effect may be irreversible at the individual level, the environmental effect on the population may be reversible

- Ecological or Social Context: the general characteristics of the area in which the WREP is located, as indicated by existing levels of human activity and associated disturbance

- Level of Confidence in the Significance Rating: level of confidence in the knowledge that supports the prediction. The level and degree of certainty of knowledge is evaluated for the determination of significance.

These criteria are defined and presented within the environmental effects analyses in Table 5-2.

### 5.3.7 Step 7 – Cumulative Environmental Effects

Within-WREP cumulative environmental effects have been assessed as part of the WREP-specific environmental effects analysis. The extent that other past, present and future projects have been considered is determined based on the guidance documentation developed by the CEA Agency (Hegmann et al. 1999). The current activities (e.g., marine transportation and commercial fisheries) and those future projects or activities that are reasonably likely to proceed (i.e., proceeding through regulatory approvals process) have been considered. The projects and activities described in Tables 5-3 and 5-4 have been identified as having the potential to act in combination with the WREP to cause cumulative environmental effects to one or more of the defined VECs in the nearshore and offshore areas, respectively.

**Table 5-3 Past, Present and Likely Future Projects and Activities in the Nearshore Area Considered in the Environmental Assessment**

| Project / Activity Name | Project/Activity Description |
|---|---|
| Marine Transportation and Vessel Traffic | Marine transportation in Placentia Bay is predominantly comprised of fishing vessels and tanker/nickel plant traffic and other vessels both commercial and recreational |
| Commercial Fisheries | Commercial fishing is an activity in Placentia Bay. Commercial fisheries include snow crab, cod, lobster and lumpfish roe. A more detailed description of commercial fisheries is outlined in Chapter 9 of this environmental assessment |

**Table 5-4 Past, Present and Likely Future Projects and Activities in the Offshore Area Considered in the Environmental Assessment**

| Project Name | Project/Activity Description |
|---|---|
| **Projects** | |
| White Rose Oilfield Development and Expansions | The WREP is located within White Rose field. The existing White Rose field involves an FPSO vessel, with four drill centres (Northern, Central, Southern and North Amethyst), and subsea flowlines tied-back to the *SeaRose FPSO*. A total of approximately 30 wells have been completed to date. The White Rose Safety Zone is approximately 95 $km^2$. The Safety Zone has been established in accordance with the *Drilling and Production Regulations* (C-NLOPB and CNSOPB 2011)<br><br>Activities associated with the White Rose and North Amethyst fields include drilling by MODU and production subsea equipment installation with tieback to the *SeaRose FPSO*. As of 2012, three shuttle tankers and four to six supply vessels provide support services in the ice-free season. An additional five supply vessels may be in service during the ice season<br><br>The SWRX drill centre will be excavated in 2012, with gas injection flowlines planned for installation in 2013 and production planned for 2014. The associated safety zone will be approximately 9 $km^2$.<br><br>The WREP will be developed using either a WHP or a drill centre (similar to existing drill centres in the White Rose field). Husky is proposing to develop up to two additional drill centres within the White Rose field |
| Hibernia Development and the HSE Project | The Hibernia oil field is located approximately 50 km northwest of the *SeaRose FPSO*. The Hibernia platform, including a GBS with storage capacity for 1.3 million barrels of oil, has been in production since November 1997. An approximately 6 $km^2$ Safety Zone has been established in accordance with the Drilling and Production Guidelines and is around the Hibernia platform and the OLS, which is approximately 2 km east of the Platform. Activities associated with this field include drilling and production activities, three multi-function support and stand-by vessels, and three purpose-built shuttle tankers that transport the crude to the International-Matex Tank Terminal Transshipment Terminal at Whiffen Head or direct to market<br><br>The HSE Project is located approximately 6 km from Hibernia and may include up to six drill centres that will be connected back to the existing Hibernia GBS. Each drill centre may include the drilling of up to 11 wells. The total approximate size of the Safety Zone to be established for HSE is 53 $km^2$, plus zones for each future flowline. Excavated drill centre excavation and subsea construction is scheduled from 2011 to 2012. Production is scheduled to commence in late 2012, with an anticipated Project life of 24 years |
| Terra Nova Development | The Terra Nova oil field is located approximately 50 km southwest of the *SeaRose FPSO*. Terra Nova has been in production since January 2002. The Terra Nova operation uses a floating production, storage and offloading (FPSO) facility that can store up to 960,000 barrels of oil. The Terra Nova Development includes four drill centres. Terra Nova completed the latest phase of its initial development drilling program in August 2007. A total of 34 distinct wellbores and sidetracks have been drilled to date<br><br>Drilling operations resumed in 2009 for approximately six months. There have been 14 development wells drilled in the Graben area, 11 development wells in the East Flank area and one extended reach producer and an extended reach water injection well in the Far East Central area. The Henry Goodrich MODU is currently on location at the southwest drill centre.<br><br>The Terra Nova Field Safety Zone extends 9.26 km (5 nautical miles) from the FPSO and is recognized by International Maritime Organization and Transport Canada. Two shuttle tankers and two to four support vessels are associated with the Terra Nova Development |

| Project Name | Project/Activity Description |
|---|---|
| Hebron | The proposed Hebron Project (which was released from CEAA in January 2012), is 46 km southwest from White Rose. The project will be developed used a standalone gravity base structure (to be constructed at Bull Arm). It will be designed to store 190,000 $m^3$ (1.2 million barrels) of crude oil, with an estimated production rate of 23,900 $m^3$/day oil. The oil will be offloaded to shuttle tankers via an offshore loading system similar to that used at Hibernia |
| **Activities** | |
| Marine Transportation and Vessel Traffic | Various marine transportation activities take place along the Atlantic coast, including tankers, cargo ships, supply vessels, cruise ships and other vessels both commercial and recreational. |
| Commercial Fisheries | There is a considerable amount of commercial fishing activity on the Grand Banks and Flemish Cap. The White Rose field does not overlap with any major fishing areas. Key fisheries in NAFO Unit Area 3Lt are snow crab and shrimp. There is a high concentration of fishing activity to the east and south (outside the 200-mile EEZ), and to the northwest and north. A more detailed description of commercial fisheries is outlined in Chapter 9 of this environmental assessment |

Results of the marine environmental effects monitoring (EEM) program, conducted in the White Rose Field since 2002, indicate that in spite of changes in sediment contamination and benthic invertebrate responses since drilling began at White Rose in 2004, there has not been any consistent accentuation of contamination or responses over those years. Zones of influence of project contaminants and effects on benthic community indices and taxa have not increased in severity or extent over time (Husky 2003, 2004, 2007, 2009, 2011).

Cumulative environmental effects have been assessed in an integrated manner for each VEC. In analyzing cumulative environmental effects within this integrated methodological framework, a number of key elements were essential for evaluating the contribution of WREP-related environmental effects. The environmental effects analysis for the EIS included a consideration of the following questions, where they were applicable.

- Are there WREP-related environmental effects that act in combination with other effects to result in cumulative environmental effects?

- Do identified WREP-related environmental effects overlap with (i.e., act in combination with) those of other past and/or present projects? This can be established through characterizing the existing baseline conditions of the VEC and then reflecting the overlapping cumulative environmental effects with those of past, present and/or future projects

- What is the contribution of the WREP to the overlapping cumulative environmental effects of past and/or present projects?

- Do the combined WREP and cumulative environmental effects of past and/or present projects overlap with those of any likely future projects and/or activities that will be carried out?

Historical trends for VECs (i.e., fish and shellfish, marine birds, marine mammals and sea turtles) are described to help characterize past and current population trends. Temporal and spatial boundaries are established for the cumulative environmental effects assessment for each of the VECs. In some cases, cumulative environmental effects assessment boundaries may vary from those defined for WREP-specific environmental effects. The cumulative environmental effects assessment included explicit indication of other projects and activities that may contribute to cumulative environmental effects for that VEC, and mitigation measures that Husky proposes to reduce the WREP's contribution to cumulative environmental effects. The proposed mitigation measures are outlined in the appropriate VEC analysis sections.

### 5.3.8 Step 8 – Determination of Significance

Analyzing and predicting the significance of environmental effects, including cumulative environmental effects, encompasses the following:

- Determining the significance of residual adverse environmental effects, for each effect, each WREP phase and for the WREP overall
- For any predicted significant adverse environmental effect, determining the capacity of renewable resources (e.g., fish species associated with the commercial fishery), that are likely to be significantly affected, to meet the needs of the present and those of the future and determining the probability of occurrence
- Establishing the level of confidence for predictions
- Estimating the probability of occurrence.

At the completion of the environmental effects evaluation, the residual adverse environmental effects are assigned an overall rating of significance for each WREP phase (e.g., construction, operation and maintenance, decommissioning and abandonment and accidental events). The significance rating for each WREP phase is presented in a residual environmental effects summary table. An example of this is provided in Table 5-5.

An overall rating of "significant" or "not significant" has been assigned for adverse environmental effects within each WREP phase on a VEC-by-VEC basis. The rating of significance was determined by applying the definition of significance to the aggregate of WREP-related environmental effects. The significance criteria were considered and applied for each VEC. Significance definitions are provided for residual environmental effects (i.e., the environmental effect remaining after the application of mitigation or effects management measures) and are VEC-specific. Significant residual environmental effects are those that are considered to be of sufficient magnitude, duration, frequency, geographic extent, and/or reversibility to cause a change in the VEC, whereby its status or integrity is altered beyond an acceptable level even after application of the mitigation measures. The thresholds developed for this assessment are based on guidance from the CEA Agency, applicable regulatory standards and requirements, previous environmental assessments and the professional experience of the WREP study team. The text accompanying each section provides a summary of the cumulative environmental effects analysis, with a significance determination for adverse cumulative environmental effects.

**Table 5-5 Example Residual Environmental Effects Summary Matrix**

| Phase | Residual Adverse Environmental Effect Rating (A) | Level of Confidence | Probability of Occurrence (Likelihood) |
|---|---|---|---|
| Construction (B) | | | |
| Installation of WHP or Drill Centre | | | |
| Operation and Maintenance | | | |
| Decommissioning and Abandonment (C) | | | |
| Accidental Events | | | |
| Cumulative Environmental Effects | | | |

KEY

Residual Environmental Effects Rating:
- S = Significant Adverse Environmental Effect
- NS = Not Significant Adverse Environmental Effect
- P = Positive Environmental Effect

Level of Confidence in the Effect Rating:
- L = Low level of Confidence
- M = Medium Level of Confidence
- H = High level of Confidence

Probability of Occurrence of Significant Effect:
- L = Low Probability of Occurrence
- M = Medium Probability of Occurrence
- H = High Probability of Occurrence

(A) As determined in consideration of established residual environmental effects rating criteria
(B) Includes all Argentia activities (engineering, construction, tow-out) of the WHP option only
(C) Includes decommissioning and abandonment of the CGS and offshore site

### 5.3.9 Step 9 – Evaluating the Need for Follow-up and Monitoring

A follow-up program, as defined in CEAA, is a program that verifies the accuracy of the environmental assessment of a project, and/or determines the effectiveness of any measures taken to mitigate the adverse environmental effects of the project.

A follow-up program will be developed for the WREP. The elements of the program will be developed through consideration of each VEC; where appropriate or warranted, follow-up measures will be recommended. In accordance with the requirements of a follow-up program, actions will be proposed for those cases where the accuracy of the environmental effects analysis for a VEC should be verified, and/or where the effectiveness of mitigation measures should be determined. The results of Steps 1 through 5 will help focus the WREP on important interactions in the development of follow-up programs.

In addition to follow-up programs pursuant to requirements of CEAA, Husky will also evaluate the need for monitoring pursuant to other statutes (such as monitoring any habitat compensation program as may be required by DFO) and principles of Husky environmental management.

## 5.4 Determining the Effects of the Environment on the White Rose Extension Project

The effects of the environment on the WREP have also been taken into consideration. Details of the WREP description were reviewed for interactions with the natural environment, including wind, waves and ice. WREP plans and activities have been designed to reflect the limitations imposed by the natural environment. An example of a table summarizing the environmental effects of the environment on the WREP is presented in Table 5-6.

**Table 5-6 Environmental Effects of the Environment on the White Rose Extension Project**

| Marine Environmental Event | Mitigation |
|---|---|
| **Nearshore Events** | |
| Wind/Waves – ROV operations | |
| Wind/Waves – barge, tug or support vessel operations | |
| Wind/Waves – access to CGS at deep-water mating site | |
| Waves – bund wall failure | |
| Waves/Currents – mooring failure | |
| Storm surges/high water levels - flooding and damage to drydock/bund wall | |
| Sea Temperature - contributor to vessel and structure icing potential | |
| Sea Temperature - exposure to personnel | |
| **Offshore Events** | |
| Tsunamis – Tanker disruption (high currents) | |
| Wind/Waves – tug or support vessel operations (e.g., ice, spill response, Search and Rescue) | |
| Waves/Low water level – affecting WHP or drill centre installation on seabed | |
| Currents – Tanker disruption | |
| Sea Temperature - contributor to vessel and structure icing potential | |
| Sea Temperature - exposure to personnel | |
| Seaonally-occurring Sea Ice and Icebergs | |
| Climate Change – Sea level rise | |
| Climate Change – Waves | |
| Climate Change - Sea Surface Temperature | |
| Climate Change - Sea Ice and Icebergs | |

A significant effect of the environment on the WREP is one that:

- Harms WREP personnel or the public
- Results in a substantial delay in construction (e.g., more than one season) or shutdown of operations
- Damages infrastructure and compromises public safety
- Damages infrastructure to the extent that repair is not economically or technically feasible.

While effects of the environment on the WREP can in turn result in effects on the environment (e.g., an oil spill could result from weather or ice conditions), this is fully addressed in the environmental assessment for each of the VECs. For instance, in the case of an accidental event, the worst case scenario event, regardless of the cause, has been assessed for each VEC. The effects of the environment on the WREP are assessed in Chapter 14.

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# 6.0 Issues Scoping

Husky submitted its Project Description on May 28, 2012, to initiate the environmental assessment process of the WREP. The C-NLOPB issued a draft Scoping Document for the WREP on June 7, 2012. A Notice of Commencement was placed on the CEAA Registry internet site to initiate the public comment period on June 8, 2012. The draft Scoping Document and Project Description were made available electronically on the C-NLOPB website.

The Scoping Document (C-NLOPB 2012a) for the WREP requires that Husky "*[R]eport on consultation undertaken by Husky with interested parties who may be affected by the project and comments that are received from interested parties and the general public respecting any matters described [in the factors to be considered listed in the Scoping Document]*".

Husky recognizes the importance of public consultation and has developed a consultation plan to engage stakeholders in its environmental and socio-economic assessments of the WREP. Husky also recognizes the importance of consultations with federal, provincial and municipal regulatory agencies. The focus of Husky's consultation program was the geographic regions most likely to be affected by the Project, including Placentia Bay, the Marystown area and St. John's. Husky has met and will continue to meet with various stakeholders to provide information on the WREP and solicit feedback from stakeholders.

Husky's consultation program included:

- Meeting with nearshore and offshore fishers and the FFAW
- Meeting interested environmental non-governmental organizations
- Meeting with government departments and agencies
- Meeting with industry organizations such as NOIA
- Conducting public open houses
- Reviewing the environmental assessment documents prepared for previous Newfoundland and Labrador offshore oil and gas developments, especially the more recent Hebron Project Comprehensive Study Report and the relevant White Rose drill centres environmental assessment
- Reviewing issues raised during consultations held for the White Rose drill centres and Hebron platform developments

Meetings, events, media briefings and presentations were recorded in an issues tracking database, along with issues or comments raised. Additionally, issues raised in the media were also recorded in the issues tracking database.

With regard to the current use of land and resources by Aboriginal persons, as per the definition of environmental effect, these factors were not considered in the environmental

assessment. The WREP Nearshore and Offshore Project and Study Areas have not historically been identified as those with Aboriginal use or title. There are no land claims before the Government of Canada or the Government of Newfoundland and Labrador for these areas. Based on this assessment, there is no interaction with current use of land and resources by Aboriginal persons, and therefore, no effect.

The following sections summarize consultations conducted to date during the preparation of the environmental assessment.

Husky and its study team developed a consultation plan designed to engage interested stakeholders, provide relevant WREP information and record comments and issues identified by participants. During preparation of the environmental assessment, the consultation program involved nine events, as listed in Table 6-1.

**Table 6-1 Stakeholder Consultation Events**

| Event | Date and Location | Number of Attendees |
|---|---|---|
| Fishers' Meetings | June 14, 2012, Arnold's Cove | 9 |
| Fishers' Meetings | June 14, 2012, Placentia | 12 |
| Fishers' Meetings | June 15, 2012, Petit Forte | 9 |
| One Ocean/FFAW | May 31 2012, FFAW Offices, St. John's | 3 |
| Open House - Placentia | June 25, 2012, Cultural Centre | 50 |
| Open House - Marystown | June 26, 2012, Marystown Hotel and Convention Centre | 10 |
| Open House - St. John's | June 28, 2012, Fluvarium, St. John's | 53 |
| Fishers/FFAW Meeting | September 20, 2012, FFAW Offices, St. John's | 10 |
| Presentation to Non-governmental Organization Groups - St. John's | October 4, 2012, Stantec Office, St. John's | 1 |

## 6.1 Stakeholder Consultation

Husky conducted three open houses in Placentia, Marystown and St. John's in June 2012. The open houses provided an opportunity for Husky to present information on key components of the WREP and for stakeholders to discuss the WREP directly with Husky. The open houses were accessible to any interested member of the public and were advertised in local newspapers and on local radio to encourage maximum participation. Husky also met with local community leaders to discuss their interests and concerns in regard to the WREP. The open houses included one session per community, from 3 to 8 PM. Attendance was open to all members of the public, with a total of 113 people attending. Information about the WREP was provided on display boards and there was an opportunity for the general public to speak directly with members of Husky's team. Exit surveys were provided to all attendees; 33 completed surveys were submitted to Husky at the Placentia open house, four at Marystown and 28 at St. John's.

Minimizing the effects on the environment, particularly on fish and on Placentia Bay was identified as important by attendees at all open house sessions.

Many open house attendees stated that they believe Husky is taking the necessary steps to minimize negative effects of the WREP. Suggestions for ways that Husky can address public concerns regarding the proposed development of the WREP included:

- Careful research, planning and implementation of the WREP to minimize negative effects
- Providing WREP information online and keeping this information updated

Various NGOs were invited to attend a presentation and/or provide comments/queries to Husky on the Project Description.

Comments made during meetings and open houses relating to matters addressed in the environmental assessment are summarized in Table 6-2, which also indicates the section of the environmental assessment where each issue or concern is addressed.

**Table 6-2 Comments Related to the Environment**

| Comment | Section of Environmental Assessment where Comment is Addressed |
|---|---|
| **Fish and Fish Habitat** | |
| In-water blasting would have an immediate, detrimental effect on fish behaviour, with perhaps a substantial and potentially longer-term effect on affected fish species | No underwater blasting will occur. Only on-land blasting during construction of graving dock |
| Potential siltation of marine environment from dewatering The Pond | Sections 2.6.3.4; 8.4.1.1; 8.5.1.2; 12.4.2.1 |
| Potential siltation of marine environment from dewatering graving dock | Sections 2.6.3.4; 8.5.12.1; 12.4.2.1 |
| What will happen to the shoreline once CGS construction is complete? | Section 2.14.1 |
| Effects of noise on fish during activities at the deep-water site | Section 8.5.1.1; 8.5.1.2; 8.5.2.1; 8.5.2.2; 9.5.1.1; 9.5.1.2 |
| **Fisheries** | |
| More information on ecological impacts was required, especially with respect to the fishing industry in high project impact areas | Chapter 9 |
| Interference with their harvesting operations or temporary loss of access to some established fishing grounds (with respect to all of the proposed work sites) | Sections 9.5.1.2; 9.5.1.2; 9.5.6 |
| Dredging operations would exclude from harvesting various species directly | Sections 9.3.2.7; 9.3.3.3; 9.4.1.1; 9.4.1.2; 9.4.2.1; 9.4.2.3; 9.5.1.2; 9.5.2.1; 9.5.3; 9.5.6 |

| Comment | Section of Environmental Assessment where Comment is Addressed |
|---|---|
| Dredging operations might cause siltation in areas beyond the boundaries of the tow-out route, excluding fishers from an even larger area | Sections 9.4.1.2; 9.5.1.2 |
| Fishers harvesting crab within or near the two potential deep-water sites in Placentia Bay indicated that the anchors and the anchor chain mooring lines might interfere with the setting and hauling of their crab gear (strings of pots) | Sections 9.4.1.2; 9.5.1.2 |
| Gear would become entangled in WREP seabed equipment if cod gillnets/crab pots were set near or over the anchor chains, or the anchors themselves | Sections 9.4.1.2; 9.5.1.2 |
| Loss of access to some fishing grounds due to the establishment of the 500 m safety zone around the CGS and also around the anchors | Sections 9.5.1.1; 9.5.1.2; 9.5.6 |
| Underwater blasting might be required at one (or both) of the proposed dredging areas, or for construction of the graving dock | No underwater blasting will occur. Only on-land blasting during construction of graving dock |
| Potential gear damage or loss between Argentia Harbour and the deep-water site | Sections 9.4.2.3; 9.5.1.1; 9.5.1.2; 9.5.2.1; 9.5.3; 9.5.6 |
| Dredging of the tow-out channel from the port of Argentia could result in, or at least encourage, the creation of a second (alternate), large vessel traffic route into the Argentia Harbour | Section 2.7.3 |
| Conventional approaches to habitat replacement do not work. Fishers expressed interest in working closely with Husky in devising more suitable and beneficial habitat replacement plans | Habitat compensation plans will be discussed with DFO |
| Interference with established harvesting activities along the WHP tow-out route to the White Rose field. Especially during the proposed tow-out timeframe - August - a time when many of these offshore harvesting activities are underway | Sections 9.4.2.1; 9.5.2.1 |
| Disturbance and disposal of any contaminated material excavated during the construction of the graving dock | Section 2.6.3.3 |
| Would excavated material would be tested before disposal | Section 2.6.3.3 |
| Disturbance and disposal of any contaminated material during dredging of the tow-out route | Sections 2.7.2.2; 2.7.3.2 |
| Use of The Pond for disposal of excavated/dredged material (The Pond may already be contaminated and that the disposal process might cause The Pond to overflow and spill contaminants into nearby marine areas) | Sections 2.6.4.2; 2.6.4.3 |
| Siltation/reduced water quality in the shoreline area adjacent to The Pond during discharge of water from The Pond | Sections 2.6.3.4; 8.5.1.1 |
| Potential interference with recreational fishing activities around the deep-water mating site | Sections 9.4.1.2; 9.5.1.2 |
| Concern about expansion of existing White Rose field safety zone | Sections 9.1.1; 9.4.2.2; 9.4.2.5; 9.4.4; 9.5.2.1 |

| Comment | Section of Environmental Assessment where Comment is Addressed |
|---|---|
| Concern about the high volume of oil-related vessel communications on radio Channel 6 (the channel that fishers have traditionally used to communicate with one another at sea) | Husky is reviewing potential improvements to radio communications protocol. |
| Proposed timing of the tow-out of the WHP to the Grand Banks (July) could interfere with swordfish and hake harvesting activities that usually take place between July and October | Sections 9.4.2.1; 9.5.2.1 |
| Oil production activities have resulted in a significant loss of fishing grounds | Sections 9.1.1; 9.4.2.2; 9.4.2.5; 9.4.4; 9.5.2.1 |
| **Birds** | |
| Cumulative effects of lighting | Section 10.5.2.3 (Offshore); 10.6.2.3 (Offshore) |
| **Marine Mammals and Sea Turtles** | |
| Increased noise environment in the offshore | Sections 10.4.2.1; 10.4.2.2; 10.5.2.1; 10.5.2.2; 12.5.1.2; 12.5.2.2 |
| **Accidental Events** | |
| Gulf of Mexico oil spill was devastating for fisheries | Sections 9.4.3; 9.5.3 |
| **Environmental Management** | |
| Where will the cement for the concrete (for CGS construction) come from? | Commercially sensitive |
| **Public Involvement** | |
| Environmental concerns are important | Chapters 15; 16 |
| The primary concern is the environment | Chapters 15; 16 |
| Important issues are job creation and environmental awareness | Chapters 15; 16 |
| Environmental safeguards and workplace diversity (especially for women) were identified as important issues. Husky could address concerns by 'careful planning/research and implementation' | Chapters 15; 16 |
| Environmental effects in Placentia Bay and project timing are important issues to them. An environmental impact assessment and fish studies could be undertaken by Husky to address | Sections 7.6.1; 8.5.1; 9.5.1; 10.5.1; 11.5.1; 12.4.2.1; 12.5.2.1; 12.6.2.1; 13.5.1; 13.5.2.1 |
| Public awareness, economic impacts and environmental impacts were important topics | Sections 7.6.1; 8.5.1; 9.5.1; 10.5.1; 11.5.1; 12.4.2.1; 12.5.2.1; 12.6.2.1; 13.5.1; 13.5.2.1 |
| The environment is always a concern for projects of this nature | Sections 7.6.1; 8.5.1; 9.5.1; 10.5.1; 11.5.1; 12.4.2.1; 12.5.2.1; 12.6.2.1; 13.5.1; 13.5.2.1 |

| Comment | Section of Environmental Assessment where Comment is Addressed |
|---|---|
| **Technical/Project Description** | |
| Will there be an increase in produced water? | Section 2.9; Table 2.1 (Water Quality) |
| What will happen to the drill cuttings? | Section 2.4.2; 2.4.3; 2.9; 2.9.1; 2.9.2; Tables 2-2. 2-3 and 2-12 |
| How will the WHP be decommissioned? | Section 2.14 |

## 6.2 Fishing Industry Consultations

This section summarizes the consultations held with the nearshore and offshore fish harvesting sectors. Information about these fisheries, including, details about local fish harvesting practices gathered from these consultations, is provided in Chapter 9. The assessment of environmental effects of the WREP on commercial fisheries, including the issues raised during the consultations and the potential mitigation and compensation measures identified to mitigate potential effects, are presented in Chapter 9.

### 6.2.1 Nearshore Study Area

#### 6.2.1.1 Consultation Approach

During preparation of the environmental assessment, Husky and members of the study team consulted with Nearshore Study Area and Nearshore Project Area fisheries representatives, individual fishers, and relevant agency managers. Fishers from various homeports were invited to attend meetings held on June 14, 2012 in Arnold's Cove and Placentia, and in Petit Forte on June 15, 2012. Other fishers on the west side of Placentia Bay, from the communities of Davis Cove and Monkstown, who were not able to attend the Petit Forte meeting, were interviewed by telephone. A meeting with FFAW managers and One Ocean was held in St. John's on May 31, 2012. Additional follow-up telephone calls and emails were used to supplement these meetings. A list of those attending the meetings is provided in Appendix A.

#### 6.2.1.2 Issues

The following summarizes the issues, concerns and advice raised during the nearshore consultations. A full list of all fishers, FFAW/One Ocean representatives and agency managers consulted during preparation of the environmental assessment is presented in Appendix A. Information about the area fisheries have been integrated into relevant sections of the commercial fisheries existing environment (Section 9.3), and the issues are discussed and addressed in the commercial fisheries assessment (Section 9.4) or the fish and fish habitat assessment (Section 8.5).

Placentia Bay commercial fisheries industry participants and other stakeholders raised a number of issues and concerns. These comments are summarized as follows.

- Many fishers were concerned that WREP activities would interfere with their harvesting operations, or result in a temporary loss of access to some of their established fishing grounds. These issues were noted with respect to all of the proposed work sites. Fishers indicated that planned dredging operations at Argentia would exclude them from harvesting various species directly within Dredge Corridor 2, for example, and/or the dredging operations might cause siltation in areas beyond the boundaries of this corridor, and thus exclude them from an even larger area.

- Fishers harvesting crab within or near the two potential deep-water sites in Placentia Bay indicated that the anchors and the anchor chain mooring lines might interfere with the setting and hauling of their crab gear (strings of pots). They would be reluctant to place their gear over the anchors (or over the mooring chains), out of concern that their crab gear would become entangled in WREP seabed equipment. The same concern was noted with respect to the setting of cod gillnets near or over the anchor chains, or the anchors themselves. They would also lose access to some fishing grounds due to the establishment of the 500 m safety zone around the CGS, and also around the anchors, if similar safety zones are required for this equipment.

- A major concern for all fishers at the Placentia meeting was the possibility that underwater blasting might be required at one (or both) of the proposed dredging areas, or for construction of the graving dock. They cited the potential for blasting activities to have an immediate, detrimental effect on fisheries resources and/or fish behaviour, with perhaps a substantial and potentially longer-term effect on affected fish species. It was recommended that, if required, any blasting operations be scheduled for the winter months (January or February), when there are few harvesting activities and little or no presence of key, 'sensitive' species, such as herring.

- Concern was raised about potential gear damage or loss along the route that Argentia-based WREP supply vessels would use to travel between that port and the deep water site.

- A concern raised at the Placentia meeting was that the proposed dredging of the tow-out channel from the port of Argentia could result in, or at least encourage, the creation of a second (alternate), large vessel traffic route into the port of Argentia. Such a development, they noted, would have a detrimental effect on fish harvesting activities in the marine traffic area leading in to the Harbour by further reducing the available area in which to set gear and harvest various species.

- Fishers at the Placentia meeting had strong views on the efficacy of conventional approaches to habitat replacement, and a poor opinion of DFO's HADD policy in general. They felt that previous "no net habitat loss" initiatives were a waste of time and achieved little success in the creation of alternative habitat for any species affected by marine construction projects. They felt that Husky should make strong efforts to devise more innovative plans and more appropriate solutions for dealing with HADD requirements. They said that the usual approach is "simply to replace one pile of rocks in one location with a similar pile in another location". They expressed great interest in working closely with Husky in devising more suitable and beneficial habitat replacement plans.

- Fishers attending the Petit Forte meeting raised some concern about the effects of noise on fish during activities at the deep water site.

- FFAW representatives raised the question of possible interference with established harvesting activities along the WHP tow-out route. It was noted that the proposed route (as depicted in the Project Description) goes through or near offshore groundfish harvesting activities along the Shelf, and the proposed tow-out timeframe - August - is the time when many of these offshore harvesting activities are underway.

- Fishers attending the Placentia meeting expressed concern about the disturbance and disposal of any contaminated material excavated during the construction of the graving dock. They asked Husky representatives if the excavated material would be tested before disposal.

- Similar concerns were raised at this meeting about the proposed disposition of dredged material (via the barge vessel pumping operations) from either of the dredging corridors located off the Argentia Peninsula. It was noted that The Pond, where the material will be dumped, may already be contaminated and that the disposal process might cause The Pond to overflow and spill contaminants into nearby marine areas. Any spill over, even if not contaminated, might cause siltation in the shoreline area adjacent to The Pond. This could affect water quality with subsequent negative effects on lobster resources in the general vicinity.

- FFAW managers mentioned potential interference with recreational fishing activities from vessel traffic coming and going within the Western Channel, as many people return to their former communities (e.g., Merasheen, among others) to participate in the annual recreational cod fishery.

#### 6.2.1.3 Mitigation Recommendations

The following mitigation measures are proposed for nearshore pre-construction and construction:

- Fisheries Liaison Committee (FLC)

- Communication/notifications

- Gear damage compensation

- Loss of access compensation

- Use of agreed routes/Vessel Traffic Separation Scheme.

The following mitigation measures are proposed for nearshore accidental events:

- Clean-up

- Compensation for demonstrated loss.

### 6.2.2 Offshore Study Area

#### 6.2.2.1 Consultation Approach

The consultation meeting with the FFAW held on 20 September opened with a presentation by D. Pinsent on proposed offshore activities. Following this presentation fishers and FFAW representatives raised a number of questions and concerns (see list of attendees in Appendix A).

The fishers' concerns fall into three basic categories, summarized in Section 6.2.2.2. An overview of FFAW comments and requests is also provided in Section 6.2.2.2.

#### 6.2.2.2 Issues

**Safety Zone Expansion**

Many of the points and concerns raised by fishers at this meeting have been raised during previous consultations for other offshore development projects (e.g., the Hebron Project). In addition to the potential loss of fishing grounds, the safety zone-related issues could mean reduced fishing efficiency and other nuisance effects related to misunderstandings and inconsistencies in communications between the two industries on the water.

While a production facility safety zone typically occupies a relatively small area, the operational "buffer zone" in which fishers feel they can safely operate extends beyond the "official" safety zone boundaries of each installation. This de facto "zone of influence" creates additional limits on harvesting activities. This problem is further exacerbated by a lack of consistency in protocols and standards concerning Call in Points and Closest Point of Approach zones around oil and gas facilities. These protocols vary from one installation to another and sometimes even vary between one radio operator and another. In this regard, fishers noted that the Communications Protocol published by One Ocean and the FFAW is very useful; when a radio operator informs a fishing vessel that it must stay farther away than the agreed distance specified in the Protocol, fishers can cite this document to clarify their access rights.

With respect to the White Rose safety zone specifically, fishers noted that they now fish on the "fringes" of that zone. They generally set their radar equipment to alarm at two miles distance from the safety zone as they approach the White Rose area. This leaves enough space to set their crab gear. Under fog or other poor weather conditions, they will leave even more "buffer" space between their gear and the boundary of the safety zone. As the fishers noted, crab gear can drift from its set position, making this buffer necessary.

Given these concerns, the fishers asked if it might be possible to move the proposed WHP placement site farther away from the west boundary of the safety zone. This would minimize the extension of the potential "zone of influence" of this new production facility to the west. At present, crab fishers will stay two miles from the west boundary of the safety zone; however, fishers are concerned that when the WHP in installed, they will have to maintain a 5 nautical mile Closest Point of Approach from this facility. If so, the de facto zone of influence from this new installation would extend beyond the boundaries of the safety zone into established, prime crab grounds to the west of that zone. An

additional concern is that in two to three years, the proponent will apply for an extension of the western boundary of the safety zone, further reducing fisher's access to these crab grounds.

Fishers also asked if the WHP would have any anchor chains that extended beyond the existing safety zone. Husky's representative stated that there would not be any anchor chains associated with the WHP.

Husky's representative responded that the proposed location of the WHP would not require an expansion of the safety zone. He went on to say that Husky applied for an expansion of the safety zone boundary for SWRX, and that dredging has already taken place in that part of the zone. In response to this statement, fishers and One Ocean's representative said that this was the first time they had heard about this proposed extension of the safety zone. They pointed out that this "new" extension had never been discussed with them and they had been consulted on this matter. In fact, the FFAW would have been consulted during the Husky Drill Centre environmental assessment (LGL 2007).

**Channel 6 Radio Traffic**

Fishers also raised a concern about the high volume of oil-related vessel communications on radio Channel 6 – the channel that fishers have traditionally used to communicate with one another at sea. Fishers operating in the vicinity of oil installations say they find it very difficult to use that Channel because it is "cluttered" up with communications between installation personnel, drill rig operators, tugs and supply boats.

Following this, there was some discussion about the role of the C-NLOPB in helping address and resolve some of these issues. It was suggested that relevant C-NLOPB managers should be participating in these oil-fisheries consultations. One Ocean's representative responded that the C-NLOPB might be permitted to attend these industry consultations, but the FFAW could also meet with the C-NLOPB to discuss fishing industry concerns. However, she noted, the most appropriate and effective way to deal with these issues is to have them tabled at the One Ocean Working Group.

**Wellhead Platform Tow Out Timing**

In response to the proposed tow out of the WHP to the Grand Banks scheduled for the summer of 2016, fishers noted that this could interfere with swordfish and hake harvesting activities that usually take place between July and October. They recommended that June would be a better month for this towing operation.

**Fish, Food and Allied Workers Concerns**

In summing up the fishing industry's overall concerns, the FFAW's Secretary Treasury, D. Decker, stated that oil production activities have resulted in a significant loss of fishing grounds, while other oil-related activities, such as seismic surveys, are negatively affecting established fish harvesting operations. However, nothing is going to change, he noted, because the fishers cannot "prove" that these cumulative effects are actually occurring. The fishing industry is presently paying the cost of doing research that might shed light on what effects these activities are having. In this respect, he suggested, the

FFAW will be looking to the oil industry to support and fund some of this research, such as the annual post-season crab survey. Further discussion of ways to improve at-sea protocols can take place at the Working Group level, he noted, but the FFAW would also like to pursue this matter directly, one-on-one, with Husky.

#### 6.2.2.3 Mitigation Recommendations

The following mitigation measures are proposed for offshore installation, operation and maintenance, decommissioning and abandonment and potential future activities:

- Route analysis/selection
- Fisheries Liaison Officer (FLO)
- Single Point of Contact (SPOC)
- Communication/notification
- Gear damage compensation.

The following mitigation measures are proposed for offshore accidental events:

- Clean-up
- Compensation for demonstrated loss.

## 6.3 Consultation Participants

Husky provided an overview presentation on the WREP to several government agencies including:

- Environment Canada
- DFO
- Transport Canada
- Newfoundland and Labrador Department of Environment and Conservation
    - Environmental Assessment Division
    - Pollution Prevention Division
    - Water Resources Management Division
- Service NL
- C-NLOPB
- Town of Placentia.

Each of these agencies have had input into the content of the Project Description, environmental assessment and/or Registration documents.

Husky and its consultants have engaged representatives of government agencies to ensure an ongoing exchange of information that has been useful in preparation of the environmental assessment (and SEIS). As well, Husky met with One Ocean, the FFAW and individual local fishers to exchange information that also assisted in the preparation of the environmental assessment.

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# 7.0 AIR QUALITY

Air Quality has been selected as a VEC due to:

- The intrinsic natural value of air quality; it is needed to sustain life and maintain the health and well-being of humans, wildlife, vegetation and other biota
- The potential for interaction with WREP activities
- If not properly managed, release of air contaminants to the atmosphere from the WREP may be harmful to human health and other biological resources in the vicinity of the WREP
- Regulatory provisions of the federal *Canadian Environmental Protection Act* (CEPA) and the *Air Pollution Control Regulations, 2004* under the Newfoundland and Labrador *Environmental Protection Act*
- GHG emissions can accumulate in the atmosphere and are believed to be a major factor in global climate change.

Air Quality comprises the assessment of changes to the quality of ambient air due to the construction, operation and decommissioning of the WREP. The releases of WREP-related GHGs have also been assessed within the Air Quality VEC as they are a contributing factor in anthropogenic alteration of climate.

The health and safety of the workers with respect to air emissions is of prime importance and is managed through programs of safety training, emergency response planning and the engineering of the offshore facilities. Existing legislation for worker health and safety and WREP-specific planning that will occur as detailed engineering proceeds will provide the requisite degree of protection for workers on the facilities.

The Air Quality VEC is addressed for the two options for WREP execution. The WHP option (Option 1) comprises the construction of first a graving dock, then a WHP that is subsequently moved offshore to conduct drilling in the White Rose field. The subsea drill centre option (Option 2) consists of the same offshore drilling activities, but conducted by offshore drilling units similar to those already used in the White Rose field. Apart from differences in the power units on Option 1 and Option 2, the air quality effects are similar, with isolated offshore emissions largely from the production of power for drilling purposes. However, Option 1 is unique in the requirement for a shore-based construction phase, and the ability of this component to be executed without significant adverse effect is an important consideration for this environmental assessment.

## 7.1 Scope of the Assessment

The regulatory requirements for assessing environmental effects on Air Quality are prescribed by both the Canadian and Newfoundland and Labrador governments, as well as in the WREP-specific Scoping Document from the C-NLOPB. The Scoping Document states that the environmental assessment must assess the environmental effects related to the construction, operation and decommissioning of the WREP on ambient air quality and GHG emissions.

In particular, the Scoping Document requires a description of the existing environmental conditions with respect to Air Quality as well as the following:

- Description and annual estimates (rates and quantities) of air emissions associated with WREP activities, including GHG emissions
- Implications for health and safety of workers that may be exposed to air emissions
- Description of potential means for reduction and reporting of air emissions
- Mitigation and monitoring
- Assessment of environmental effects, including cumulative environmental effects.

The federal government has set objectives for air quality which are taken into account by federal agencies in project review, including the C-NLOPB. For the most part, the Newfoundland and Labrador regulated limits correspond to the upper limits of the Maximum Acceptable category of air quality set under CEPA.

The National Ambient Air Quality (NAAQ) Objectives under CEPA and the Newfoundland and Labrador *Air Pollution Control Regulations, 2004* for specified criteria air contaminants (CACs) are presented in Table 7-1.

**Table 7-1 Newfoundland and Labrador *Air Pollution Control Regulations, 2004* and *Canadian Environmental Protection Act* National Ambient Air Quality Objectives**

| Pollutant and units (alternative units in brackets) | Averaging Time Period | Newfoundland and Labrador | Canada | | | |
|---|---|---|---|---|---|---|
| | | Maximum Permissible Ground Level Concentration | Canada-wide Standards | NAAQ Objectives | | |
| | | | | Maximum Desirable | Maximum Acceptable | Maximum Tolerable |
| Nitrogen dioxide $\mu g/m^3$ (ppb) | 1 hour | 400 (213) | - | - | 400 (213) | 1,000 (532) |
| | 24 hour | 200 (106) | - | - | 200 (106) | 300 (160) |
| | Annual | 100 (53) | - | 60 (32) | 100 (53) | - |
| Sulphur dioxide $\mu g/m^3$ (ppb) | 1 hour | 900 (344) | - | 450 (172) | 900 (344) | - |
| | 3 hour | 600 (228) | | | | |
| | 24 hour | 300 (115) | - | 150 (57) | 300 (115) | 800 (306) |
| | Annual | 60 (23) | - | 30 (11) | 60 (23) | - |
| Total Suspended Particulate Matter $\mu g/m^3$ | 24 hour | 120 | - | - | 120 | 400 |
| | Annual | 60 | - | 60 | 70 | - |
| $PM_{2.5}$ $\mu g/m^3$ | 24 hour | 25 | 30 (by 2010) Based on the 98$^{th}$ percentile ambient measurement annually, averaged over 3 consecutive years | - | - | - |
| $PM_{10}$ $\mu g/m^3$ | 24 hour | 50 | - | - | - | - |
| Carbon Monoxide $mg/m^3$ (ppm) | 1 hour | 35 (31) | - | 15 (13) | 35 (31) | - |
| | 8 hour | 15 (13) | - | 6 (5) | 15 (13) | 20 (17) |

For climate and GHG emissions, national guidance is provided by the Canadian Environmental Assessment Agency (CEA Agency 2003) in "*Incorporating Climate Change Considerations in Environmental Assessment: General Guidance for Practitioners*" and includes guidance on the environmental assessment of GHG emissions from the WREP and from the related industrial sector. In the guidance document it is suggested that, where project emissions are medium or high, preparation of a GHG management plan is required.

## 7.2 Environmental Assessment Boundaries

The Nearshore and Offshore Project and Study Areas are defined in the Environmental Assessment Methods Chapter (Chapter 5). The Offshore Area is the same for Option 1 and Option 2, while the Nearshore Study Area is only applicable to Option 1.

### 7.2.1 Spatial Boundaries

The Nearshore Affected Area is the area where the air quality could potentially be affected by WREP activities within and surrounding the Nearshore Project Area, including associated physical works and activities required for CGS construction and dredging of the CGS tow-out route. The Nearshore Affected Area for the Air Quality VEC encompasses a circular area extending from the centre of the construction site with a radius of 5 km, as presented in Figure 7-1. Emissions from the construction of the WHP would be similar to those from an earth-moving project covering a similar footprint. For example, the construction of a shopping mall, or apartment complex with a similar footprint would involve similar construction activities, resulting in similar emissions. Most of the dust emissions would deposit within the defined radius of 5 km. The site of the future Vale Inco Hydro-met Nickel Processing facility is also included in Figure 7-1 to indicate the location for current baseline air monitoring in the region (see Section 7.4.1).

The Offshore Affected Area is the area within and beyond the Offshore Project Area where there is reasonable potential that air quality could be affected by WREP including both development options) works and activities. The Offshore Affected Area for Air Quality as defined by air dispersion modelling is 85 km by 85 km (Figure 7-2). This domain is sufficient to show the reduction of the proposed WREP emissions to near background levels. The spatial boundary for GHG emissions is global, as the effects on climate change are through the cumulative action of global emissions.

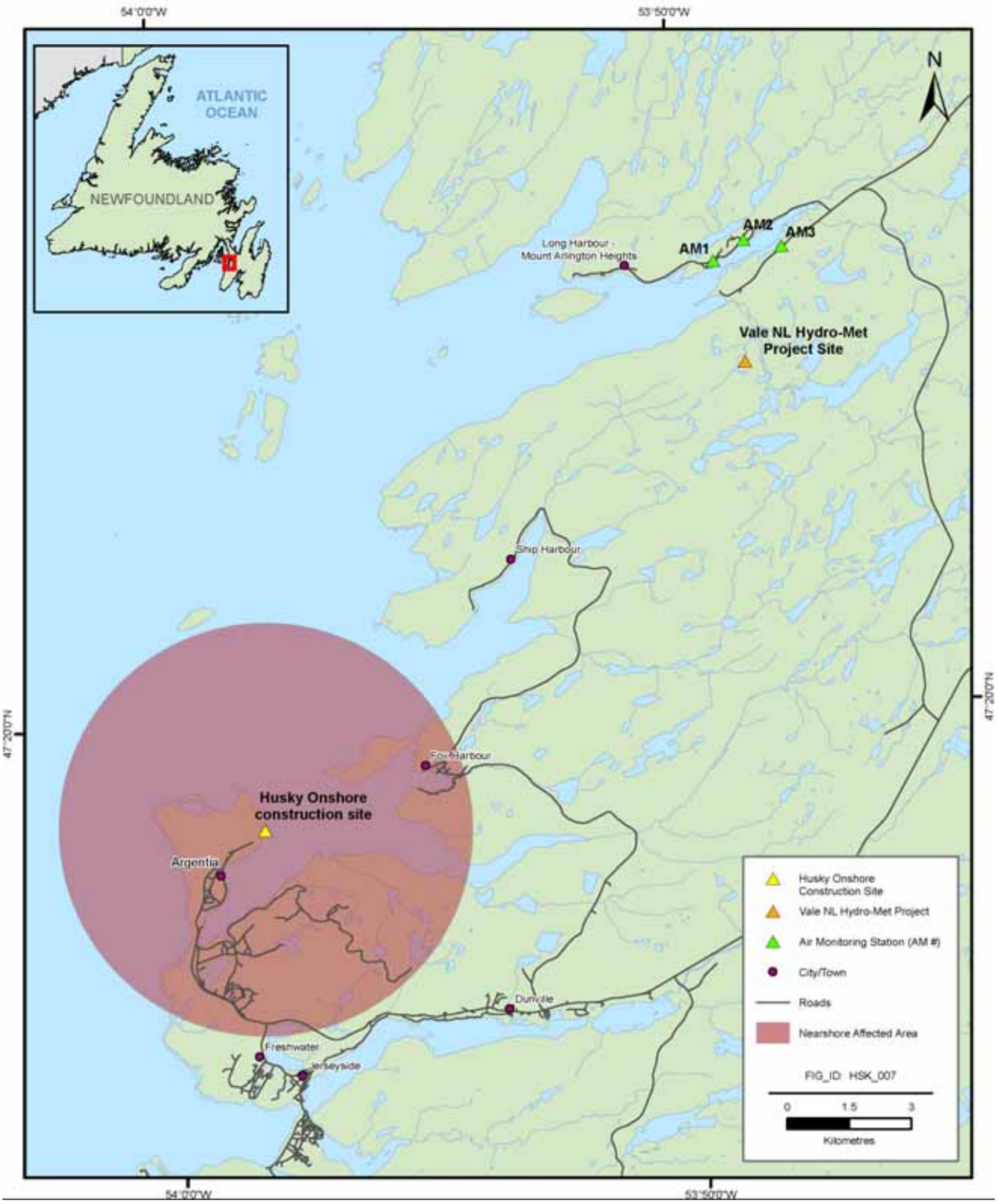



**Figure 7-1 Nearshore Affected Area, Air Quality**

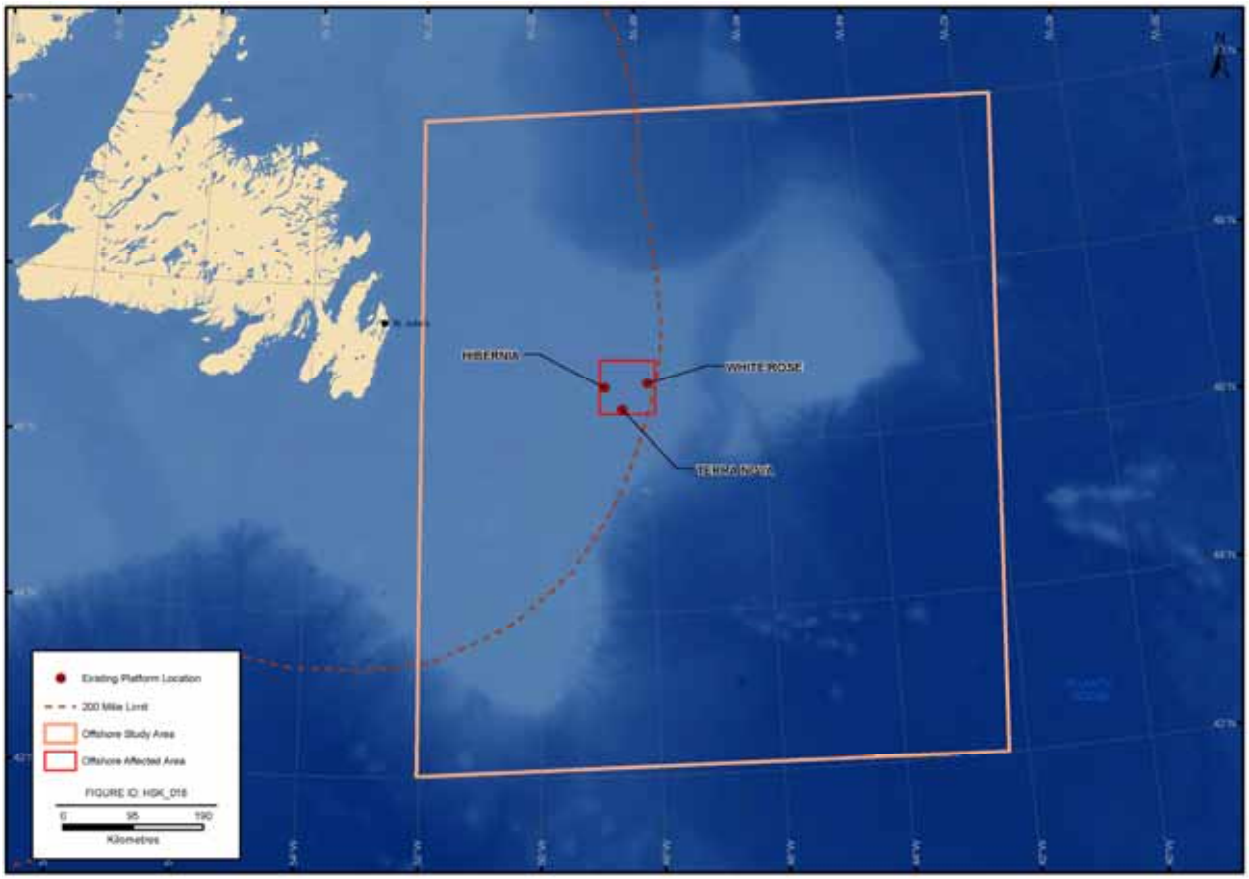



**Figure 7-2 Offshore Affected Area, Air Quality**

### 7.2.2 Temporal Boundaries

The temporal boundaries for the assessment are defined in Chapter 5 and outlined in Table 7-1.

**Table 7-2 Temporal Boundaries of Nearshore and Offshore Study Areas**

| Study Area | Temporal Boundary |
|---|---|
| Nearshore | • In the case of the WHP development option, site preparation, graving dock construction, construction of CGS, dredging, topsides mating and tow-out will occur over an estimated 30 to 38 months, from 2013 to 2016. Some activity will occur at all times of year until completion.<br>• In the case of the subsea drill centre development option, no nearshore activities will occur. |
| Offshore | • In the case of the WHP development option, site preparation, installation of the WHP and initial production/maintenance will occur from 2016 or 2017. The WHP will be decommissioned and abandoned in accordance with standard practices at the end of its production life, which is anticipated to be 25 years.<br>• The subsea drill centre option is scheduled to begin the construction phase in 2014, with first oil expected in 2015. Under this option, the wells will be plugged and abandoned at the end of its production life (anticipated to be 20 years), and the subsea infrastructure removed or abandoned in accordance with relevant regulations. |

### 7.2.3 Administrative

The administrative boundaries for the assessment of Air Quality pertain mainly to regulatory limits and standards for the air emissions in the Nearshore and Offshore Project Areas, where such limits and standards exist. These limits are set by regulatory authorities to reflect environmental protection objectives, with the intent of being protective of air quality and human and environmental health. The NAAQ Objectives and the Newfoundland and Labrador *Air Pollution Control Regulations, 2004* for specified CACs were presented in Table 7-1 for reference.

## 7.3 Definition of Significance

### 7.3.1 Change in Ambient Air Quality

For a change in ambient air quality a significant adverse residual environmental effect is one that degrades the quality of the air such that the maximum WREP-related ground level concentration (GLC) of the CAC being assessed repeatedly exceeds stipulated air quality guidelines.

The air quality guidelines applicable to the evaluation of significance for the WREP are the Newfoundland and Labrador *Air Pollution Control Regulations, 2004* for the nearshore and the NAAQ Objectives for the “tolerable”, “acceptable” and “desirable” levels for the offshore (as presented in Table 7-1). The maximum “tolerable” level denotes a concentration beyond which appropriate action is required to protect the health of the general population. The maximum “acceptable” level is intended to provide protection against effects on soil, water, vegetation, visibility and human wellbeing. The maximum “desirable” level is the long-term goal for air quality.

### 7.3.2 Change in Greenhouse Gas Emissions

The CEA Agency (2003) guidance provides that

> "… the environmental assessment process cannot consider the bulk of GHG emitted from already existing developments. Furthermore, unlike most project-related environmental effects, the contribution of an individual project to climate change cannot be measured".

Therefore, it is recognized that it is not possible to assess significance related to a measured environmental effect on climate change on a WREP-specific basis. At the same time, it is recognized that a scientific consensus is emerging with respect to global emissions of GHG and consequent changes to global climate as generally representing a significant cumulative environmental effect. WREP emissions of GHG will only minutely contribute to these global emissions. For the purpose of the WREP environmental assessment change in GHG emissions is considered by: conducting a preliminary scoping of GHG emissions; determining jurisdictional considerations (including GHG policies or plans); determining the industry profile (where possible); and considering the magnitude, intensity and duration of WREP emissions as directed by the CEA Agency guidance (CEA Agency 2003). The WREP-related GHG emissions are compared to similar projects, and to provincial, national and global GHG emissions. Three categories are described in the CEA Agency guidance: low, medium and high. In this environmental assessment, these are attributed to numerical values (on tonnes of carbon dioxide equivalent ($CO_{2eq}$) per annum basis) of less than $10^5$, greater than $10^5$ and less than $10^6$, and greater than $10^6$, for low, medium and high categories, respectively. Where the GHG emissions are considered to be either medium or high, a GHG management plan must be prepared.

## 7.4 Existing Environment

The existing environmental conditions pertaining to the Air Quality within and surrounding the Nearshore and Offshore Project and Study Areas are described in the following sub-sections.

### 7.4.1 Nearshore

#### 7.4.1.1 Air Quality

The air quality surrounding the Nearshore Project and Study Areas is generally good despite having been the location of military and industrial activities for over 70 years. The proposed WHP construction site is a brownfield site that has undergone several geophysical and environmental evaluations and extensive remediation (see Stantec 2011 for a list of reports reviewed as part of the site selection process).

The closest operational industrial sites are the Whiffen Head Transshipment Terminal and the North Atlantic Oil Refinery, located approximately 50 km north of Argentia. The Vale Inco Long Harbour project (Hydro-met) is currently under construction approximately 16 km from the proposed construction site in Argentia. The nearest residents are in communities 4 and 5 km from the proposed site.

Ambient air quality in Newfoundland and Labrador is monitored by the Newfoundland and Labrador Department of Environment and Conservation (NLDEC), Environment Canada and the major industrial operations within the Province (NLDEC 2012). The Province operates a number of ambient air monitoring stations for Environment Canada under the National Air Pollution Surveillance program and routinely audits the monitoring conducted by the local industries. On an annual basis this data is then published by the Province in an Annual Ambient Air Report.

There are six monitoring locations under the National Air Pollution Surveillance program in Newfoundland and Labrador, with St. John's being the closest to the Nearshore Project and Study Areas. Due to the distance between St. John's and Argentia, the measured data would not be representative of the air quality near Argentia. Instead, background air quality data for the Nearshore Project and Study Areas were obtained from nearby industrial sites (industrial ambient monitoring networks) and from the National Pollutant Release Inventory (NPRI) reporting database.

Although not yet operational, in 2010 Vale Newfoundland and Labrador set up a series of ambient air monitors in Long Harbour and Mt. Arlington Heights to monitor air emissions from their proposed Hydro-met Nickel Processing facility. Three stations have been installed, measuring nitrogen oxides ($NO_X$)/nitrogen dioxide ($NO_2$) and particulate matter less than 2.5 microns ($PM_{2.5}$), and by the end of 2011 all three were operational (NLDEC 2012). The locations of these stations in relation to the proposed construction site at Argentia are illustrated in Figure 7-1. A summary of the data collected over the past two years is presented in Tables 7-3 and 7-4.

As shown in Tables 7-3 and 7-4, there have been no exceedances of the Newfoundland and Labrador *Air Pollution Control Regulations, 2004* at either of Vale's air monitoring sites in Long Harbour/Mt. Arlington Heights during the available record.

#### 7.4.1.2 Greenhouse Gas Emissions

In March 2004, Environment Canada implemented the Greenhouse Gas Emissions Reporting Program (GHGRP), which involved the mandatory reporting for any facilities in Canada emitting more than 100 kt of $CO_{2eq}$. In the 2009 reporting year, this reporting threshold was lowered to 50 kt of $CO_{2eq}$.

The total reported GHG emissions from the province of Newfoundland and Labrador in 2010, under the GHGRP, was 4,545,909 tonnes of $CO_{2eq}$ (Environment Canada 2012b). These emissions were based on a total of eight reporting facilities.

The nearest industrial facility to the proposed nearshore construction site that currently reports GHG emissions to Environment Canada is the North Atlantic Refinery. According to the 2010 National GHG Emissions Report, the annual emissions of GHGs from the North Atlantic Refinery in Come by Chance were approximately 1,019,300 tonnes $CO2_{eq}$ (Environment Canada 2012c). These emissions represent 22 percent of the provincial total. This source will be the major contributor to concentrations of GHGs in the vicinity of the nearshore Study Area.

**Table 7-3 Ambient Air Monitoring Results for the Vale Inco Hydro-met Nickel Processing Facility, Particulate Matter less than 2.5 ($PM_{2.5}$) microns in Diameter**

| Monitoring Station | $PM_{2.5}$ ($\mu g/m^3$) | | | | | |
|---|---|---|---|---|---|---|
| | 2010 | | | 2011 | | |
| | # of Valid Days | Average | 24-hr Max | # of Valid Days | Average | 24-Hr Max |
| **Community Centre (AM1)** | | | | | | |
| January | 31 | 3.9 | 7.3 | 25 | 4 | 7.6 |
| February | 28 | 3.3 | 8.4 | 28 | 3.9 | 6.7 |
| March | 31 | 3.7 | 8.2 | 31 | 5.3 | 10.7 |
| April | 30 | 3.8 | 10.5 | 30 | 5.3 | 12.7 |
| May | 31 | 3.5 | 10.4 | 31 | 3.4 | 6.4 |
| June | 29 | 3.5 | 9.8 | 30 | 3 | 6.6 |
| July | 31 | 4.9 | 15.3 | 31 | 4.4 | 10.8 |
| August | 31 | 4.2 | 8.6 | 31 | 2.9 | 6.1 |
| September | 28 | 5.1 | 20.5 | 30 | 3.4 | 9.6 |
| October | 31 | 2.4 | 5.9 | 31 | 3.1 | 10.8 |
| November | 30 | 2.8 | 5.2 | 30 | 4 | 10.7 |
| December | 31 | 3.4 | 9.1 | 17 | 3.4 | 11.8 |
| **Main Road (AM2)** | | | | | | |
| January | - | - | - | 31 | 5 | 7.7 |
| February | - | - | - | 22 | 5.3 | 8.5 |
| March | - | - | - | 31 | 6.4 | 11.5 |
| April | 8 | 2 | 3.6 | 30 | 6.2 | 12.8 |
| May | 31 | 2.4 | 6.9 | 31 | 4.9 | 8 |
| June | 30 | 4.2 | 11.9 | 30 | 4.7 | 9.2 |
| July | 31 | 3.6 | 15.5 | 31 | 6.6 | 12.7 |
| August | 31 | 3.4 | 8.3 | 31 | 5 | 10.6 |
| September | 28 | 4.1 | 21.6 | 30 | 6 | 9.9 |
| October | 31 | 2.3 | 4.4 | 31 | 5 | 12.7 |
| November | 30 | 2.5 | 6.3 | 30 | 7.2 | 14.4 |
| December | 31 | 4.8 | 9.2 | 20 | 6.5 | 18.1 |
| **Access Road (AM3)** | | | | | | |
| January | - | - | - | - | - | - |
| February | - | - | - | - | - | - |
| March | - | - | - | - | - | - |
| April | - | - | - | - | - | - |
| May | - | - | - | - | - | - |
| June | - | - | - | 15 | 3.1 | 7 |
| July | - | - | - | 31 | 4.9 | 11.3 |
| August | - | - | - | 31 | 4.8 | 7.6 |
| September | - | - | - | 30 | 5 | 8.4 |
| October | - | - | - | 31 | 4.9 | 12.1 |
| November | - | - | - | 30 | 5 | 9.8 |
| December | - | - | - | 31 | 4.9 | 10 |

Source: NLDEC 2012

**Table 7-4 Ambient Air Monitoring Results for the Vale Inco Hydro-met Nickel Processing Facility, Nitrogen Oxides/Nitrogen Dioxide**

| Monitoring Station | $NO_X/NO_2$ ($\mu g/m^3$) | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 2010 | | | | | | | 2011 | | | | | | |
| | # of Valid Hours | Average | | Maximums | | | | # of Valid Days | Average | | Maximums | | | |
| | | | | 1-hour | | 24-hour | | | | | 1-hour | | 24-hour | |
| | | $NO_X$ | $NO_2$ | $NO_X$ | $NO_2$ | $NO_X$ | $NO_2$ | | $NO_X$ | $NO_2$ | $NO_X$ | $NO_2$ | $NO_X$ | $NO_2$ |
| **Community Centre (AM1)** | | | | | | | | | | | | | | |
| January | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| February | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| March | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| April | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| May | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| June | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| July | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| August | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| September | - | - | - | - | - | - | - | 167 | 5.1 | 4.2 | 47.9 | 18.5 | 8.8 | 7.8 |
| October | - | - | - | - | - | - | - | 714 | 6.6 | 6 | 35.7 | 26.9 | 11.8 | 11 |
| November | - | - | - | - | - | - | - | 687 | 6.4 | 6.2 | 28.9 | 22.9 | 9.9 | 8.8 |
| December | - | - | - | - | - | - | - | 705 | 5.5 | 5.2 | 46.8 | 34.3 | 11.3 | 9.9 |
| **Main Road (AM2)** | | | | | | | | | | | | | | |
| January | - | - | - | - | - | - | - | 714 | 10.3 | 8.5 | 46.1 | 33.7 | 29.9 | 22.4 |
| February | - | - | - | - | - | - | - | 645 | 9.8 | 8.8 | 40.6 | 32.5 | 24.8 | 20.5 |
| March | - | - | - | - | - | - | - | 709 | 10.4 | 9.4 | 36 | 30.1 | 21.8 | 19 |
| April | 198 | 9.6 | 4 | 52.9 | 13 | 16.9 | 5.7 | 690 | 15.7 | 11.5 | 53.6 | 41.5 | 25.9 | 19.5 |
| May | 711 | 10.5 | 3.6 | 69.1 | 16.6 | 29.5 | 9 | 714 | 11.6 | 9.6 | 52.1 | 42.4 | 33.2 | 26.8 |
| June | 683 | 9.2 | 3.2 | 47.3 | 9.8 | 16.6 | 5 | 671 | 10.7 | 8 | 58 | 37.2 | 36.5 | 25.4 |
| July | 714 | 11.3 | 3.2 | 27.7 | 7.8 | 17.1 | 6.3 | 707 | 18.8 | 14.1 | 76.5 | 56.3 | 32.9 | 25.3 |
| August | 712 | 10.6 | 3.2 | 46.6 | 12.1 | 19 | 7.2 | 650 | 14.6 | 10.2 | 52.3 | 33.8 | 29.3 | 20.7 |
| September | 663 | 14.9 | 5 | 100.9 | 30.4 | 67.1 | 16.9 | 680 | 6.3 | 5 | 41.2 | 23.9 | 18 | 12.3 |
| October | 714 | 11.4 | 6.6 | 70.5 | 32.4 | 22.9 | 13 | 682 | 3.9 | 3.4 | 16.6 | 15.3 | 9.4 | 7.4 |
| November | 687 | 12.7 | 9 | 74.2 | 39 | 27.2 | 20.2 | 692 | 5.5 | 4.9 | 24 | 18.8 | 9.4 | 7.6 |
| December | 712 | 8.8 | 6.5 | 63.5 | 42.5 | 28.8 | 20.9 | 706 | 5.9 | 5.3 | 40.2 | 32.6 | 12.2 | 10.7 |
| **Access Road (AM3)** | | | | | | | | | | | | | | |
| January | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| February | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| March | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| April | - | - | - | - | - | - | - | - | - | - | - | - | - | - |

| Monitoring Station | $NO_X/NO_2$ (µg/m$^3$) | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 2010 | | | | | | | 2011 | | | | | | |
| | # of Valid Hours | Average | | Maximums | | | | # of Valid Days | Average | | Maximums | | | |
| | | | | 1-hour | | 24-hour | | | | | 1-hour | | 24-hour | |
| | | $NO_X$ | $NO_2$ | $NO_X$ | $NO_2$ | $NO_X$ | $NO_2$ | | $NO_X$ | $NO_2$ | $NO_X$ | $NO_2$ | $NO_X$ | $NO_2$ |
| May | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| June | - | - | - | - | - | - | - | 353 | 3 | 2.1 | 22.5 | 15.8 | 7.2 | 4.8 |
| July | - | - | - | - | - | - | - | 712 | 2.3 | 1.8 | 38.4 | 26.1 | 6.4 | 4.4 |
| August | - | - | - | - | - | - | - | 683 | 2.5 | 1.7 | 17.4 | 13.3 | 5.7 | 3.6 |
| September | - | - | - | - | - | - | - | 685 | 1.6 | 1.2 | 19.2 | 9.5 | 4 | 2.2 |
| October | - | - | - | - | - | - | - | 714 | 1.7 | 1.4 | 16.8 | 15 | 4.7 | 3.8 |
| November | - | - | - | - | - | - | - | 691 | 2.4 | 1.8 | 31.8 | 18.7 | 8.2 | 5.1 |
| December | - | - | - | - | - | - | - | 706 | 2 | 1.5 | 62.4 | 25.7 | 9.4 | 6.2 |

Source: NLDEC 2012

The national total for the 2010 reporting year, under the GHGRP, was 261 Mt of $CO_{2eq}$. These emissions were based on a total of 537 facilities reporting and represent only those facilities emitting an excess of 50 kt of $CO_{2eq}$ (Environment Canada 2012c).

In 2004, global GHG emissions were estimated to be 49,000 Mt of $CO_{2eq}$ (Barker et al. 2007). Canadian total GHG emissions, at 690 Mt $CO_{2eq}$, were 1.4 percent of the global total in 2004.

### 7.4.2 Offshore

#### 7.4.2.1 Air Quality

Given the offshore location, air quality within the Offshore Project and Study Areas is likely to be good, with only occasional local exposure to exhaust products from existing offshore oil production facilities (i.e., Hibernia, Terra Nova and White Rose), supply ships and other vessels in the area; each platform would generally be downwind of another less than 15 percent of the time. This region also receives long-range contaminants from the industrial mid-west and northeastern seaboard of the United States.

To assess the existing ambient air quality in the Offshore Study Area, site-specific emissions data were collected from NPRI. These reports are completed and submitted annually by each of the offshore oil and gas operators located near the proposed WREP. The 2010 NPRI data for CACs for the existing platforms are summarized in Table 7-5.

**Table 7-5 2010 Reported National Pollutant Release Inventory Emissions Data by Platform**

| Facility | Air Emissions (tonnes/year) | | | | | |
|---|---|---|---|---|---|---|
| | CO | $NO_X$ | TPM | $PM_{10}$ | $PM_{2.5}$ | VOC |
| Terra Nova | 452 | 2,448 | 124 | 122 | 122 | 4,442 |
| Hibernia | 617 | 1,029 | 135 | 135 | 135 | 407 |
| *SeaRose FPSO* | 686 | 2,013 | 209 | 209 | 208 | 238 |
| Source: Environment Canada 2012d | | | | | | |

#### 7.4.2.2 Greenhouse Gas Emissions

The 2010 GHG emissions data for the existing platforms, as reported to the GHGRP for the 2010 reporting year, are summarized in Table 7-6.

**Table 7-6 2010 Reported Greenhouse Gas Emissions Data by Platform**

| Facility | GHG Emissions (tonnes$CO_{2eq}$/year) | | | |
|---|---|---|---|---|
| | $CO_2$ | $CH_4$ | $N_2O$ | Total |
| Terra Nova | 569,634 | 22,976 | 11,616 | 604,227 |
| Hibernia | 491,117 | 31,121 | 4,644 | 526,882 |
| *SeaRose FPSO* | 394,690 | 27,691 | 9,405 | 431,786 |
| Source: Environment Canada 2012c | | | | |

The national GHG emissions by sector during 1990 to 2010 are provided in Table 7-7.

**Table 7-7 Summary of Canada's Estimated Greenhouse Gas Emissions (1990 to 2010) by Sector**

| GHG Emission Categories | GHG Emissions Data ($MtCO_{2eq}$/yr) | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | 1990 | 2000 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 |
| Total | 589 | 718 | 740 | 726 | 751 | 731 | 690 | 692 |
| Energy | 467 | 589 | 599 | 585 | 611 | 591 | 560 | 562 |
| Stationary Combustion | 279 | 345 | 343 | 329 | 353 | 335 | 315 | 308 |
| Transport | 146 | 180 | 193 | 192 | 196 | 194 | 187 | 195 |
| Fugitive Sources | 42 | 63 | 63 | 65 | 63 | 62 | 59 | 59 |
| Industrial Process | 56 | 52 | 60 | 60 | 59 | 59 | 51 | 52 |
| Solvent & Other Product Use | 0.18 | 0.45 | 0.38 | 0.33 | 0.33 | 0.34 | 0.26 | 0.24 |
| Agriculture | 47 | 55 | 58 | 57 | 57 | 58 | 56 | 56 |
| Waste | 19 | 21 | 22 | 23 | 23 | 22 | 22 | 22 |
| Land Use, Land-use Change and Forestry | -67 | -62 | 54 | 65 | 51 | -17 | -12 | 72 |

Source: Environment Canada 2012c, 2012e
Note: (-) represents GHG sinks

As presented in Table 7-7, the major contributor of GHG emissions in Canada is the energy sector, which is made up of stationary combustion sources (including electricity and heat generation, fossil fuel production and refining, mining and oil and gas extraction, manufacturing industries, construction, commercial and institutional, residential and agriculture and forestry), transport (including civil aviation, road transportation, railways, navigation and other transportation) and fugitive emissions (including coal mining and oil and natural gas). The energy sector represented approximately 81 percent of the national GHG emissions in 2010 (Environment Canada 2012c).

## 7.5 White Rose Extension Project-Valued Environmental Components Interactions

### 7.5.1 Nearshore (Wellhead Platform Option Only)

The construction of the WHP (Option 1) will consist of a number of onshore and nearshore activities. The CGS will be constructed in a purpose-built graving dock at Argentia, NL. The nearest residents to the construction site are in Fox Harbour (4 km), Freshwater (5 km), Jerseyside (6 km) and Placentia (9 km) from the site.

This construction site will require general excavating and grading on land, the excavation of the graving dock, concrete gravity structure construction, shoreline and channel dredging, CGS tow-out and mating at the deep-water construction site in Placentia Bay.

The activities involved with each of the above tasks are further described in the following sub-sections in relation to their interaction with the Air Quality to result in a potential environmental effect.

#### 7.5.1.1 Graving Dock Construction

During the construction of the graving dock, air emissions, including GHG emissions, could be expected from the following activities:

- Vehicle traffic (carbon monoxide (CO), sulphur dioxide ($SO_2$), $NO_X$, total suspended particulate (TSP), GHGs)
- Site clearing and grading equipment (CO, $SO_2$, $NO_X$, TSP, GHGs)
- Earth-moving equipment during the excavation of the graving dock (CO, $SO_2$, $NO_X$, TSP)
- Potential power generation (CO, $SO_2$, $NO_X$, TSP, GHGs).

The graving dock site is to be constructed in the northeast portion of the Northside Peninsula and will cover an area of approximately 5 ha. The overall construction site, including the graving dock area, will cover an area of approximately 20 ha. The site will require leveling and grading, using standard pieces of earth-moving equipment, as well as the excavation of the graving dock to a depth of 20 m. Existing roadways and parking will require upgrades and the site will operate on existing grid power, although there is a possibility of using diesel power to supply lighting and water pumps during the graving dock excavation.

The excavation of the graving dock is expected to take six to eight months, during which air emissions resulting from the combustion of fossil fuel in the various diesel engines of the earth-moving equipment (and potential running of lighting and water pumps) will be expected, as well as dust emissions from material handling.

#### 7.5.1.2 Concrete Gravity Structure Construction

During the construction of the CGS, air emissions, including GHG emissions, will result from the following activities:

- Vehicle traffic (CO, $SO_2$, $NO_X$, TSP, GHGs)
- Concrete production (total particulate matter (TPM), particulate matter less than 10 microns ($PM_{10}$), $PM_{2.5}$)
- Bulk material handling (CO, $SO_2$, $NO_X$, TSP, GHGs)
- Back-up power generation (CO, $SO_2$, $NO_X$, TSP, GHGs).

The construction of the CGS will involve the production of approximately 64,000 $m^3$ of concrete. Typical air emissions resulting from the concrete production include TPM, $PM_{10}$ and $PM_{2.5}$. The concrete will be produced on site and will be transported to the graving dock site via concrete trucks. The operation of such trucks, along with other on-site construction vehicles, will result in emissions of particulate, combustion gases ($SO_2$, CO, $NO_X$) and GHGs.

#### 7.5.1.3 Tow-out and Installation of Topsides

Following the construction of the CGS at the graving dock site, the structure will be towed to the deep-water mating site in Placentia Bay for installation of the topside structure. During CGS tow-out and topsides mating, air emissions, including GHG emissions will result from the following activities:

- Shoreline and channel excavation and dredging (CO, $SO_2$, $NO_X$, TSP, GHGs)
- Vessel (tug boats, accommodation vessel, assistant tug, supply boat, support vessels, logistics vessel, single- or dual-crane heavy lift vessel) and helicopter traffic (CO, $SO_2$, $NO_X$, TSP, GHGs)
- Topsides stand-by generator (CO, $SO_2$, $NO_X$, TSP, GHGs).

Prior to the tow-out of the CGS to the deep-water mating site, the graving dock will be flooded and the shoreline will be excavated using land-based equipment and a coastal dredger will be used to remove the shoreline berm and create an exit channel for the structure. Air emissions related to the operation of land-based excavation equipment will be similar to those resulting from onsite clearing and grading activities and include combustion gases (CO, $SO_2$, $NO_X$), particulate matter (TPM, $PM_{10}$, $PM_{2.5}$) and GHG emissions. Emissions resulting from the operation of a coastal dredger will be similar to those emitted during vessel operation, and include CO, $SO_2$, $NO_X$, TSP, $PM_{10}$, $PM_{2.5}$ and GHGs.

Following dredging, the CGS will be towed, using four tug boats, to the deep-water mating site in Placentia Bay for topsides mating. The mating of the topsides with the CGS will be accomplished via one of two methods: float-over or heavy lift via the use of a single- or dual-crane heavy lift vessel. Air emissions related to topsides mating will result from the operation of various vessels (e.g., support, accommodation, tug, supply, heavy-lift vessel) and from the operation of the topsides standby generator.

### 7.5.2 Offshore

#### 7.5.2.1 Installation and Commissioning

The offshore construction and installation of the WHP will involve the tow-out of the completed platform from the deep-water mating site to its final destination in the White Rose field, the installation and commissioning, including installation of flowlines to connect to existing infrastructure.

If a subsea drill centre (Option 2) is selected to develop West White Rose, the offshore construction and installation of subsea drill centres will involve dredging a drill centre, installation of the subsea infrastructure, installation of flowlines to connect to existing infrastructure.

Air emissions, including GHGs, will result from the following activities associated with each development option:

- Vessel (ocean going tugs/vessels, trailing suction hopper dredge vessel) and helicopter traffic (CO, $SO_2$, $NO_X$, TSP, GHGs)
- Power generation (CO, $SO_2$, $NO_X$, TSP, GHGs).

#### 7.5.2.2 Operation and Maintenance

WREP offshore operations and maintenance activities for both the WHP and subsea drill centre development options have the potential to interact with the Air Quality. Air emissions, including GHGs, will result from offshore operation and maintenance activities including:

- Vessel (e.g., supply, support, tow, standby) and helicopter traffic (CO, $NO_X$, TSP, volatile organic carbons (VOCs), GHGs);
- Power generation (CO, $NO_X$, TSP, VOCs, $SO_2$, GHGs);
- Flaring (CO, $NO_X$, VOCs, TSP, GHGs);
- Fugitive and venting emissions (e.g., standby generators, product loading, unloading and storage, chemical and fuel storage, leaking valves, pumps seals, compressor seals, flanges/connectors, and pressure relief valves, packing and seals) (CO, $NO_X$, TSP, VOCs, GHGs); and
- Maintenance activities (e.g., welding) (TSP, VOCs).

The activities during WREP operation and maintenance producing air emissions are similar for both development options, with the greatest difference being that the WHP development option (Option 1) is a permanent structure with a life span of approximately 25 years. The subsea drill centre (Option 2) consists of a mobile offshore drilling unit (MODU) that will be on site for a cumulative duration of up to four years for the West White Rose drill centre, assuming 16 wells at a drilling rate of 90 days per well. However, wells are not likely to be drilled in immediate succession, but over the life of the WREP.

#### 7.5.2.3 Decommissioning and Abandonment

WREP decommissioning and abandonment activities will be similar to those associated with the construction and installation of the WHP and subsea drill centres and will consist of the removal of the WHP and mobile drilling units, plugging and abandoning of the wells, operation of vessels and helicopters and various surveys. Air emissions, including GHGs, associated with decommissioning and abandonment activities will result from:

- Vessel (e.g., supply, support, tow, standby) and helicopter traffic (CO, $NO_X$, TSP, VOCs, GHGs)

- Power generation (CO, $NO_X$, TSP, VOCs, GHGs).

#### 7.5.2.4 Potential Future Activities

During the operation of the WREP a number of other activities within the White Rose field could occur. Such activities include geotechnical, geophysical and environmental surveys, excavation of drill centres and dredge material disposal, drill operations at potential future drilling centres, hook up and commissioning of drill centres and the installation of additional infrastructure. The operation of these activities with the WREP will result in emissions of various CACs and GHGs similar to those outlined above for WREP commissioning, installation and operation, and therefore have the potential to interact with the Air Quality.

### 7.5.3 Accidental Events

During WREP construction and operation there is potential for air emissions during an accidental event such as marine diesel fuel spills from support vessels, hydrocarbon surface spills, marine vessel incidents, collisions, synthetic-based mud whole mud spill, subsea blowout. Each of these events would result in the release of hydrocarbons and therefore the release of fugitive air emissions.

### 7.5.4 Summary

The interactions from nearshore and offshore construction, installation, operation and maintenance activities with the Air Quality VEC that have potential to result in an environmental effect include vehicle traffic, power generation, flaring, and vessel and helicopter operations. In summary, the WREP can have effects on the Air Quality that can be categorized as:

- A change in ambient air quality (CACs); and

- A change in GHG emissions.

    - Option 1, the WHP development option will include CGS construction, topsides mating, installation, commissioning, development drilling, operations and maintenance and decommissioning activities. The WHP will consist of a CGS, with a topsides consisting of drilling facilities, wellheads and support services (including accommodations), utilities, flare boom and a helideck. The WHP will be tied back to the *SeaRose FPSO* via existing subsea infrastructure. This option assumes development of the West White Rose pool plus up to two future subsea drill centres.

    - Option 2, the subsea drill centre will require an excavated subsea drill centre in West White Rose pool into which subsea well infrastructure will be placed. Drilling of subsea wells will be accomplished via a MODU. The drill centre will be tied back to the *SeaRose FPSO* via existing subsea infrastructure. This option assumes development in the West White Rose pool plus up to two additional

future subsea drill centres. Option 2 does not involve any onshore or nearshore construction activities.

As both development options have the potential to result in an environmental effect on the Atmospheric Environment, they have both been carried forward within this environmental assessment.

A summary of the potential environmental effects resulting from WREP-VEC interactions, including accidental and cumulative environmental effects, is provided in Table 7-8. Most of the activities listed in Table 7-8 contribute to air and GHG emissions because of the generation of power required to carry out the activity; however, emissions from power generation have been accounted for under power generation and flaring.

**Table 7-8 Potential White Rose Extension Project-Valued Environmental Component Interactions: Air Quality**

| Potential WREP Activities, Physical Works, Discharges and Emissions | Change in Air Quality | Change in GHG Emissions |
|---|---|---|
| **Nearshore** | | |
| ***Pre-construction*** | | |
| Grading of site | x | x |
| Construction of new temporary buildings and structures | x | x |
| Upgrading/installation of infrastructure (e.g., site roads, buildings, cranes) | x | x |
| Bulk material handling (sand, cement, crushed rock, aggregate) | x | x |
| Construction of graving dock (include sheet pile/driving, potential grouting) | x | x |
| ***CGS Construction Topsides Mating*** | | |
| *Onshore (Argentia Construction Site)* | | |
| Concrete production | x | x |
| Back-up power generation | x | x |
| Transportation of materials, equipment, and personnel | x | x |
| Bulk material handling (sand, cement, crushed rock, aggregate) | x | x |
| *Marine (Argentia and Deep-water Mating Site)* | | |
| Dredging | x | x |
| Hook-up and commissioning of topsides | x | x |
| Operation of helicopters, supply, support, standby, mooring and tow vessels/barges/ ROVs | x | x |
| **Offshore** | | |
| ***Wellhead Platform Installation/Commissioning*** | | |
| Operation of helicopters and supply, support, standby and tow vessels/barges | x | x |
| Additional hook-up, production testing and commissioning | x | x |
| ***Subsea Drill Centre Excavation/Installation*** | | |
| Dredging and disposal of dredge material (at existing White Rose field disposal site) | x | x |
| Operation of helicopters and supply, support, standby and tow vessels/barges | x | x |
| ***Production/Operation and Maintenance*** | | |
| Maintenance activities | x | |
| Power generation | x | x |
| Vent and flare system | x | x |
| Operation of helicopters, supply, support, standby and tow vessels/barges/ ROVs | x | x |
| ***Decommissioning and Abandonment*** | | |
| Operation of Helicopters | x | x |
| Operation of Vessels (supply/support/standby/tow vessels/barges/diving/ ROVs) | x | x |
| **Potential Future Activities** | | |
| Surveys (e.g., geophysical, geological, geotechnical, environmental, ROV, diving) | x | x |
| Excavation of drill centres (including disposal of dredge spoils) | x | x |
| Drilling operations from MODU at potential future drilling centres | x | x |

| Potential WREP Activities, Physical Works, Discharges and Emissions | Change in Air Quality | Change in GHG Emissions |
|---|---|---|
| WBM and SBM Cuttings | | |
| Hook-up and commissioning of drill centres | x | x |
| **Accidental Events** | | |
| Marine diesel fuel spill from support vessel | x | x |
| Flare blowdown event | x | x |
| Subsea hydrocarbon blowout | x | x |
| Hydrocarbon surface spill | x | x |
| Other spills (e.g., fuel, waste materials) | x | x |
| Marine vessel incident (i.e., collision, marine diesel fuel spill) | x | x |
| **Cumulative Environmental Effects** | | |
| Commercial fisheries (nearshore and offshore) | x | x |
| Marine traffic (nearshore and offshore) | x | x |
| White Rose Oilfield Development (including North Amethyst and South White Rose extension drill centre)) | x | x |
| Terra Nova Development | x | x |
| Hibernia Oil Development | x | x |
| Hibernia Southern Extension Project | x | x |
| Hebron Oil Development | x | x |
| Offshore Exploration Seismic Activity | x | x |
| Offshore Exploration Drilling Activity | x | x |

## 7.6 Environmental Effects Analysis and Mitigation

### 7.6.1 Nearshore (Wellhead Platform Only)

#### 7.6.1.1 Pre-Construction and Graving Dock Construction

**Change in Air Quality**

During site preparation and excavation of the graving dock, air emissions will result from the operation of earth-moving equipment and onsite vehicles and possibility supplying lighting and water pumps, through the combustion of diesel fuel.

The primary air emissions associated with the operation of the above noted equipment are particulate matter (TSP, $PM_{10}$, $PM_{2.5}$) and combustion gases (CO, $NO_X$, $SO_2$). An estimate of the emissions resulting from site preparation and graving dock excavation is provided in Table 7-9. These emissions were estimated using an equipment inventory provided by Husky and emission factors acquired from the United States Environmental Protection Agency (US EPA), Non Road Program (US EPA 2010) and the US EPA AP-42, Compilation of Air Pollutant Emission Factors, Chapter 3.3, Gasoline and Diesel Industrial Engines (US EPA 1996a). The emissions from the transportation of materials and personnel were calculated using emission factors from Transport Canada's "Urban Transportation Emission Calculator (2011).

**Table 7-9 Criteria Air Contaminants Emissions Estimates for Graving Dock Facility Preparation (Site Preparation and Graving Dock Excavation) - Argentia Site**

| Activity | Total Emissions (tonnes) | | | | |
|---|---|---|---|---|---|
| | CO | $NO_X$ | $SO_2$ | PM | THC (A) |
| Mobilization and Demobilization | 0.45 | 1.21 | 0.15 | 0.06 | 0.08 |
| Site Clearing | 0.53 | 1.71 | 0.23 | 0.10 | 0.08 |
| Mass Excavation | 41.6 | 115.9 | 15.5 | 6.20 | 4.22 |
| Wall Construction | 1.33 | 5.75 | 0.87 | 0.15 | 0.17 |
| Final Grading | 0.32 | 0.91 | 0.12 | 0.05 | 0.04 |
| General Service | 2.40 | 3.29 | 0.49 | 0.44 | 0.36 |
| Transportation | 8.14 | 1.37 | 0.007 | 0.035 | 0.454 |
| **TOTAL** | **46.6** | **128.7** | **17.3** | **7.01** | **4.97** |

Source; US EPA 1996a, 2010; Transport Canada 2011
(A) THC = Total hydrocarbon

Excavation of the graving dock will take place over a period of six to eight months. Over this this time period, there will be releases of CACs from the combustion of diesel fuel and generation of airborne particulates. Dust suppression mitigation to be implemented include:

- Disturbed area maintained as small as practically achievable
- Water truck or sprinkler deployment to prevent airborne dust, with increased watering during periods where wind speeds exceed 25 km/h
- Watering of all dirt stockpiles
- Drop distance of loose material (e.g., gravel, sand, dirt) as small as practically achievable
- Implementation of permanent dust control measures immediately after earth-disturbing activities are completed
- Limiting vehicle speeds on-site to 25 km/h
- Implementing wheel or truck washers where vehicles enter or exit the construction site
- Clean-up of adjacent paved areas where soil material is visible.

**Change in Greenhouse Gas Emissions**

During site preparation and excavation of the graving dock, GHG emissions will result from operation of excavation, grading and earth-moving equipment, as well as from the operation of onsite vehicles, through the combustion of diesel fuel. The majority of the emissions will be carbon dioxide ($CO_2$). These emissions were estimated using an equipment inventory provided by Husky and emission factors acquired from the US EPA (US EPA 1996a, 2010) and Transport Canada (Transport Canada 2011).

The estimated emissions of $CO_2$ from site preparation and construction of the graving dock are presented in Table 7-10.

**Table 7-10 Carbon Dioxide Emissions Estimates for Graving Dock Facility Preparation for Concrete Gravity Structure Construction - Argentia Site**

| Activity | $CO_2$ Emissions (tonnes $CO_2$) |
|---|---|
| Mobilization and Demobilization | 103 |
| Site Clearing | 163 |
| Mass Excavation | 10,838 |
| Wall Construction | 507 |
| Final Grading | 85 |
| General Service | 354 |
| Transportation | 461 |
| **TOTAL** | **12,049** |
| Source: US EPA 1996a, 2010; Transport Canada 2011 | |

As the excavation of the graving dock will take place over six to eight months, these emissions will be temporary in nature and minor in quantity and in environmental effect.

#### 7.6.1.2 Concrete Gravity Structure Construction and Installation (Onshore and Marine)

**Change in Air Quality**

During the construction and installation of the CGS, emissions of combustion gases (CO, $NO_X$, $SO_2$) and particulate matter (TSP, $PM_{10}$, $PM_{2.5}$) will result from the combustion of diesel fuel in on-site vehicles used for the transportation of materials, equipment and personnel and for material handling. Emissions of particulate matter and combustion gases will also result from concrete production. Fugitive releases of particulate will occur during the material handling sand and aggregate for concrete production.

Approximately 64,000 $m^3$ of concrete will be produced on site and used to construct the CGS. An overview of the estimated emissions of CACs resulting from the production of concrete on site is provided in Table 7-11. These emissions have been estimated using emission factors acquired from the US EPA Non Road Program (US EPA 2010).

**Table 7-11 Criteria Air Contaminants Emission Estimates Resulting from Concrete Production**

| Equipment | Total Emissions (tonnes) | | | | |
|---|---|---|---|---|---|
| | CO | $NO_X$ | $SO_2$ | PM | THC (A) |
| Concrete Plant (150 cubic yards/hr) | 0.168 | 0.748 | 0.105 | 0.046 | 0.040 |
| Concrete Truck | 0.364 | 1.608 | 0.225 | 0.113 | 0.100 |
| Concrete Pump (assume 75 $m^3$/hr) | 0.210 | 0.718 | 0.096 | 0.054 | 0.043 |
| **TOTAL** | **0.741** | **3.07** | **0.426** | **0.213** | **0.183** |
| Source: US EPA 2010<br>(A) THC = Total hydrocarbon | | | | | |

The concrete will be produced on site via a concrete batch plant, using aggregate from a nearby quarry. The batch plant will be equipped with a dust collection system (e.g., baghouse) to mitigate releases of particulate matter. The specific technology to be used will be confirmed during the tender process for WREP construction.

During tow-out of the CGS, emissions will result from the combustion of diesel fuel during the operation of the coastal dredger and the various vessels required towing the CGS structure to the deep-water mating site in Placentia Bay and to support in the mating of the CGS to its topsides structure. During the installation of the topsides, air emissions may also result from hook-up and commissioning through the use of the topsides standby generator.

Emission estimates related to the operation of the various vessels required to tow the CGS to the deep-water mating site and mate it with the topside structure have been quantified and are presented in Table 7-12. The emission factors used to calculate these emissions were acquired from the US EPA (US EPA 2005).

**Table 7-12 Criteria Air Contaminants Emission Estimates Related to the Tow-out of the Concrete Gravity Structure and Topsides Mating**

| Vessel | Total Emissions (tonnes) | | | | | |
|---|---|---|---|---|---|---|
| | CO | $NO_X$ | $SO_2$ | $PM_{10}$ | $PM_{2.5}$ | THC (A) |
| Heavy Lift Transportation Vessel | 0.945 | 12.0 | 9.88 | 0.619 | 0.498 | 0.430 |
| Tugs | 1.18 | 15.0 | 12.4 | 0.773 | 0.623 | 0.537 |
| Dual-Crane Heavy Lift Vessel | 155.9 | 1,984 | 1,630 | 102.1 | 82.2 | 70.9 |
| Accommodation Vessel | 3.17 | 40.3 | 33.1 | 2.07 | 1.67 | 1.44 |
| Assistant Tug | 23.6 | 300.7 | 247.0 | 15.5 | 12.5 | 10.7 |
| Supply Boat | 0.525 | 6.68 | 5.49 | 0.344 | 0.277 | 0.239 |
| Tugs | 5.02 | 63.9 | 52.5 | 3.29 | 2.65 | 2.28 |
| **TOTAL** | **190** | **2,423** | **1,990** | **125** | **100** | **87** |

Source: US EPA 2005
(A) THC = Total hydrocarbon

The construction of the CGS is expected to occur over a period of 20 to 24 months. The tow-out and topsides mating at the deep-water mating site is expected to occur over six to eight weeks. The emissions of CACs related to these activities will be temporary in nature, are localized and relatively minor in quantity and environmental effect.

## Change in Greenhouse Gas Emissions

During CGS construction and installation, GHG emissions will result from the combustion of diesel fuel in on-site vehicles, during the production of concrete and from vessel traffic related to the towing of the CGS and mating with the topsides structure.

The estimated GHG emissions resulting from the production of approximately 64,000 $m^3$ of concrete are presented in Table 7-13. The emission factors used to calculate these emissions were acquired from US EPA Non Road Program (US EPA 2010).

**Table 7-13 Greenhouse Gas Emission Estimates from Concrete Production**

| Activity | $CO_2$ Emissions (tonnes $CO_2$) |
|---|---|
| Concrete Plant (150 cubic yards/hr) | 73.6 |
| Concrete Truck | 160.7 |
| Concrete Pump (assume 75 $m^3$/hr) | 68.5 |
| **TOTAL** | **302.9** |

Source: US EPA 2010

The estimated GHG emissions resulting from vessel operation during the CGS tow-out and topsides mating are presented in Table 7-14. The emission factors used to calculate these emissions were acquired from the US EPA (US EPA 2005).

**Table 7-14 Greenhouse Gas Emission Estimates Resulting from Concrete Gravity Structure Tow-out and Topsides Mating**

| Activity | $CO_2$ Emissions (tonnes $CO_2$) |
|---|---|
| Heavy Lift Transportation Vessel | 557 |
| Tugs | 697 |
| Dual Crane Heavy Lift Vessel | 91,997 |
| Accommodation Vessel | 1,868 |
| Assistant Tug | 13,939 |
| Supply Boat | 310 |
| Tugs | 2,962 |
| **TOTAL** | **112,330** |
| Source: US EPA 2005 | |

Emissions of GHGs from the construction of the CGS and topsides mating will be temporary in nature and relatively minor in quantity and environmental effect.

A summary of the potential environmental effects on the Air Quality during the construction and installation phases of the WREP is provided in Table 7-15.

#### 7.6.1.3 Accidental Events

During the nearshore construction and installation of the CGS the following accidental events could occur:

- Graving dock breach
- Marine vessel incident (including collision) (i.e., marine diesel fuel spill).

Only the marine vessel incident and spill could result in a potential environmental effect on Air Quality through a release of fugitive gases to the atmosphere. Please see Section 3.7 for a discussion on the oil spill scenarios that were modelled and Section 16.9 for a summary of Husky's oil spill response plan.

A summary of the potential environmental effects on the Air Quality due to accidental events attributable to the nearshore WREP activities is provided in Table 7-16.

**Table 7-15 Air Quality Environmental Effects Assessment Matrix (Construction)**

| WREP Activity | Potential Positive (P) or Negative (N) Environmental Effect | Mitigation Measure | Evaluation Criteria for Assessing Environmental Effects [A] | | | | | | Significance Rating | Level of Confidence |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | Magnitude | Geographic Extent | Frequency | Duration | Reversibility | Ecological / Socio-cultural / Economic Significance | | |
| **Pre-construction and Excavation of Graving Dock** | | | | | | | | | | |
| Grading of site | Change in air quality (N)<br>Change in GHG emissions (N) | • Proper maintenance and efficient operation of machinery<br>• Dust suppression during dry periods | L | 1 | 1 | 1 | R | 2 | NS | H |
| Construction of new buildings and upgrading/installation of infrastructure | Change in air quality (N)<br>Change in GHG emissions (N) | • Proper maintenance and efficient operation of machinery<br>• Dust suppression during dry periods | L | 1 | 1 | 2 | R | 2 | NS | H |
| Bulk material handling | Change in air quality (N)<br>Change in GHG emissions (N) | • Proper maintenance and efficient operation of machinery<br>• Dust suppression during dry periods | L | 1 | 1 | 2 | R | 2 | NS | H |
| Construction of graving dock | Change in air quality (N)<br>Change in GHG emissions (N) | • Proper maintenance and efficient operation of machinery<br>• Dust suppression during dry periods | L | 1 | 1 | 2 | R | 2 | NS | H |
| **CGS Construction** | | | | | | | | | | |
| ***Onshore*** | | | | | | | | | | |
| Concrete production | Change in air quality (N)<br>Change in GHG emissions (N) | • Proper maintenance and efficient operation of machinery<br>• Dust collection system | L | 1 | 1 | 3 | R | 2 | NS | H |
| Back-up power generation | Change in air quality (N)<br>Change in GHG emissions (N) | • Proper maintenance and efficient operation of machinery | L | 1 | 1 | 3 | R | 2 | NS | H |
| Transportation of materials, equipment and personnel | Change in air quality (N)<br>Change in GHG emissions (N) | • Proper maintenance and efficient operation of machinery | L | 1 | 1 | 3 | R | 2 | NS | H |
| Bulk material handling | Change in air quality (N)<br>Change in GHG emissions (N) | • Proper maintenance and efficient operation of machinery<br>• Minimizing drop height distance | L | 1 | 1 | 3 | R | 2 | NS | H |
| ***Marine*** | | | | | | | | | | |
| Dredging | Change in air quality (N)<br>Change in GHG emissions (N) | • Use of vessels suitable for each work activity and vessel inspections | L | 1 | 1 | 2 | R | 1 | NS | H |
| Hook-up and commissioning of topsides | Change in air quality (N)<br>Change in GHG emissions (N) | • Proper maintenance and efficient operation of machinery | L | 1 | 1 | 2 | R | 1 | NS | H |
| Operation of helicopters and vessels | Change in air quality (N)<br>Change in GHG emissions (N) | • Use of vessels/aircraft suitable for each work activity and vessel inspections<br>• Maintenance and inspections | L | 1 | 1 | 2 | R | 1 | NS | H |

| WREP Activity | Potential Positive (P) or Negative (N) Environmental Effect | Mitigation Measure | Evaluation Criteria for Assessing Environmental Effects (A) | | | | | | Significance Rating | Level of Confidence |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | Magnitude | Geographic Extent | Frequency | Duration | Reversibility | Ecological / Socio-cultural / Economic Significance | | |
| **Offshore Installation/Commissioning** | | | | | | | | | | |
| Operation of helicopters and vessels/barges | Change in air quality (N)<br>Change in GHG emissions (N) | • Use of vessels/aircraft suitable for each work activity and vessel inspections<br>• Maintenance and inspections | L | 1 | 1 | 2 | R | 1 | NS | H |
| Additional hook-up, production, testing and commissioning (WHP) | Change in air quality (N)<br>Change in GHG emissions (N) | | L | 1 | 1 | 2 | R | 1 | NS | H |
| Dredging and disposal of dredge material (subsea drill centre) | Change in air quality (N)<br>Change in GHG emissions (N) | • Vessel traffic mitigation strategies, including the use of vessels suitable for each work activity and vessel inspections | L | 1 | 1 | 2 | R | 1 | NS | H |

Key:

**Magnitude:**
N = Negligible (essentially no effect)
L = Low: <10 percent of the population or habitat in the Study Area will be affected
M = Medium: 11 to 25 percent of the population or habitat in the Study Area will be affected
H = High: >25 percent of the population or habitat in the Study Area will be affected

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

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

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

**Reversibility** (population level):
R = Reversible
I = Irreversible

**Ecological / Socio-cultural / Economic Significance:**
1 = Relatively pristine area not affected by human activity
2 = Evidence of existing adverse activity
3 = High level of existing adverse activity

**Significance Rating:**
S = Significant
NS = Not Significant
P = Positive

**Level of Confidence:**
L = Low level of confidence
M = Medium level of confidence
H = High level of confidence

(A) Where there is more than one potential environmental effect, the evaluation criteria rating is assigned to the environmental effect with the greatest potential for harm

**Table 7-16 Air Quality Environmental Effects Assessment Matrix (Accidental Events Nearshore)**

| WREP Activity | Potential Positive (P) or Negative (N) Environmental Effect | Mitigation Measure | Evaluation Criteria for Assessing Environmental Effects (A) | | | | | | Significance Rating | Level of Confidence |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | Magnitude | Geographic Extent | Frequency | Duration | Reversibility | Ecological / Socio-cultural / Economic Significance | | |
| Marine vessel incident (including collision) | Change in air quality (N)<br>Change in GHG emissions (N) | • Spill Prevention<br>• Training, preparation, equipment inventory and emergency response drills<br>• Routine inspections of equipment<br>• Vessels will not be re-fueled in the Nearshore Project Area<br>• Oil Spill Response Plan<br>• Adhere to MARPOL | L | 2 | 1 | 2 | R | 1 | NS | H |

Key:

**Magnitude:**
N = Negligible (essentially no effect)
L = Low: <10 percent of the population or habitat in the Study Area will be affected
M = Medium: 11 to 25 percent of the population or habitat in the Study Area will be affected
H = High: >25 percent of the population or habitat in the Study Area will be affected

**Geographic Extent:**
1 = <1 km radius
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**Frequency:**
1 = <11 events/year
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5 = >200 events/year
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**Duration:**
1 = <1 month
2 = 1 to 12 months
3 = 13 to 36 months
4 = 37 to 72 months
5 = >72 months

**Reversibility** (population level):
R = Reversible
I = Irreversible

**Ecological / Socio-cultural / Economic Significance:**
1 = Relatively pristine area not affected by human activity
2 = Evidence of existing adverse activity
3 = High level of existing adverse activity

**Significance Rating:**
S = Significant
NS = Not Significant
P = Positive

**Level of Confidence:**
L = Low level of confidence
M = Medium level of confidence
H = High level of confidence

(A) Where there is more than one potential environmental effect, the evaluation criteria rating is assigned to the environmental effect with the greatest potential for harm

### 7.6.2 Offshore

#### 7.6.2.1 Installation and Commissioning

**Wellhead Platform**

***Change in Air Quality***

During the offshore construction and installation of the WHP (Option 1), activities such as vessel and helicopter traffic and power generation have the potential to interact with the existing air quality.

During the installation and commissioning of the WHP, air emissions of particulate matter (TPM, $PM_{10}$, $PM_{2.5}$) and combustion gases (CO, $SO_2$, $NO_X$) will result from the operation of the four ocean-going tugs required to tow the platform from its deep-water mating site to the White Rose field. Air emissions, through the combustion of diesel fuel in vessels, will also result from the operation of the various vessels required to complete diving/ROV operations and installation of flowlines and pipelines between the WHP and existing infrastructure. Emissions from the operation of the supporting vessels will be similar to those presented in Table 7-12 for a supply vessel. During WREP commissioning, power will be supplied via three dual-fired turbine generators (two operating and one spare) located on the WHP. During WREP commissioning these generators will operate on diesel fuel until such time when produced gas is available. Typical air emissions from the operation of diesel-fuelled turbine generators include TPM, $PM_{10}$, $PM_{2.5}$, CO, $SO_2$ and $NO_X$. The estimated emissions resulting from the operation of two typical turbine generators on diesel fuel are presented in Table 7-17. The emissions presented below were calculated using emission factors acquired from the US EPA AP-42 Compilation of Air Pollutant Emission Factors Chapter 3.1, Stationary Gas Turbines (US EPA 2000a).

**Table 7-17 Estimated Emissions of Criteria Air Contaminants Resulting from Power Generation during WHP Installation and Commissioning**

| Equipment | Air Emissions (tonnes/year) | | | | | |
|---|---|---|---|---|---|---|
| | CO | $NO_X$ | $SO_2$ | TPM | $PM_{10}$ | $PM_{2.5}$ |
| Power Generation | 0.126 | 699 | 1.31 | 5.46 | 5.24 | 4.91 |
| Source: US EPA 2000a | | | | | | |

The WHP development option may also involve the development of up to two subsea drill centres, which would require a dredger as with the subsea drill centre development option. Typical emissions from the operation of a dredger include TPM, $PM_{10}$, $PM_{2.5}$, CO, $SO_2$ and $NO_X$. The emissions resulting from the operation of a typical dredger are presented in Table 7-18. The emission factors used to calculate the emissions presented below were acquired from the US EPA's "Analysis of Commercial Marine Vessel Emissions and Fuel Consumption" (2000b).

**Table 7-18 Estimated Emissions of Critical Air Contaminants from the Operation of a Trailing Suction Hopper Dredger for a Subsea Drill Centre**

| Equipment | Air Emissions (tonnes/year) | | | | | |
|---|---|---|---|---|---|---|
| | CO | $NO_X$ | $SO_2$ | TPM | $PM_{10}$ | $PM_{2.5}$ |
| Trailing Suction Hopper Dredger | 10.8 | 43.4 | 46.4 | 0.97 | 0.94 | 0.51 |
| Source: US EPA 2000b | | | | | | |

Emissions of CACs during WREP installation and commissioning will be temporary in nature, small in magnitude and will cease when the installation and commissioning phase of the WREP is completed.

### *Change in Greenhouse Gas Emissions*

Emissions of GHGs during the construction and installation phases of the WHP at its offshore location will result from the operation of supply and tow vessels, helicopter traffic and power generation. The majority of the emissions from the operation of this equipment include $CO_2$ from the combustion of diesel fuel.

During the installation and commissioning of the WHP, $CO_2$ emissions will result from the operation of the four ocean-going tugs required to tow the platform from its deep-water mating site to the White Rose field. $CO_2$ will also be emitted from the operation of the various vessels required to complete diving/ROV operations and installation of flowlines and pipelines between the WHP and existing infrastructure. $CO_2$ emissions from the operation of the supporting vessels will be similar to those presented in Table 7-14 for a supply vessel.

Emissions of $CO_2$ related to power generation during WREP installation and commissioning have been estimated at a rate per year and are presented in Table 7-19. The emissions presented below were calculated using emission factors acquired from the US EPA AP-42 Compilation of Air Pollutant Emission Factors Chapter 3.1, Stationary Gas Turbines (US EPA 2000a).

**Table 7-19 Estimated Emissions of Greenhouse Gas from Power Generation for Power Generation during Wellhead Platform Installation and Commissioning**

| Equipment | $CO_2$ | $CH_4$ | $N_2O$ | $CO_{2eq}$ (tonnes/year) |
|---|---|---|---|---|
| Power Generation | 124,756 | - | - | 124,756 |
| Source: US EPA 2000a | | | | |

As discussed above, the WHP development option may also involve the development of up to two subsea drill centres, which would require a dredger as with the subsea drill centre development option. The emissions of $CO_2$ resulting from the operation of a typical dredger are presented in Table 7-20. The emission factors used to calculate the emissions presented below were acquired from the US EPA's "Analysis of Commercial Marine Vessel Emissions and Fuel Consumption" (2000b).

**Table 7-20 Estimated Emissions of Greenhouse Gas from the Operation of a Typical Dredger for a Subsea Drill Centre**

| Equipment | $CO_2$ | $CH_4$ | $N_2O$ | $CO_{2eq}$ (tonnes/year) |
|---|---|---|---|---|
| Trailing Suction Hopper Dredger | 2,923 | - | - | 2,923 |
| Source: US EPA 2000b | | | | |

These emissions will be short-term, relatively limited in quantity and mitigated by efficient engine design.

## Subsea Drill Centres

### *Change in Air Quality*

The offshore construction and installation of the subsea drill centres (Option 2) will involve dredging a subsea drill centre, dredge spoil disposal, installation of subsea infrastructure, installation of flowlines to connect the new infrastructure with existing infrastructure and modifications to existing infrastructure. Such activities will be carried out using a dredge vessel, along with other supporting vessels to assist with installing the new infrastructure and laying the new flowlines. The operation of such vessels will result in emissions of CACs through the combustion of diesel fuel in the vessel engines.

Emissions from the operation of a typical dredger have been quantified and are presented in Table 7-16. These emissions represent dredging for one subsea centre; however the subsea drill centre development option for the WREP could have up to four subsea centres.

Emissions from the operation of the supporting vessels will be similar to those presented in Table 7-12 for a supply vessel.

### *Change in Greenhouse Gas Emissions*

Emissions of GHGs from the installation and commissioning of subsea drill centres will result from the operation of the dredger and the supporting vessels used to install the new infrastructure and flowlines. Emissions of GHGs from the operation of the typical dredger have been quantified and are presented in Table 7-20.

GHG emissions from the operation of the supporting vessels will be similar to those presented in Table 7-14 for a support vessel.

As the installation and commissioning of the subsea drill centres is a temporary activity, emissions of CACs and GHGs from this activity will be temporary in nature.

### 7.6.2.2 Operations and Maintenance

**Wellhead Platform (Option 1)**

***Change in Air Quality***

During normal operation of the WHP, air emissions will result from power generation, flaring, vessel and helicopter traffic, and from fugitive sources (i.e., vents, flanges).

Power generation will be supplied via three 10 MW dual-fuelled turbine generators (two operating and one spare) during normal operation. As described above, during the installation of the WREP the turbines will operate on diesel fuel. Once the facility is fully operational, the turbines will operate on 95 percent fuel gas and 5 percent diesel. The turbine generators will supply all power requirements for the topside components of the WHP. The primary emissions from the combustion of produced gas in the turbines include $NO_X$, CO, TSP, $PM_{10}$ and $PM_{2.5}$. The fuel gas composition analysis indicates that there is no hydrogen sulphide ($H_2S$) present in the gas; therefore, the combustion of this fuel will not result in emissions of $SO_2$ or $H_2S$. However, as the turbines will operate approximately 5 percent of the time on diesel fuel, $SO_2$ emissions have been considered during power generation.

The flare system is an essential component of the pressure relief and safety system of the WHP. The flare system will be designed to prevent over-pressurization of equipment during process upset conditions and to dispose of associated gas produced during emergency situations (i.e., blowdown). The air emissions during flaring include CO, $NO_X$, TSP, $PM_{10}$ and $PM_{2.5}$. A small amount of fuel gas will be continuously used for flare pilots during the operation of the WHP. However, the associated air emissions will be minimal. This background flaring represents flaring associated with normal operations.

During normal operations of the WHP, a stand-by vessel will be in the vicinity of the WHP 365 days/year and at least one supply vessel will also be in operation as required travelling between the east coast of Newfoundland and the offshore WREP site. Helicopters will also routinely travel between the east coast of Newfoundland and the offshore WREP site to transport employees to and from work, approximately three round-trip flights per week. Typical emissions from the operation of vessel and helicopter engines include CO, $NO_X$, $SO_2$, TSP, $PM_{10}$ and $PM_{2.5}$.

In additional to the above estimated emissions, minor amounts of TSP and VOCs will be emitted during various routine maintenance activities, including welding, grinding and solvent use. Fugitive releases of VOCs may also result from such sources as leaking valves, pumps seals, compressor seals, flanges/connectors, pressure relief valves and ventilation exhausts, which are considered minor and intermittent sources. As the detailed design work for the WREP has yet to be completed, a fugitive emissions inventory cannot be quantified at this time. In general, fugitive emissions are a minor component of the total air emissions of the normal WHP operation.

A summary of the estimated emissions released from the operation of the WHP are provided in Table 7-21. Emissions for the operation of support vessels were calculated using emission factors acquired from the US EPA, “Best Practices in Preparing Port Emission Inventories” (US EPA 2005) and the US EPA “Analysis of Commercial Marine Vessels Emissions and Fuel Consumption Data” (US EPA 2000b). Emissions from the

operation of the helicopters were calculated using emission factors acquired from the European Environment Agency, "Emission Inventory Guidebook" (2009). For normal, background flaring, emissions were estimated using emission factors from the US EPA AP-42, Chapter 13.5, Industrial Flaring (US EPA 1991) and Chapter 1.4, Natural Gas Combustion (US EPA 1998).

**Table 7-21 Summary of Estimates based on Operation of the Wellhead Platform**

| Activity | Total Emissions (tonnes/year) | | | | |
|---|---|---|---|---|---|
| | CO | $NO_X$ | $SO_2$ | PM | THC |
| Operation of Support Vessel | 80.5 | 1,024 | 841.4 | 52.7 | 36.6 |
| Operation of Helicopters | 6.10 | 0.41 | 0.16 | 0[b] | 0[b] |
| Power Generation | 61.8 | 276.3 | 3.88 | 5.49 | 0.99 |
| Normal Operations - Flaring | 35.0 | 6.44 | - | 719.6 | 13.3 |
| **TOTAL** | **183.4** | **1,307** | **845.4** | **777.7** | **50.8** |
| Source: US EPA 1991, 1998, 2000a, 2000b, 2005, 2009 | | | | | |

To predict the GLCs of the various CACs emitted during normal operation, air dispersion modelling was conducted. The WREP is regulated by the C-NLOPB, which does not require a specific dispersion model. Husky has chosen to carry out the air dispersion modelling for the operation of the WHP using the province's preferred model, CALPUFF, derived from the California Puff Model. Modelling methods and input data used for the environmental assessment of the WREP are included in "Air Emissions Study, White Rose Extension Project" (Stantec 2012c).

The maximum predicted GLCs for normal operation are presented in Table 7-22.

**Table 7-22 Summary of Model Predictions - Maximum Predicted Ground-level Concentrations for Normal Operation (Wellhead Platform Option)**

| Contaminant | Averaging Period | Receptor | Location (UTM) | | Maximum Predicted GLC (µg/m$^3$) | NL *Air Pollution Control Regulations, 2004* (µg/m$^3$) |
|---|---|---|---|---|---|---|
| | | | Easting (m) | Northing (m) | | |
| $NO_2$ | 1-hour | Hibernia | 669419 | 5179807 | 0.681 | 400 |
| | | Terra Nova | 693372 | 5149964 | 0.784 | |
| | | White Rose (*SeaRose FSPO*) | 727708 | 5186021 | 7.450 | |
| | 24-hour | Hibernia | 669419 | 5179807 | 0.105 | 200 |
| | | Terra Nova | 693372 | 5149964 | 0.166 | |
| | | White Rose (*SeaRose FSPO*) | 727708 | 5186021 | 3.70 | |
| | Annual | Hibernia | 669419 | 5179807 | 0.004 | 100 |
| | | Terra Nova | 693372 | 5149964 | 0.005 | |
| | | White Rose (*SeaRose FSPO*) | 727708 | 5186021 | 0.201 | |
| $SO_2$ | 1-hour | Hibernia | 669419 | 5179807 | 0.010 | 900 |
| | | Terra Nova | 693372 | 5149964 | 0.011 | |
| | | White Rose (*SeaRose FSPO*) | 727708 | 5186021 | 0.105 | |
| | 3-hour | Hibernia | 669419 | 5179807 | 0.007 | 600 |
| | | Terra Nova | 693372 | 5149964 | 0.005 | |
| | | White Rose (*SeaRose FSPO*) | 727708 | 5186021 | 0.103 | |

| Contaminant | Averaging Period | Receptor | Location (UTM) | | Maximum Predicted GLC ($\mu g/m^3$) | NL *Air Pollution Control Regulations, 2004* ($\mu g/m^3$) |
|---|---|---|---|---|---|---|
| | | | Easting (m) | Northing (m) | | |
| $SO_2$ (cont.) | 24-hour | Hibernia | 669419 | 5179807 | 0.001 | 300 |
| | | Terra Nova | 693372 | 5149964 | 0.002 | |
| | | White Rose (*SeaRose FSPO*) | 727708 | 5186021 | 0.052 | |
| | Annual | Hibernia | 669419 | 5179807 | 0.000 | 60 |
| | | Terra Nova | 693372 | 5149964 | 0.000 | |
| | | White Rose (*SeaRose FSPO*) | 727708 | 5186021 | 0.003 | |
| CO | 1-hour | Hibernia | 669419 | 5179807 | 0.173 | 35,000 |
| | | Terra Nova | 693372 | 5149964 | 0.176 | |
| | | White Rose (*SeaRose FSPO*) | 727708 | 5186021 | 1.69 | |
| | 8-hour | Hibernia | 669419 | 5179807 | 0.083 | 15,000 |
| | | Terra Nova | 693372 | 5149964 | 0.069 | |
| | | White Rose (*SeaRose FSPO*) | 727708 | 5186021 | 1.47 | |
| TPM | 1-hour | Hibernia | 669419 | 5179807 | 0.014 | - |
| | | Terra Nova | 693372 | 5149964 | 0.015 | |
| | | White Rose (*SeaRose FSPO*) | 727708 | 5186021 | 0.147 | |
| | 24-hour | Hibernia | 669419 | 5179807 | 0.002 | 120 |
| | | Terra Nova | 693372 | 5149964 | 0.003 | |
| | | White Rose (*SeaRose FSPO*) | 727708 | 5186021 | 0.073 | |
| | Annual | Hibernia | 669419 | 5179807 | 0.000 | 60 |
| | | Terra Nova | 693372 | 5149964 | 0.000 | |
| | | White Rose (*SeaRose FSPO*) | 727708 | 5186021 | 0.004 | |
| $PM_{10}$ | 1-hour | Hibernia | 669419 | 5179807 | 0.013 | - |
| | | Terra Nova | 693372 | 5149964 | 0.015 | |
| | | White Rose (*SeaRose FSPO*) | 727708 | 5186021 | 0.141 | |
| | 24-hour | Hibernia | 669419 | 5179807 | 0.002 | 50 |
| | | Terra Nova | 693372 | 5149964 | 0.003 | |
| | | White Rose (*SeaRose FSPO*) | 727708 | 5186021 | 0.070 | |
| $PM_{2.5}$ | 1-hour | Hibernia | 669419 | 5179807 | 0.012 | - |
| | | Terra Nova | 693372 | 5149964 | 0.014 | |
| | | White Rose (*SeaRose FSPO*) | 727708 | 5186021 | 0.132 | |
| | 24-hour | Hibernia | 669419 | 5179807 | 0.002 | 25 |
| | | Terra Nova | 693372 | 5149964 | 0.003 | |
| | | White Rose (*SeaRose FSPO*) | 727708 | 5186021 | 0.066 | |

Results from the air dispersion modelling for normal operation, as presented in Table 7-22, show that the emissions would meet the Newfoundland and Labrador *Air Pollution Control Regulations, 2004* and the NAAQ objectives.

### *Change in Greenhouse Gas Emissions*

During operation, emissions of GHGs will result from power generation and from the operation of vessels and helicopters.

GHGs, including $CO_2$, nitrous oxide ($N_2O$) and methane ($CH_4$), are emitted during the operation of turbine generators when operating on either diesel or natural gas. $CO_2$ and

$N_2O$ are produced during the combustion process, as is $CH_4$ in the case of diesel fuel oil. Greater amounts of $CO_2$ are released during the combustion of diesel versus natural gas due to the higher carbon content. In terms of natural gas combustion, low levels of $CH_4$ are present in the exhaust gas as unburned fuel (US EPA 2000a). It is anticipated that once the platform is fully operational, the dual-fuelled turbines will operate on 95 percent natural gas and 5 percent diesel, thereby reducing the quantity of GHGs emitted.

GHGs, including $CO_2$, will be emitted during the routine operation of standby vessels, supply vessels and helicopters through the combustion of diesel fuel. An emissions inventory for the GHG emissions related to the overall operation phase of the WHP was prepared and the results are presented in Table 7-23.

As presented in Table 7-23, the estimated GHG emissions for the operation of the WHP are similar to those reported for other existing oil platforms located near the Offshore Study Area (Section 7.4.2.2). Emissions factors were acquired from various chapters within the US EPA AP-42 Compilation of Air Pollutant Emission Factors (US EPA 1991, 1998, 2000a, 2000b, 2005) and the Climate Registry, "Default Emission Factors" (2012).

**Table 7-23 Greenhouse Gas Emissions Related to Operation (Wellhead Platform Option)**

| Activity | $CO_2$ (tonnes/yr) | $CH_4$ (tonnes/yr) | $N_2O$ (tonnes/yr) | $CO_{2eq}$ (tonnes/yr) |
|---|---|---|---|---|
| Operation of Support Vessel | 47,485 | 0 (A) | 0 (A) | 47,485 |
| Operation of Helicopters | 402.6 | 0.01 | 0.04 | 416 |
| Power Generation | 89,645 | 6.52 | 2.27 | 90,486 |
| Normal Operations - Flaring | 11,139 | 0.01 | 0.01 | 11,142 |
| **Total** | **148,672** | **6.5** | **2.3** | **149,529** |

Source: US EPA 1991, 1998, 2000a, 2000b, 2005; Climate Registry 2012
(A) Emissions for $CH_4$ and $N_2O$ have been determined to be minimal

Under CEA Agency guidance, the WREP (WHP Option) would also be considered a medium emitter (greater than $10^5$ and less than $10^6$) and require the development of a GHG Management Plan.

**Subsea Drill Centres (Option 2)**

***Change in Air Quality***

During the operation and maintenance of the subsea drill centres, drilling will be accomplished via the use of a MODU. The MODU will also be used to conduct the drilling completions and well interventions. The crude that will be produced via drilling from the subsea drill centres will be transported directly to the *SeaRose FPSO* for processing.

The majority of the emissions of CACs from the operation and maintenance of the subsea drill centres will result from the operation of the MODU, through the combustion of diesel fuel in the turbines and/or diesel engines. Typical annual emissions related to the operation of the MODU are presented in Table 7-24. The emissions presented in the below table was acquired from the 2011 emissions report prepared by the GSF Grand Banks Semi-Submersible MODU provided to Stantec by Husky. Emissions data pertaining to particulate matter was calculated using fuel usage and emission factors acquired from the US EPA AP-42, Compilation of Air Pollutant Emission Factors,

Chapter 3.4, Large Stationary Diesel and All Stationary Dual-fuel Engines (US EPA 1996b).

**Table 7-24 Estimated Annual Critical Air Contaminants Emissions from a Mobile Offshore Drilling Unit**

| Air Contaminant | Emissions (tonnes/year) |
|---|---|
| CO | 75.61 |
| $NO_X$ | 284.64 |
| $SO_2$ | 18.03 |
| TPM | 6.2 |
| $PM_{10}$ | 5.1 |
| $PM_{2.5}$ | 4.26 |
| Source: US EPA 1996b | |

To predict GLCs of CACs related to the operation of the MODU, air dispersion modelling was conducted using CALPUFF. Modelling details are included in "Air Emissions Study, White Rose Extension Project" (Stantec 2012c). The maximum predicted GLCs for the operation of the MODU are presented in Table 7-25.

**Table 7-25 Summary of Model Predictions - Maximum Predicted Ground Level Concentrations for Normal Operation of a Mobile Offshore Drilling Unit (Option 2)**

| Contaminant | Averaging Period | Receptor | Location (UTM) | | Maximum Predicted GLC (µg/m$^3$) | NL *Air Pollution Control Regulations, 2004* (µg/m$^3$) |
|---|---|---|---|---|---|---|
| | | | Easting (m) | Northing (m) | | |
| $NO_2$ | 1-hour | Hibernia | 669419 | 5179807 | 0.81 | 400 |
| | | Terra Nova | 693372 | 5149964 | 1.1 | |
| | | White Rose (*SeaRose FSPO*) | 727708 | 5186021 | 24.5 | |
| | 24-hour | Hibernia | 669419 | 5179807 | 0.16 | 200 |
| | | Terra Nova | 693372 | 5149964 | 0.3 | |
| | | White Rose (*SeaRose FSPO*) | 727708 | 5186021 | 8.10 | |
| | Annual | Hibernia | 669419 | 5179807 | 0.005 | 100 |
| | | Terra Nova | 693372 | 5149964 | 0.009 | |
| | | White Rose (*SeaRose FSPO*) | 727708 | 5186021 | 0.570 | |
| $SO_2$ | 1-hour | Hibernia | 669419 | 5179807 | 0.042 | 900 |
| | | Terra Nova | 693372 | 5149964 | 0.058 | |
| | | White Rose (*SeaRose FSPO*) | 727708 | 5186021 | 1.26 | |
| | 3-hour | Hibernia | 669419 | 5179807 | 0.026 | 600 |
| | | Terra Nova | 693372 | 5149964 | 0.049 | |
| | | White Rose (*SeaRose FSPO*) | 727708 | 5186021 | 0.980 | |
| | 24-hour | Hibernia | 669419 | 5179807 | 0.008 | 300 |
| | | Terra Nova | 693372 | 5149964 | 0.014 | |
| | | White Rose (*SeaRose FSPO*) | 727708 | 5186021 | 0.420 | |
| | Annual | Hibernia | 669419 | 5179807 | 0.000 | 60 |
| | | Terra Nova | 693372 | 5149964 | 0.001 | |
| | | White Rose (*SeaRose FSPO*) | 727708 | 5186021 | 0.029 | |
| CO | 1-hour | Hibernia | 669419 | 5179807 | 0.210 | 35,000 |
| | | Terra Nova | 693372 | 5149964 | 0.300 | |
| | | White Rose (*SeaRose FSPO*) | 727708 | 5186021 | 6.50 | |
| | 8-hour | Hibernia | 669419 | 5179807 | 0.072 | 15,000 |
| | | Terra Nova | 693372 | 5149964 | 0.140 | |
| | | White Rose (*SeaRose FSPO*) | 727708 | 5186021 | 3.80 | |

| Contaminant | Averaging Period | Receptor | Location (UTM) | | Maximum Predicted GLC (µg/m$^3$) | NL *Air Pollution Control Regulations, 2004* (µg/m$^3$) |
|---|---|---|---|---|---|---|
| | | | Easting (m) | Northing (m) | | |
| TPM | 1-hour | Hibernia | 669419 | 5179807 | 0.020 | - |
| | | Terra Nova | 693372 | 5149964 | 0.030 | |
| | | White Rose (*SeaRose FSPO*) | 727708 | 5186021 | 0.560 | |
| | 24-hour | Hibernia | 669419 | 5179807 | 0.004 | 120 |
| | | Terra Nova | 693372 | 5149964 | 0.006 | |
| | | White Rose (*SeaRose FSPO*) | 727708 | 5186021 | 0.180 | |
| | Annual | Hibernia | 669419 | 5179807 | 0.00 | 60 |
| | | Terra Nova | 693372 | 5149964 | 0.00 | |
| | | White Rose (*SeaRose FSPO*) | 727708 | 5186021 | 0.013 | |
| $PM_{10}$ | 1-hour | Hibernia | 669419 | 5179807 | 0.010 | - |
| | | Terra Nova | 693372 | 5149964 | 0.020 | |
| | | White Rose (*SeaRose FSPO*) | 727708 | 5186021 | 0.450 | |
| | 24-hour | Hibernia | 669419 | 5179807 | 0.003 | 50 |
| | | Terra Nova | 693372 | 5149964 | 0.005 | |
| | | White Rose (*SeaRose FSPO*) | 727708 | 5186021 | 0.150 | |
| $PM_{2.5}$ | 1-hour | Hibernia | 669419 | 5179807 | 0.010 | - |
| | | Terra Nova | 693372 | 5149964 | 0.020 | |
| | | White Rose (*SeaRose FSPO*) | 727708 | 5186021 | 0.390 | |
| | 24-hour | Hibernia | 669419 | 5179807 | 0.003 | 25 |
| | | Terra Nova | 693372 | 5149964 | 0.004 | |
| | | White Rose (*SeaRose FSPO*) | 727708 | 5186021 | 0.130 | |

Results from the air dispersion modelling for normal operation of the MODU, as presented in Table 7-25, show that the emissions would meet the Newfoundland and Labrador *Air Pollution Control Regulations, 2004* and the NAAQ objectives.

During the operation of the subsea drill centres, emissions of CACs will also result from the operation of supply and support vessels as well as helicopters. These emissions will be similar to those presented above in Table 7-21. The MODU may conduct flaring for short periods during well testing (not scheduled). Such emissions would be similar in magnitude to those presented in Table 7-21, for normal flaring on the WHP.

### *Change in Greenhouse Gas Emissions*

During the operation of the subsea drill centres, emissions of GHGs will result from the operation of the MODU, associated vessels and helicopters. GHGs, including $CO_2$, $N_2O$ and $CH_4$, are emitted during the combustion of diesel fuel in turbines and diesel engines. An emissions inventory for the GHG emissions related to the operation of the MODU was prepared and the results are presented in Table 7-26. GHG emissions from the operation of the MODU were acquired from Husky. Emissions for the operation of support vessels were calculated using emission factors acquired from the US EPA, “Best Practices in Preparing Port Emission Inventories” (US EPA 2005) and the US EPA “Analysis of Commercial Marine Vessels Emissions and Fuel Consumption Data” (US EPA 2000b). Emissions from the operation of the helicopters were calculated using emission factors acquired from the Climate Registry, “Default Emission Factors” (2012).

**Table 7-26 Greenhouse Gas Emissions from the Operation of a Mobile Offshore Drilling Unit**

| Activity | $CO_2$ | $CH_4$ | $N_2O$ | $CO_{2eq}$ (tonnes/year) |
|---|---|---|---|---|
| MODU Operation | 14,800 | 0.83 | 1.01 | 15,132 |
| Operation of Support Vessel | 47,485 | 0 (A) | 0 (A) | 47,485 |
| Operation of Helicopter | 403 | 0.01 | 0.04 | 416 |
| Total | 62,688 | 0.84 | 1.05 | 63,033 |

Source: US EPA 2000b, 2005; Climate Registry 2012
(A) Emissions of $CH_4$ and $N_2O$ have been determined to be minimal

A summary of the potential environmental effects on the Air Quality during the operations and maintenance phase of the WREP is provided in Table 7-27.

#### 7.6.2.3 Offshore Decommissioning and Abandonment

WREP activities associated with decommissioning and abandonment of the WHP and subsea drill centres will be similar to those associated with construction and installation, with regard to emissions of CACs and GHGs. Particularly, emissions may result from the operation of vessels and helicopters, which will be required to aid in the removal of the WHP and MODU, plugging and abandoning of the wells and to conduct surveys. The environmental effect of each of these activities will be temporary in nature and medium in magnitude, geographic extent and duration. The same mitigation measures will be implemented during decommissioning as were used during construction.

The summary of potential environmental effects on the Air Quality from decommissioning and abandonment-related activities is provided in Table 7-28.

**Table 7-27 Air Quality Environmental Effects Assessment Matrix (Operation and Maintenance)**

| WREP Activity | Potential Positive (P) or Negative (N) Environmental Effect | Mitigation Measure | Evaluation Criteria for Assessing Environmental Effects [A] | | | | | | Significance Rating | Level of Confidence |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | Magnitude | Geographic Extent | Frequency | Duration | Reversibility | Ecological / Socio-cultural / Economic Significance | | |
| Power generation and pilot flaring | Change in air quality (N)<br>Change in GHG emissions (N) | • Efficient technology<br>• Use of natural gas as primary fuel | M | 3 | 1 | 5 | R | 2 | NS | H |
| Operation of helicopters and vessels | Change in air quality (N)<br>Change in GHG emissions (N) | • Properly maintained and efficient operation<br>• Maintenance and inspections | M | 3 | 1 | 5 | R | 2 | NS | H |
| Maintenance activities | Change in Air Quality (N) | | N | 1 | 1 | 5 | R | 2 | NS | H |
| Vent and flare system | Change in air quality (N)<br>Change in GHG emissions (N) | • Monitor the number of flaring events<br>• Investigate the use of efficient/reduced emission and incorporate into design where technically and economically feasible. | M | 3 | 1 | 5 | R | 2 | NS | H |
| Operation of the MODU (Option 2) | Change in air quality (N)<br>Change in GHG emissions (N) | • Properly maintained and efficient operation<br>• Maintenance and inspections | M | 3 | 1 | 4 | R | 2 | NS | H |

Key:

**Magnitude:**
N = Negligible (essentially no effect)
L = Low: <10 percent of the population or habitat in the Study Area will be affected
M = Medium: 11 to 25 percent of the population or habitat in the Study Area will be affected
H = High: >25 percent of the population or habitat in the Study Area will be affected

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

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

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

**Reversibility** (population level):
R = Reversible
I = Irreversible

**Ecological / Socio-cultural / Economic Significance:**
1 = Relatively pristine area not affected by human activity
2 = Evidence of existing adverse activity
3 = High level of existing adverse activity

**Significance Rating:**
S = Significant
NS = Not Significant
P = Positive

**Level of Confidence:**
L = Low level of confidence
M = Medium level of confidence
H = High level of confidence

**Table 7-28 Air Quality Environmental Effects Assessment Matrix (Decommissioning and Abandonment)**

| WREP Activity | Potential Positive (P) or Negative (N) Environmental Effect | Mitigation Measure | Evaluation Criteria for Assessing Environmental Effects (A) | | | | | | Significance Rating | Level of Confidence |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | Magnitude | Geographic Extent | Frequency | Duration | Reversibility | Ecological / Socio-cultural / Economic Significance | | |
| Operation of helicopters and vessels | Change in air quality (N)<br>Change in GHG emissions (N) | • Properly maintained and efficient operation<br>• Maintenance and inspections | L | 3 | 1 | 3 | R | 2 | NS | H |

Key:

**Magnitude:**
N = Negligible (essentially no effect)
L = Low: <10 percent of the population or habitat in the Study Area will be affected
M = Medium: 11 to 25 percent of the population or habitat in the Study Area will be affected
H = High: >25 percent of the population or habitat in the Study Area will be affected

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

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

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

**Reversibility** (population level):
R = Reversible
I = Irreversible

**Ecological / Socio-cultural / Economic Significance:**
1 = Relatively pristine area not affected by human activity
2 = Evidence of existing adverse activity
3 = High level of existing adverse activity

**Significance Rating:**
S = Significant
NS = Not Significant
P = Positive

**Level of Confidence:**
L = Low level of confidence
M = Medium level of confidence
H = High level of confidence

(A) Where there is more than one potential environmental effect, the evaluation criteria rating is assigned to the environmental effect with the greatest potential for harm

#### 7.6.2.4 Potential Future Activities

Throughout the operation of the WHP and subsea drill centres, other potential future activities could occur that would result in emissions of CACs and GHGs through the combustion of diesel fuel in vessels conducting surveys (e.g., geophysical, geotechnical, environmental, diving, ROVs), excavation of drill centres, drilling operations from an MODU, hook up and commissioning of additional drill centres and installation of flowlines. The emissions related to such activities would be comparable to the emissions that were assessed for the operation of both the WHP and subsea drill center options.

#### 7.6.2.5 Accidental Events

**Change in Air Quality**

Accidental releases of air emissions (CACs) during the operation of the WHP or MODU in the offshore environment could result from marine diesel fuel spill from a support vessel or the WHP/MODU, flare blowdown event, subsea hydrocarbon blowout, hydrocarbon surface spill or marine vessel incidents (including collisions). Each of these events would result in the release of hydrocarbons and therefore, the release of fugitive air emissions into the atmosphere. A number of preventative or mitigative measures would limit the magnitude, extent, duration and overall effect on Air Quality, if the event took place; these include:

- Spill prevention
- Training, preparation, equipment inventory, prevention and emergency response drills
- Routine inspections of equipment
- no re-fuelling of vessels in the Nearshore Project Area
- Oil Spill Response Plan
- Emergency Response Contingency Plan
- Adherence to MARPOL.

There is also a risk of an explosion and/or fire in the case of fuel and chemical leaks or spills. Systems, resources and training will be in place to reduce the likelihood of explosions and fires on the platform and to respond to any such incidents that occur.

Accidental releases of air emissions could also result during emergency flaring events. Emergency flaring allows for the prevention of over-pressurization of equipment and safely disposes of associated gas during process upset conditions. During a depressurization blowdown, greater volumes of gas tend to be flared over short periods of time. Husky has determined that approximately 7,400 $m^3$ (Husky 2012d) of gas could be flared following a WHP blowdown. The estimated emissions related to a WHP blowdown are provided in Table 7-29. These emissions were calculated using emission factors acquired from the US EPA AP-42, Compilation of Air Pollutant Emission Factors, Chapter 13.5, Industrial Flares (US EPA 1991) assuming that the release would occur

over a 10-minute period and a total of 12 blowdowns could occur within any given year. If a similar situation was to occur while drilling from the MODU, emissions of similar magnitude would be released.

**Table 7-29 Flaring Emissions Resulting from a Wellhead Platform Blowdown**

| Activity | Total Emissions (tonnes/year) | | | | |
|---|---|---|---|---|---|
| | CO | $NO_X$ | TPM | $PM_{10}$ | $PM_{2.5}$ |
| Flaring – Depressurization | 0.00044 | 0.097 | 0.011 | 0.011 | 0.011 |
| Source: US EPA 1991 | | | | | |

Air dispersion modelling was performed to predict the maximum ambient GLCs during a WHP flare blowdown event. Modelling details are provided in "Air Emissions Study, White Rose Extension Project" (Stantec 2012c). The maximum predicted GLCs during a WHP flare blowdown event are presented in Table 7-30.

**Table 7-30 Summary of Model Predictions - Maximum Predicted Ground-level Concentration for a Wellhead Platform Flare Blowdown Event**

| Contaminant | Averaging Period | Receptor | Location (UTM) | | Maximum Predicted GLC ($\mu g/m^3$) | NL *Air Pollution Control Regulations, 2004* ($\mu g/m^3$) |
|---|---|---|---|---|---|---|
| | | | Easting (m) | Northing (m) | | |
| $NO_2$ | 1-hour | Hibernia | 669419 | 5179807 | 0.682 | 400 |
| | | Terra Nova | 693372 | 5149964 | 0.784 | |
| | | White Rose (*SeaRose FSPO*) | 727708 | 5186021 | 7.45 | |
| | 24-hour | Hibernia | 669419 | 5179807 | 0.105 | 200 |
| | | Terra Nova | 693372 | 5149964 | 0.164 | |
| | | White Rose (*SeaRose FSPO*) | 727708 | 5186021 | 3.69 | |
| | Annual | Hibernia | 669419 | 5179807 | 0.004 | 100 |
| | | Terra Nova | 693372 | 5149964 | 0.005 | |
| | | White Rose (*SeaRose FSPO*) | 727708 | 5186021 | 0.200 | |
| $SO_2$ | 1-hour | Hibernia | 669419 | 5179807 | 0.010 | 900 |
| | | Terra Nova | 693372 | 5149964 | 0.011 | |
| | | White Rose (*SeaRose FSPO*) | 727708 | 5186021 | 0.105 | |
| | 3-hour | Hibernia | 669419 | 5179807 | 0.007 | 600 |
| | | Terra Nova | 693372 | 5149964 | 0.005 | |
| | | White Rose (*SeaRose FSPO*) | 727708 | 5186021 | 0.103 | |
| | 24-hour | Hibernia | 669419 | 5179807 | 0.001 | 300 |
| | | Terra Nova | 693372 | 5149964 | 0.002 | |
| | | White Rose (*SeaRose FSPO*) | 727708 | 5186021 | 0.052 | |
| | Annual | Hibernia | 669419 | 5179807 | 0.000 | 60 |
| | | Terra Nova | 693372 | 5149964 | 0.000 | |
| | | White Rose (*SeaRose FSPO*) | 727708 | 5186021 | 0.003 | |
| CO | 1-hour | Hibernia | 669419 | 5179807 | 0.153 | 35,000 |
| | | Terra Nova | 693372 | 5149964 | 0.176 | |
| | | White Rose (*SeaRose FSPO*) | 727708 | 5186021 | 1.67 | |
| | 8-hour | Hibernia | 669419 | 5179807 | 0.070 | 15,000 |
| | | Terra Nova | 693372 | 5149964 | 0.059 | |
| | | White Rose (*SeaRose FSPO*) | 727708 | 5186021 | 1.46 | |

| Contaminant | Averaging Period | Receptor | Location (UTM) | | Maximum Predicted GLC (µg/m$^3$) | NL *Air Pollution Control Regulations, 2004* (µg/m$^3$) |
|---|---|---|---|---|---|---|
| | | | Easting (m) | Northing (m) | | |
| TPM | 1-hour | Hibernia | 669419 | 5179807 | 0.013 | - |
| | | Terra Nova | 693372 | 5149964 | 0.015 | |
| | | White Rose (*SeaRose FSPO*) | 727708 | 5186021 | 0.147 | |
| | 24-hour | Hibernia | 669419 | 5179807 | 0.002 | 120 |
| | | Terra Nova | 693372 | 5149964 | 0.003 | |
| | | White Rose (*SeaRose FSPO*) | 727708 | 5186021 | 0.073 | |
| | Annual | Hibernia | 669419 | 5179807 | 0.000 | 60 |
| | | Terra Nova | 693372 | 5149964 | 0.000 | |
| | | White Rose (*SeaRose FSPO*) | 727708 | 5186021 | 0.004 | |
| $PM_{10}$ | 1-hour | Hibernia | 669419 | 5179807 | 0.013 | - |
| | | Terra Nova | 693372 | 5149964 | 0.015 | |
| | | White Rose (*SeaRose FSPO*) | 727708 | 5186021 | 0.140 | |
| | 24-hour | Hibernia | 669419 | 5179807 | 0.002 | 50 |
| | | Terra Nova | 693372 | 5149964 | 0.003 | |
| | | White Rose (*SeaRose FSPO*) | 727708 | 5186021 | 0.070 | |
| $PM_{2.5}$ | 1-hour | Hibernia | 669419 | 5179807 | 0.012 | - |
| | | Terra Nova | 693372 | 5149964 | 0.014 | |
| | | White Rose (*SeaRose FSPO*) | 727708 | 5186021 | 0.132 | |
| | 24-hour | Hibernia | 669419 | 5179807 | 0.002 | 25 |
| | | Terra Nova | 693372 | 5149964 | 0.003 | |
| | | White Rose (*SeaRose FSPO*) | 727708 | 5186021 | 0.065 | |

Results from the air dispersion modelling for a flaring event during a WHP blowdown, as presented in Table 7-30, show that the emissions would meet the Newfoundland and Labrador *Air Pollution Control Regulations, 2004* and the NAAQ Objectives.

### Change in Greenhouse Gas Emissions

Accidental events that would lead to an unplanned release of GHGs in the Offshore Project Area during the operation of the WHP or subsea drill centre would include an emergency depressurization to the flare, subsea blowout or a fire resulting from a fuel or hydrocarbon spill.

A summary of the potential environmental effects on the Air Quality due to offshore accidental events attributable to WREP is provided in Table 7-31.

**Table 7-31 Air Quality Environmental Effects Assessment Matrix (Accidental Events Offshore)**

| WREP Activity | Potential Positive (P) or Negative (N) Environmental Effect | Mitigation Measure | Evaluation Criteria for Assessing Environmental Effects [A] | | | | | | Significance Rating | Level of Confidence |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | Magnitude | Geographic Extent | Frequency | Duration | Reversibility | Ecological / Socio-cultural / Economic Significance | | |
| Marine diesel fuel spill from support vessel and/or MODU | Change in air quality (N)<br>Change in GHG emissions (N) | • Conduct periodic maintenance and repair on vessels<br>• Train personnel in spill prevention and awareness<br>• Spill Response Plan | L | 5 | 1 | 2 | R | 2 | NS | H |
| Subsea hydrocarbon blowout from WHP or subsea drill centres | Change in air quality (N)<br>Change in GHG emissions (N) | • Drilling design and geotechnical surveys<br>• Alert/Emergency Response Contingency Plan<br>• Spill Response Plan | L | 5 | 1 | 3 | R | 2 | NS | H |
| Hydrocarbon surface spill from WHP or subsea drill centres | Change in air quality (N)<br>Change in GHG emissions (N) | • Conduct periodic maintenance and repair on Platform and vessels<br>• Train personnel in spill prevention<br>• SOPs for oil handling operations<br>• Spill Response Plan | L | 1 | 1 | 2 | R | 2 | NS | H |
| Flare blowdown event, WHP | Change in air quality (N)<br>Change in GHG emissions (N) | • Routine maintenance, including a LDAR<br>• Proper training for process operators | L | 2 | 2 | 1 | R | s | NS | H |
| Other spills (e.g., fuel) from WHP or subsea drill centres | Change in air quality (N)<br>Change in GHG emissions (N) | • Conduct periodic inspection, maintenance and repair of facilities and equipment<br>• Train personnel in spills management and awareness<br>• SOPs for chemical handling and storage<br>• Spill Response Plan | L | 1 | 1 | 2 | R | 2 | NS | H |
| Marine vessel incident (including collisions) | Change in air quality (N)<br>Change in GHG emissions (N) | • Risk awareness, emergency response and preventative measures, training on fuel handling and storage<br>• Spill Response Plan | L | 5 | 1 | 2 | R | 1 | NS | H |

| WREP Activity | Potential Positive (P) or Negative (N) Environmental Effect | Mitigation Measure | Evaluation Criteria for Assessing Environmental Effects [A] | | | | | | Significance Rating | Level of Confidence |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | Magnitude | Geographic Extent | Frequency | Duration | Reversibility | Ecological / Socio-cultural / Economic Significance | | |

Key:

**Magnitude:**
N = Negligible (essentially no effect)
L = Low: <10 percent of the population or habitat in the Study Area will be affected
M = Medium: 11 to 25 percent of the population or habitat in the Study Area will be affected
H = High: >25 percent of the population or habitat in the Study Area will be affected

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

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

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

**Reversibility** (population level):
R = Reversible
I = Irreversible

**Ecological / Socio-cultural / Economic Significance:**
1 = Relatively pristine area not affected by human activity
2 = Evidence of existing adverse activity
3 = High level of existing adverse activity

**Significance Rating:**
S = Significant
NS = Not Significant
P = Positive

**Level of Confidence:**
L = Low level of confidence
M = Medium level of confidence
H = High level of confidence

(A) Where there is more than one potential environmental effect, the evaluation criteria rating is assigned to the environmental effect with the greatest potential for harm

### 7.6.3 Cumulative Environmental Effects

In association with the WREP environmental effects analysis discussed in the previous sections, a review of other projects and activities that have potential for environmental effects to interact cumulatively with the WREP was conducted. Other projects for consideration of cumulative environmental effects include:

- Hibernia oil development and Hibernia Southern Extension (drilling and production)
- Terra Nova development (drilling and production)
- White Rose oilfield development (including North Amethyst and South White Rose extension drill centre) (drilling and production)
- Offshore exploration drilling activities
- Offshore exploration seismic activities
- Hebron oil development (construction and operation)
- Marine traffic (nearshore and offshore)
- Commercial fisheries (nearshore and offshore).

#### 7.6.3.1 Nearshore (Wellhead Platform Only)

The interaction of air emissions from marine traffic and commercial fisheries with the nearshore WREP construction activities could result in cumulative effects on Air Quality. However, the air emissions related to the nearshore construction of the CGS will be temporary, are relatively small in quantity, small in geographic extent and short in duration and thus are not likely to have substantial cumulative overlaps with other air emission in the Nearshore Study Area.

#### 7.6.3.2 Offshore

**Wellhead Platform**

***Change in Air Quality***

The ambient air quality in the Offshore Study Area reflects the influence of emissions from other projects and activities occurring within and outside the Offshore Project Area.

Long-range transport of airborne emissions also contributes additional loading to the local airshed from sources located on the eastern seaboard of the United States and Canada, outside of the Offshore Study Area. However, these contributions are likely to be on the margin of detection due to the distance from the eastern seaboard to the Offshore Project Area.

To assess the environmental effect that the operation of the existing (White Rose, Terra Nova and Hibernia) and planned (Hebron) oil developments would have on the air quality, air dispersion modelling was conducted. Modelling details are included in in the

"Air Emissions Study, White Rose Extension Project" (Stantec 2012c). The maximum predicted GLCs for the cumulative operation of the proposed WHP with the existing and planned oil developments is presented in Table 7-32. For each of the offshore installations, concentration mapping for $NO_2$ (the main contaminant of concern in the offshore environment) for all time periods modelled is illustrated in Figures 7-3 to 7-5.

**Table 7-32 Summary of Model Predictions - Maximum Predicted Ground-level Concentrations for the Cumulative Scenario (Wellhead Platform)**

| Contaminant | Averaging Period | Receptor | Location (UTM) | | Maximum Predicted GLC (µg/m$^3$) | NL *Air Pollution Control Regulations, 2004* (µg/m$^3$) |
|---|---|---|---|---|---|---|
| | | | Easting (m) | Northing (m) | | |
| $NO_2$ | 1-hour | Hibernia | 669419 | 5179807 | 15.04 | 400 |
| | | Terra Nova | 693372 | 5149964 | 34.3 | |
| | | White Rose (*SeaRose FSPO*) | 727708 | 5186021 | 12.76 | |
| | 24-hour | Hibernia | 669419 | 5179807 | 3.94 | 200 |
| | | Terra Nova | 693372 | 5149964 | 18.1 | |
| | | White Rose (*SeaRose FSPO*) | 727708 | 5186021 | 4.85 | |
| | Annual | Hibernia | 669419 | 5179807 | 0.147 | 100 |
| | | Terra Nova | 693372 | 5149964 | 0.537 | |
| | | White Rose (*SeaRose FSPO*) | 727708 | 5186021 | 0.496 | |
| $SO_2$ | 1-hour | Hibernia | 669419 | 5179807 | 0.010 | 900 |
| | | Terra Nova | 693372 | 5149964 | 0.011 | |
| | | White Rose (*SeaRose FSPO*) | 727708 | 5186021 | 0.105 | |
| | 3-hour | Hibernia | 669419 | 5179807 | 0.007 | 600 |
| | | Terra Nova | 693372 | 5149964 | 0.005 | |
| | | White Rose (*SeaRose FSPO*) | 727708 | 5186021 | 0.103 | |
| | 24-hour | Hibernia | 669419 | 5179807 | 0.001 | 300 |
| | | Terra Nova | 693372 | 5149964 | 0.002 | |
| | | White Rose (*SeaRose FSPO*) | 727708 | 5186021 | 0.052 | |
| | Annual | Hibernia | 669419 | 5179807 | 0.000 | 60 |
| | | Terra Nova | 693372 | 5149964 | 0.000 | |
| | | White Rose (*SeaRose FSPO*) | 727708 | 5186021 | 0.003 | |
| CO | 1-hour | Hibernia | 669419 | 5179807 | 3.137 | 35,000 |
| | | Terra Nova | 693372 | 5149964 | 1.944 | |
| | | White Rose (*SeaRose FSPO*) | 727708 | 5186021 | 1.825 | |
| | 8-hour | Hibernia | 669419 | 5179807 | 0.709 | 15,000 |
| | | Terra Nova | 693372 | 5149964 | 1.426 | |
| | | White Rose (*SeaRose FSPO*) | 727708 | 5186021 | 1.469 | |
| TPM | 1-hour | Hibernia | 669419 | 5179807 | 0.686 | - |
| | | Terra Nova | 693372 | 5149964 | 0.370 | |
| | | White Rose (*SeaRose FSPO*) | 727708 | 5186021 | 0.496 | |
| | 24-hour | Hibernia | 669419 | 5179807 | 0.068 | 120 |
| | | Terra Nova | 693372 | 5149964 | 0.110 | |
| | | White Rose (*SeaRose FSPO*) | 727708 | 5186021 | 0.073 | |
| | Annual | Hibernia | 669419 | 5179807 | 0.005 | 60 |
| | | Terra Nova | 693372 | 5149964 | 0.009 | |
| | | White Rose (*SeaRose FSPO*) | 727708 | 5186021 | 0.013 | |

| Contaminant | Averaging Period | Receptor | Location (UTM) | | Maximum Predicted GLC ($\mu g/m^3$) | NL *Air Pollution Control Regulations, 2004* ($\mu g/m^3$) |
|---|---|---|---|---|---|---|
| | | | Easting (m) | Northing (m) | | |
| $PM_{10}$ | 1-hour | Hibernia | 669419 | 5179807 | 0.686 | - |
| | | Terra Nova | 693372 | 5149964 | 0.370 | |
| | | White Rose (*SeaRose FSPO*) | 727708 | 5186021 | 0.496 | |
| | 24-hour | Hibernia | 669419 | 5179807 | 0.068 | 50 |
| | | Terra Nova | 693372 | 5149964 | 0.110 | |
| | | White Rose (*SeaRose FSPO*) | 727708 | 5186021 | 0.070 | |
| $PM_{2.5}$ | 1-hour | Hibernia | 669419 | 5179807 | 0.686 | - |
| | | Terra Nova | 693372 | 5149964 | 0.367 | |
| | | White Rose (*SeaRose FSPO*) | 727708 | 5186021 | 0.494 | |
| | 24-hour | Hibernia | 669419 | 5179807 | 0.067 | 25 |
| | | Terra Nova | 693372 | 5149964 | 0.110 | |
| | | White Rose (*SeaRose FSPO*) | 727708 | 5186021 | 0.067 | |

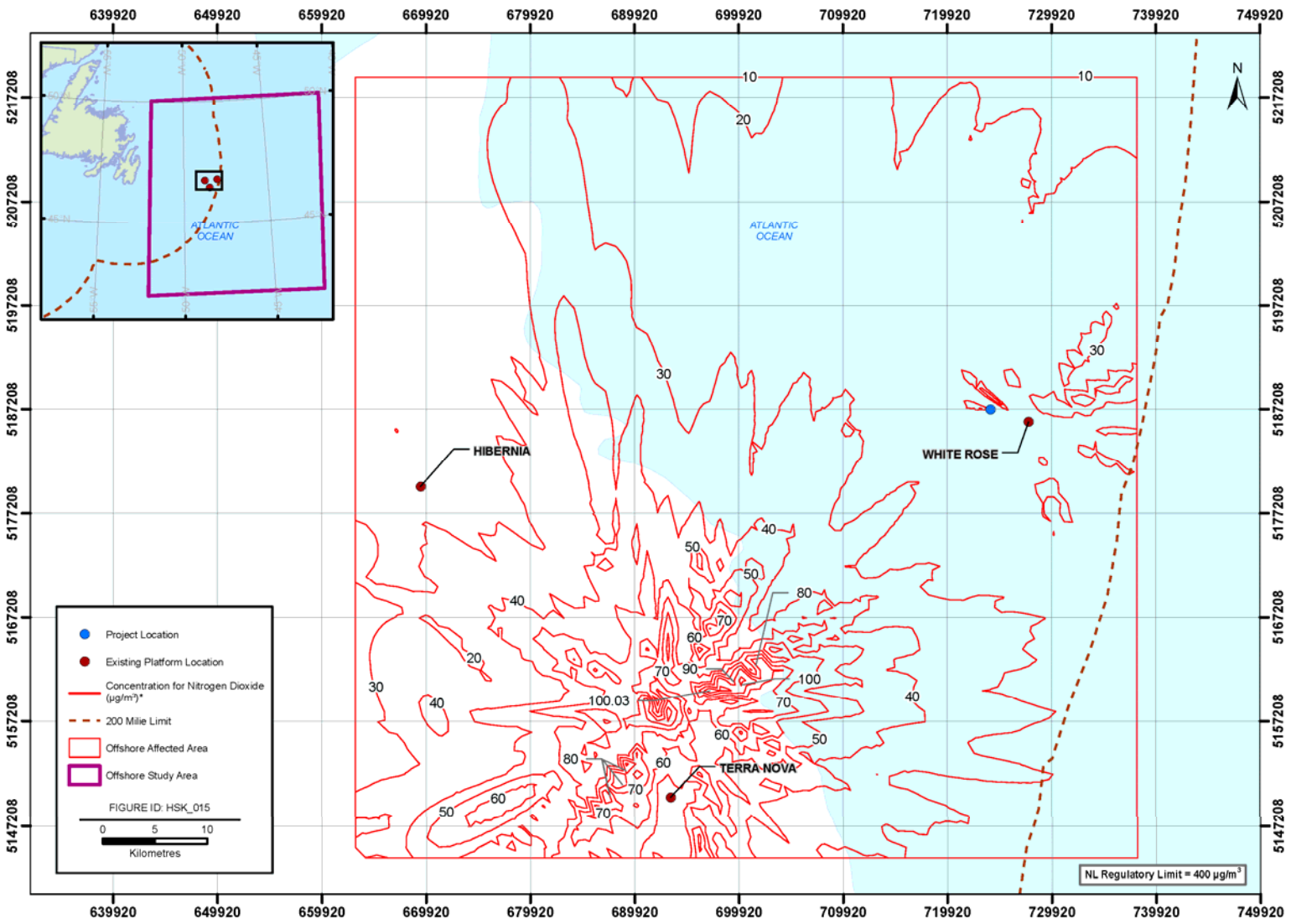



**Figure 7-3 Maximum Predicted 1-hour Ground Level Concentration for Nitrogen Dioxide – Wellhead Platform Cumulative**

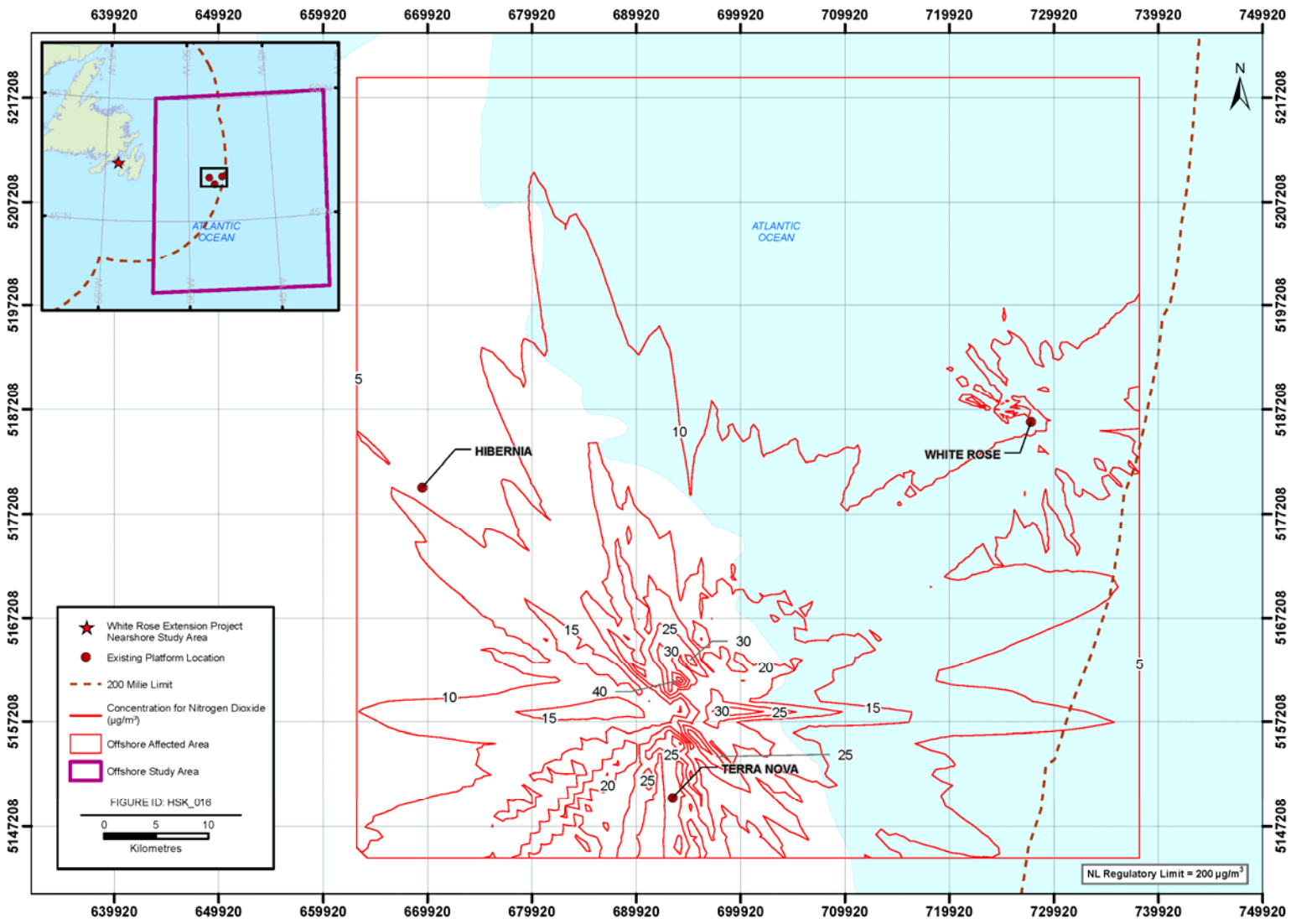



**Figure 7-4 Maximum Predicted 24-hour Ground Level Concentration for Nitrogen Dioxide – Wellhead Platform Cumulative**

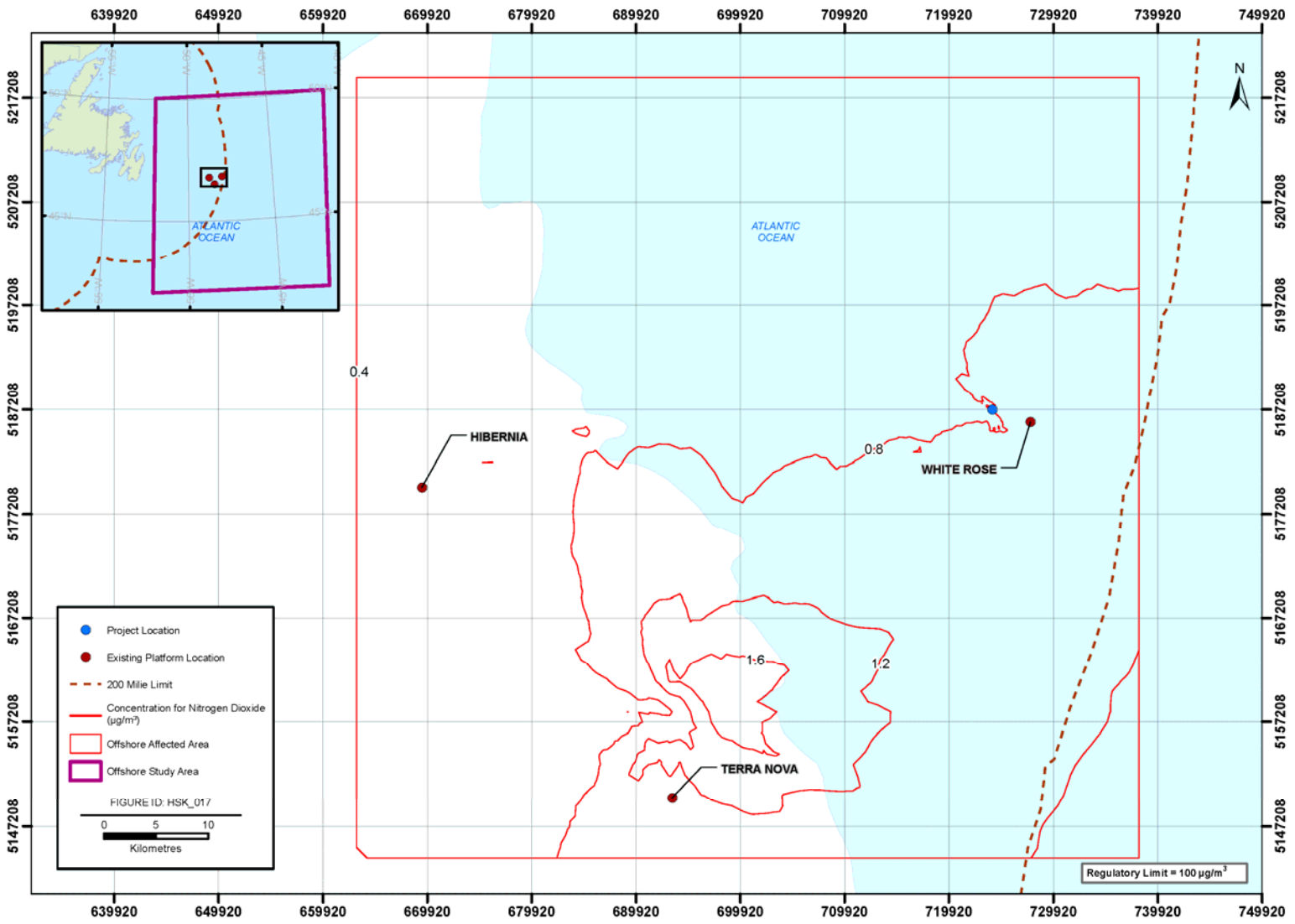



**Figure 7-5 Maximum Predicted Annual Ground Level Concentration for Nitrogen Dioxide – Wellhead Platform Cumulative**

Results from the air dispersion modelling, as presented in Table 7-32, show that the cumulative emissions resulting from the operation of all existing and currently planned oil developments would meet the Newfoundland and Labrador *Air Pollution Control Regulations, 2004* and the NAAQ Objectives. The cumulative environmental effects analysis modelling does not account for effects of downwash, which could increase GLCs in some cases in close proximity to the platforms.

### *Change in Greenhouse Gas Emissions*

The cumulative environmental effect of the release of GHGs during the operation of the WHP with the operation of the existing production platforms was assessed by preparing an emissions inventory of GHGs and comparing that reported for the other platforms.

The WHP will emit GHGs (including $CO_2$, $N_2O$ and $CH_4$) from power generation, routine and non-routine flaring and vessel and helicopter traffic. The individual contributions of GHGs from each of the existing platforms in the area and the WHP as well as their combined contribution are presented in Table 7-33.

**Table 7-33 2010 Greenhouse Gas Emissions Data by Platform against the National Total (Wellhead Platform – Option 1)**

| Facility | GHG Emissions (tonnes$CO_{2eq}$/year) | | | |
|---|---|---|---|---|
| | **$CO_2$** | **$CH_4$** | **$N_2O$** | **Total** |
| Terra Nova | 569,634 | 22,976 | 11,616 | 604,227 |
| Hibernia | 491,117 | 31,121 | 4,644 | 526,882 |
| *Sea Rose FPSO* | 394,690 | 27,691 | 9,405 | 431,786 |
| WREP Operation | 148,672 | 137 | 719 | 149,529 |
| National Total | 247,002,347 | 9,787,246 | 2,853,422 | 261,868,761 |
| Source: Environment Canada 2012c | | | | |

As presented in Table 7-33, the estimated GHG emissions resulting from the operation of the WHP are predicted to be much lower than those currently being reported from the other existing offshore developments in the area. Once in operation, the WHP will report annual emissions of CACs and GHG to Environment Canada under the NPRI and the National GHG Reporting schemes, as well as meet the reporting requirements pursuant to the Offshore Waste Treatment Guidelines.

## Subsea Drill Centres

### *Change in Air Quality*

Air dispersion modelling was conducted to assess the potential cumulative environmental effect that the operation of the MODU, together with existing and planned oil developments (Hebron), would have on air quality in the offshore affected area. The maximum predicted GLCs for the cumulative operation of the MODU with the existing and planned oil developments is presented in Table 7-34. Concentration mapping for $NO_2$ (the main contaminant of concern in the offshore environment) for each of the time periods modelled are presented in Figures 7-6 to 7-8.

**Table 7-34 Summary of Model Predictions - Maximum Prediction Ground-level Concentrations for the Cumulative Operation of the Mobile Offshore Drilling Unit (Option 2)**

| Contaminant | Averaging Period | Receptor | Location (UTM) | | Maximum Predicted GLC ($\mu g/m^3$) | NL *Air Pollution Control Regulations, 2004* ($\mu g/m^3$) |
|---|---|---|---|---|---|---|
| | | | Easting (m) | Northing (m) | | |
| $NO_2$ | 1-hour | Hibernia | 669419 | 5179807 | 15.00 | 400 |
| | | Terra Nova | 693372 | 5149964 | 34.3 | |
| | | White Rose (*SeaRose FSPO*) | 727708 | 5186021 | 23.60 | |
| | 24-hour | Hibernia | 669419 | 5179807 | 3.90 | 200 |
| | | Terra Nova | 693372 | 5149964 | 18.1 | |
| | | White Rose (*SeaRose FSPO*) | 727708 | 5186021 | 8.00 | |
| | Annual | Hibernia | 669419 | 5179807 | 0.150 | 100 |
| | | Terra Nova | 693372 | 5149964 | 0.540 | |
| | | White Rose (*SeaRose FSPO*) | 727708 | 5186021 | 0.850 | |
| $SO_2$ | 1-hour | Hibernia | 669419 | 5179807 | 0.056 | 900 |
| | | Terra Nova | 693372 | 5149964 | 0.076 | |
| | | White Rose (*SeaRose FSPO*) | 727708 | 5186021 | 1.590 | |
| | 3-hour | Hibernia | 669419 | 5179807 | 0.034 | 600 |
| | | Terra Nova | 693372 | 5149964 | 0.065 | |
| | | White Rose (*SeaRose FSPO*) | 727708 | 5186021 | 1.200 | |
| | 24-hour | Hibernia | 669419 | 5179807 | 0.011 | 300 |
| | | Terra Nova | 693372 | 5149964 | 0.018 | |
| | | White Rose (*SeaRose FSPO*) | 727708 | 5186021 | 0.540 | |
| | Annual | Hibernia | 669419 | 5179807 | 0.000 | 60 |
| | | Terra Nova | 693372 | 5149964 | 0.001 | |
| | | White Rose (*SeaRose FSPO*) | 727708 | 5186021 | 0.037 | |
| CO | 1-hour | Hibernia | 669419 | 5179807 | 3.140 | 35,000 |
| | | Terra Nova | 693372 | 5149964 | 1.940 | |
| | | White Rose (*SeaRose FSPO*) | 727708 | 5186021 | 6.230 | |
| | 8-hour | Hibernia | 669419 | 5179807 | 0.700 | 15,000 |
| | | Terra Nova | 693372 | 5149964 | 1.400 | |
| | | White Rose (*SeaRose FSPO*) | 727708 | 5186021 | 3.700 | |
| TPM | 1-hour | Hibernia | 669419 | 5179807 | 0.690 | - |
| | | Terra Nova | 693372 | 5149964 | 0.370 | |
| | | White Rose (*SeaRose FSPO*) | 727708 | 5186021 | 0.570 | |
| | 24-hour | Hibernia | 669419 | 5179807 | 0.070 | 120 |
| | | Terra Nova | 693372 | 5149964 | 0.110 | |
| | | White Rose (*SeaRose FSPO*) | 727708 | 5186021 | 0.180 | |
| | Annual | Hibernia | 669419 | 5179807 | 0.005 | 60 |
| | | Terra Nova | 693372 | 5149964 | 0.010 | |
| | | White Rose (*SeaRose FSPO*) | 727708 | 5186021 | 0.021 | |
| $PM_{10}$ | 1-hour | Hibernia | 669419 | 5179807 | 0.690 | - |
| | | Terra Nova | 693372 | 5149964 | 0.370 | |
| | | White Rose (*SeaRose FSPO*) | 727708 | 5186021 | 0.500 | |
| | 24-hour | Hibernia | 669419 | 5179807 | 0.070 | 50 |
| | | Terra Nova | 693372 | 5149964 | 0.110 | |
| | | White Rose (*SeaRose FSPO*) | 727708 | 5186021 | 0.150 | |

| Contaminant | Averaging Period | Receptor | Location (UTM) | | Maximum Predicted GLC ($\mu g/m^3$) | NL *Air Pollution Control Regulations, 2004* ($\mu g/m^3$) |
|---|---|---|---|---|---|---|
| | | | Easting (m) | Northing (m) | | |
| $PM_{2.5}$ | 1-hour | Hibernia | 669419 | 5179807 | 0.690 | - |
| | | Terra Nova | 693372 | 5149964 | 0.370 | |
| | | White Rose (*SeaRose FSPO*) | 727708 | 5186021 | 0.490 | |
| | 24-hour | Hibernia | 669419 | 5179807 | 0.070 | 25 |
| | | Terra Nova | 693372 | 5149964 | 0.110 | |
| | | White Rose (*SeaRose FSPO*) | 727708 | 5186021 | 0.130 | |

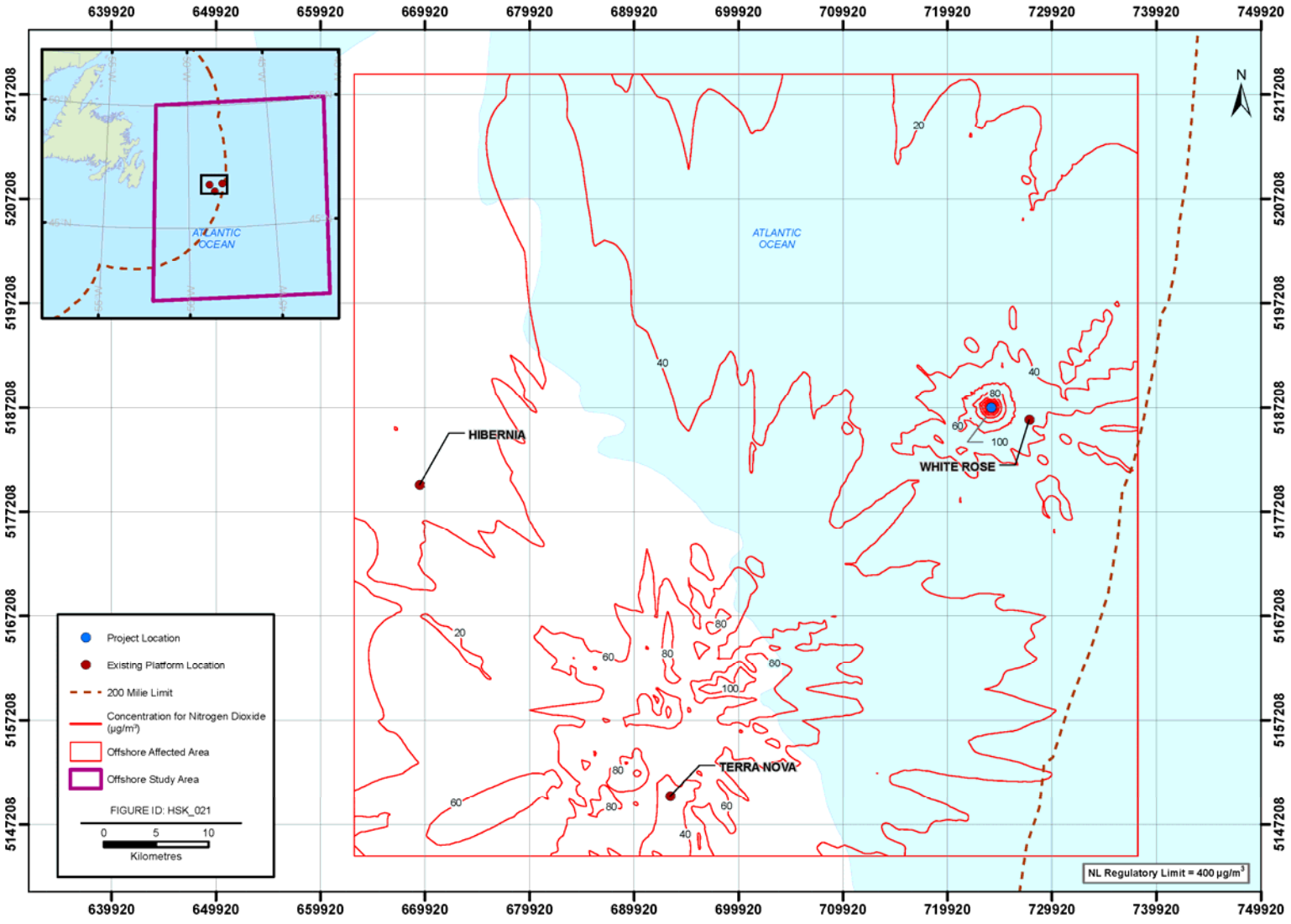



**Figure 7-6 Maximum Predicted 1-hour Ground Level Concentration for Nitrogen Dioxide – Mobile Offshore Drilling Unit Cumulative**

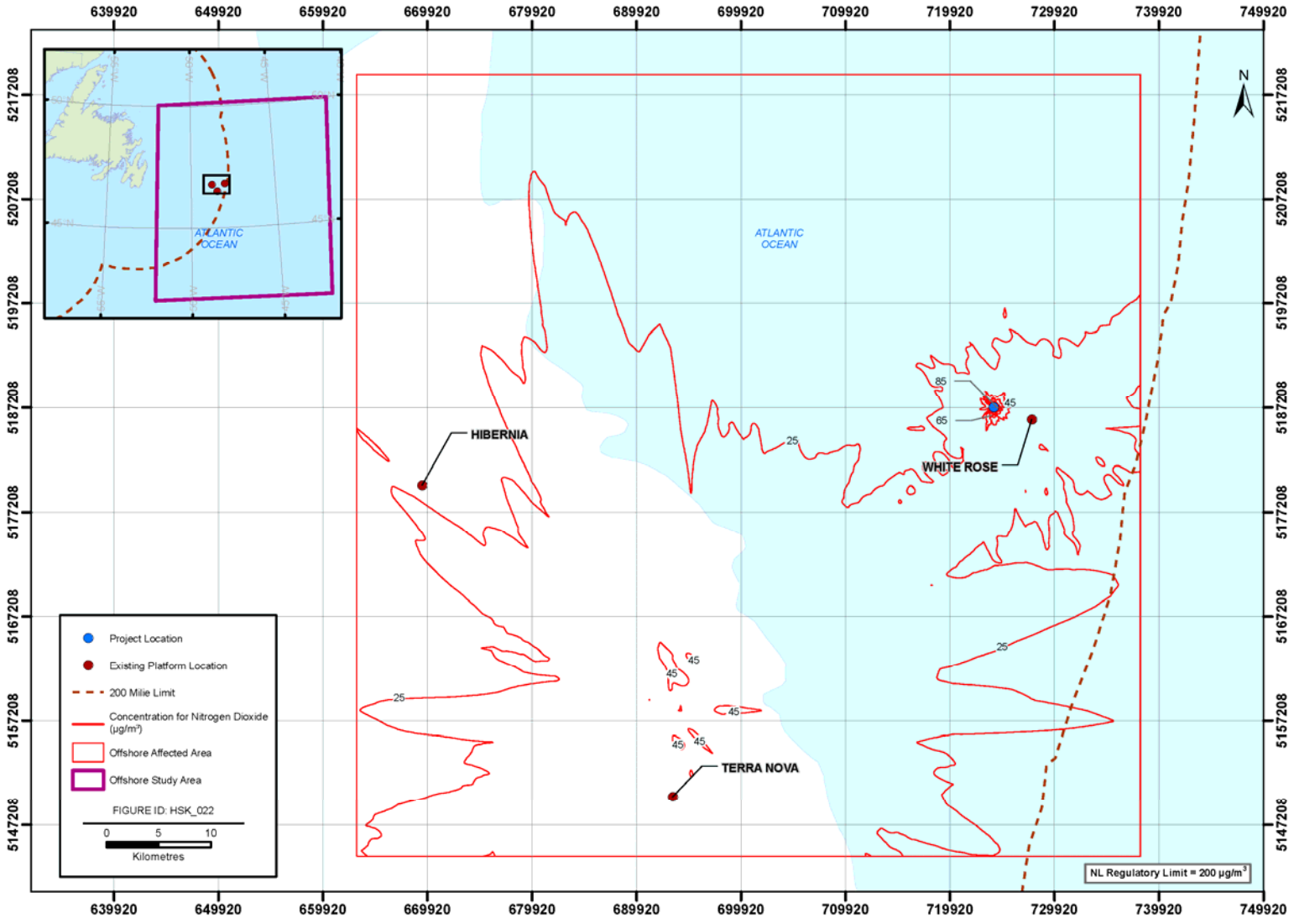



**Figure 7-7 Maximum Predicted 24-hour Ground Level Concentration for Nitrogen Dioxide – Mobile Offshore Drilling Unit Cumulative**

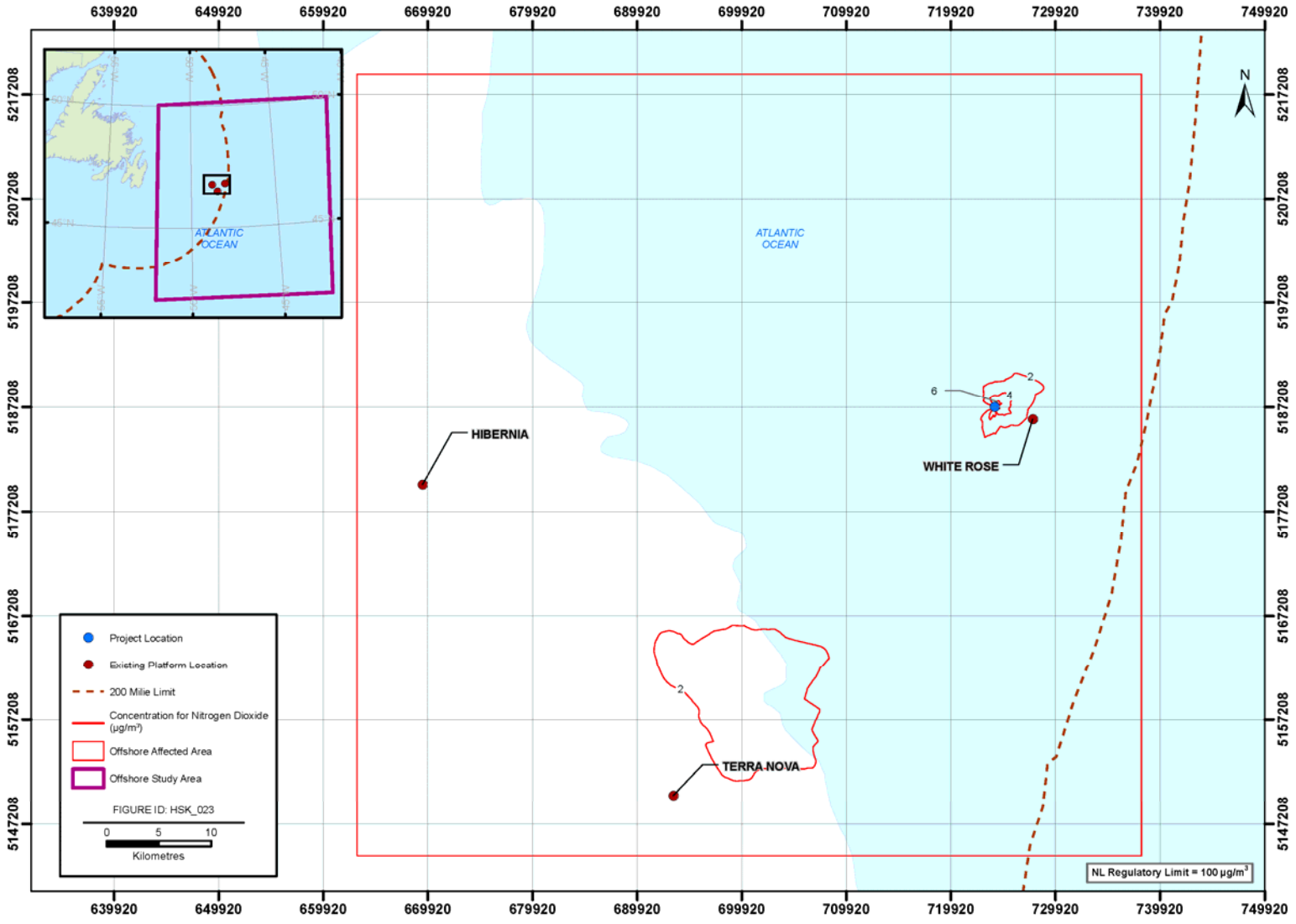



**Figure 7-8 Maximum Predicted Annual Ground Level Concentration for Nitrogen Dioxide – Mobile Offshore Drilling Unit Cumulative**

### *Change in Greenhouse Gas Emissions*

As with the operation of the WHP, the cumulative environmental effect of the release of GHGs during the operation of the MODU with the operation of the existing production platforms was assessed by preparing an emissions inventory of GHGs and comparing the emission estimates to those currently reported to Environment Canada by the existing platforms offshore eastern Newfoundland and Labrador.

The MODU will emit GHGs (including $CO_2$, $N_2O$ and $CH_4$) from the combustion of diesel fuel in turbines and/or diesel engines. The individual contributions of GHGs from each of the existing platforms in the area and the MODU as well as their combined contribution are presented in Table 7-35.

**Table 7-35 2010 Greenhouse Gas Emissions Data by Platform and for the Operation of a Mobile Offshore Drilling Unit**

| Facility | GHG Emissions (tonnes$CO_{2eq}$/year) | | | |
|---|---|---|---|---|
| | $CO_2$ | $CH_4$ | $N_2O$ | Total |
| Terra Nova | 569,634 | 22,976 | 11,616 | 604,227 |
| Hibernia | 491,117 | 31,121 | 4,644 | 526,882 |
| *Sea Rose FPSO* | 394,690 | 27,691 | 9,405 | 431,786 |
| MODU Operation | 14,800 | 17.4 | 313 | 15,132 |
| Source: Environment Canada 2012c | | | | |

As with the cumulative operation of the WHP, the estimated GHG emissions resulting from the operation of the MODU are much lower than those currently being reported from the other existing offshore developments in the area. Once the WREP is in operation, the MODU will report annual emissions of CACs and GHG to Environment Canada under the NPRI and the National GHG Reporting schemes, as well as meet the reporting requirements pursuant to the OWTG (NEB et al. 2010).

## 7.6.4 Determination of Significance

The determination of significance is based on the definitions provided in Section 7.3. It considers the magnitude, geographic extent, duration, frequency, reversibility and ecological context of each environmental effect and their interactions, as presented in the preceding analysis.

### 7.6.4.1 Change in Air Quality

The change in air quality attributable to the construction, operation and decommissioning of the WREP (Option 1 and Option 2) is expected to be low in magnitude, local in extent, short-term in duration (during construction, but continue for the life of the WREP during operation) and reversible. Components associated with all phases of the WREP for both development options, including power generation, MODU operation, flaring and fugitive releases, as well as accidental releases and cumulative environmental effects, will result in emissions that will not exceed applicable maximum GLCs.

Therefore, by implementing the proposed mitigation measures, the environmental effects on Air Quality during the construction, operation and decommissioning phases of the WREP (including both development options), accidental events and cumulative environmental effects, is predicted to be not significant. A summary of the environmental effects for a change in air quality is provided in Table 7-36.

**Table 7-36 Residual Environmental Effects Summary: Change in Ambient Air Quality**

| Phase | Residual Adverse Environmental Effect Rating [(A)] | Level of Confidence | Probability of Occurrence (Likelihood) |
|---|---|---|---|
| Construction/Installation | NS | H | N/A [(B)] |
| Operation and Maintenance | NS | H | N/A |
| Decommissioning and Abandonment | NS | H | N/A |
| Accidental Events | NS | H | N/A |
| Cumulative Environmental Effects | NS | H | N/A |

KEY

Residual Environmental Effects Rating:
S = Significant Adverse Environmental Effect
NS = Not Significant Adverse Environmental Effect

Level of Confidence in the Effect Rating:
L = Low level of Confidence
M = Medium Level of Confidence
H = High level of Confidence

Probability of Occurrence of Significant Effect:
L = Low Probability of Occurrence
M = Medium Probability of Occurrence
H = High Probability of Occurrence
N/A = Not Applicable

NA = Not applicable
(A) As determined in consideration of established residual environmental effects rating criteria
(B) Effect is not predicted to be significant, therefore the probability of occurrence rating is not required under CEAA

### 7.6.4.2 Change in Greenhouse Gas Emissions

Construction and operation of the WREP (Option 1 and Option 2) will result in a change in GHG emissions. The magnitude of these emissions is ranked low (Option 2) to medium (Option 1) for both the construction (which applies only to Option 1) and operation phases (which applies to both options) of the WREP. Based on the information provided and the CEA Agency guidance (CEA Agency 2003), the WREP development Option 1 would require the preparation of a GHG Management Plan, as it has been found to be a medium emitter.

The geographic extent of a change in GHG emissions is provincial, national and ultimately, global. The duration is short-term during construction, but continues for the life of the WREP during the operations phase. Nevertheless, it is not yet possible to determine the environmental effect of these emissions on climate change (CEA Agency 2003). In the unlikely event of a large-scale accidental event, the WREP's GHG emissions will be temporarily increased.

Therefore, the WREP-related change in GHG emissions, including accidental events, and the potential cumulative change in GHG emissions, is rated as not significant. There is moderate level of confidence in this significance prediction due to the evolving nature of climate change science and the contributions of anthropogenic GHG to climate change. A summary of the environmental effects for a change in GHG is provided in Table 7-37.

**Table 7-37 Residual Environmental Effects Summary Matrix – Greenhouse Gas Emissions**

| Phase | Residual Adverse Environmental Effect Rating [A] | Level of Confidence | Probability of Occurrence (Likelihood) |
|---|---|---|---|
| Construction/Installation | NS | M | N/A [B] |
| Operation and Maintenance | NS | M | N/A |
| Decommissioning and Abandonment | NS | M | N/A |
| Accidental Events | NS | M | N/A |
| Cumulative Environmental Effects | NS | M | N/A |

KEY

Residual Environmental Effects Rating:
S = Significant Adverse Environmental Effect
NS = Not Significant Adverse Environmental Effect

Level of Confidence in the Effect Rating:
L = Low level of Confidence
M = Medium Level of Confidence
H = High level of Confidence

Probability of Occurrence of Significant Effect:
L = Low Probability of Occurrence
M = Medium Probability of Occurrence
H = High Probability of Occurrence
N/A = Not Applicable

NA = Not Applicable
(A) As determined in consideration of established residual environmental effects rating criteria
(B) Effect is not predicted to be significant, therefore the probability of occurrence rating is not required under CEAA

### 7.6.5 Follow-up and Monitoring

During the construction of the WREP (including both development options), there is no proposed follow-up or monitoring required for air quality or GHG.

In the operation and maintenance phase, there is no proposed follow-up or monitoring required for air quality or GHG, beyond the routine reporting under Environment Canada (NPRI and GHG Reporting). The WREP (including both development options) will adhere to proactive maintenance scheduling and procedures to monitor and reduce factors such as corrosion, vibration, mechanical wear and fatigue. During the operation of the WREP, compliance with environmental regulatory requirements and standards and emissions of CACs and GHGs will be documented annually and submitted as required by federal government reporting program.

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# 8.0 FISH AND FISH HABITAT

The Fish and Fish Habitat VEC includes marine finfish and shellfish and the habitat upon which they depend, including benthic habitat, plankton, water and sediment. Under Canada's *Fisheries Act*, 'fish habitat' refers to spawning grounds, nursery grounds and areas used for rearing, food, supply and migration that fish depend upon directly or indirectly as part of their life cycle. Potential environmental effects of routine WREP activities and accidental events are assessed in this section. Fish and fish habitat was selected as a VEC because of:

- Regulatory requirements of the *Fisheries Act*
- Potential for change in habitat quality and habitat quantity and potential mortality due to WREP activities
- The ecological, social and economic importance of marine fish and fish habitat.

This VEC is of particular concern to fishers, fisheries managers, conservation organizations, marine scientists and other local stakeholders. This VEC focuses on species and habitat of shellfish and not-at-risk marine fish species (at risk species being listed on Schedule 1 of SARA or assessed as at risk by COSEWIC). Marine fish species at risk are described in Section 12.3.1 and assessed in Section 12.4.2.

## 8.1 Environmental Assessment Boundaries

### 8.1.1 Spatial Boundaries

The spatial boundaries of the Nearshore and Offshore Project and Study Areas are defined in the Effects Assessment Methods (Chapter 5; Figures 5-1 to 5-4). The Affected Areas for the WREP have been determined based on the results of modelling.

### 8.1.2 Temporal Boundaries

The temporal boundaries for the assessment are defined in Chapter 5 and outlined in Table 8-1. Specific temporal considerations for the assessment of Fish and Fish Habitat include seasonal aspects of their life cycles such as spawning and migration.

**Table 8-1 Temporal Boundaries of Nearshore and Offshore Study Areas**

| Study Area | Temporal Boundary |
|---|---|
| **Nearshore** | • In the case of the WHP development option, site preparation, graving dock construction, construction of CGS, dredging, topsides mating and tow-out will occur over an estimated 30 to 38 months from 2013 to 2016. Some activity will occur at all times of year until completion.<br>• In the case of the subsea drill centre development option, no nearshore activities will occur |
| **Offshore** | • In the case of the WHP development option, site preparation, installation of the WHP and initial production/maintenance will occur from 2016 to 2017. The WHP will be decommissioned and abandoned in accordance with standard practices at the end of its production life, which is anticipated to be 25 years<br>• The subsea drill centre option is scheduled to begin construction in 2014, with first oil expected in 2015. Under this option, the wells will be plugged and abandoned at the end of its production life (anticipated to be 20 years), and the subsea infrastructure removed or abandoned in accordance with relevant regulations |

### 8.1.3 Administrative Boundaries

Marine fish and fish habitat in Canada are protected under the *Fisheries Act* and by the *Policy for the Management of Fish Habitat* (DFO 1986), administered by DFO. The Act applies to all projects and activities in or near water and states that "*[N]o person shall carry on any work, undertaking or activity that results in the harmful alteration or disruption, or the destruction, of fish habitat.*" (*Fisheries Act*, Section 35(1)). The goal of the Policy is to achieve "*no net loss of the productive capacity of fish habitats*". In addition, Environment Canada administers Section 36 of the *Fisheries Act*, which prohibits the deposit of a deleterious substance in waters frequented by fish.

## 8.2 Definition of Significance

A significant adverse residual environmental effect is one that affects fish and/or fish habitat resulting in a decrease in abundance or alteration in distribution of the population over more than one generation within the Nearshore and/or Offshore Study Area. Natural recruitment may not reestablish the populations(s) to baseline conditions within several generations, or avoidance of the area become permanent.

A significant adverse residual environmental effect on fish habitat is one that results in an unmitigated or non-compensated net loss of fish habitat as required in the case of a harmful alteration, disruption or destruction (HADD) authorization under the *Fisheries Act*. An adverse environmental effect that does not meet the above criteria is evaluated as not significant.

## 8.3 Existing Environment

The physical environment of the Nearshore and Offshore Study Areas is described in Chapter 4. In the following sections, the environment pertaining to fish and fish habitat is briefly discussed for both the Nearshore and Offshore Study Areas. The main fish

habitat components include phytoplankton, zooplankton (including meroplankton), the water column, macroinvertebrates and benthic habitat. Where possible, site-specific primary and technical literature is used to describe the habitat. DFO survey data for NAFO Divisions 3Ps (includes Nearshore Study Area) and NAFO Division 3L (includes Offshore Project Area) has also been incorporated.

### 8.3.1 Nearshore

The Nearshore Study Area is located within the inner portion of Placentia Bay (Figure 5-2) and includes the area where construction activities will occur at Argentia and at the deep-water mating site (if the WHP option is selected). The Nearshore Study Area is considered to be biologically rich and ecologically important for many fish species that use the area for feeding, migration and spawning (Bradbury et al. 2000, 2003; Lawson and Rose 2000; Robichaud and Rose 2006; DFO 2007a; CPAWS 2009). Placentia Bay Extension has been designated an Ecologically and Biologically Sensitive Area (EBSA) by DFO (2007b) (refer to Section 13.3.1.1) within the Placentia Bay-Grand Banks Large Ocean Management Area (PBGB-LOMA), owing to its importance in the life cycle of many species, including Atlantic cod (*Gadus morhua*), cunner (*Tautogolabrus adspersus*) and capelin (*Mallotus villosus*). It has also been identified as one of five areas in Canada for 'Integrated Management' in order to manage increasing anthropogenic activities, while also protecting a diverse and ecologically important coastal system. Since 2000, DFO and the Government of Newfoundland and Labrador, as well as local stakeholders, have joined to form the Placentia Bay Integrated Management Planning Committee.

#### 8.3.1.1 Physical Environment

The physical environment of the Nearshore Study Area has been described in detail in previous environmental assessments in Placentia Bay (i.e., Newfoundland Transshipment Terminal (NTT) 1996; VBNC 2002, 2007; Newfoundland LNG Ltd. 2006; Newfoundland and Labrador Refining Corporation 2007). A detailed review of the oceanography of the Nearshore Study Area is provided in Section 4.2.2.

#### 8.3.1.2 Habitat

Placentia Bay is a deep water, exposed bay with shorelines dominated by coarse grained gravel and cliffs. Placentia Bay is approximately 105 km long and is bounded by the Burin Peninsula to the west and Avalon Peninsula to the east. The entrance to the Bay is approximately 87 km wide, and the average depth is 240 m at the middle of the Bay. The western side of the Bay is characterized by several islands, including Merasheen Island, Long Island and Red Island; as well as banks and shoals and highly productive coastal habitats such as eelgrass (*Zostera marina*) beds and salt marsh habitat (Catto et al. 1999). A well-defined channel runs along the eastern side of the Bay and is the designated shipping lane. The head of Placentia Bay has several estuaries (i.e., Come by Chance gut, Big Pond near Arnold's Cove, Swift Current), which provide important habitat for juvenile fish and shellfish and anadromous fishes (Catto et al. 1999). Exchange between the bay and the marine environment outside the bay is limited due to the bathymetry in this area (Davidson et al. 1984). Beaches shift seasonally and annually in response to changes in onshore-offshore movement of sediment (Catto et al. 1997; DFO 2008b).

The predominant vegetation in the intertidal zone are rockweeds (*Fucus* spp., *Ascophyllum nodosum*), *Corallina* spp. and sour weed (*Desmarestia* sp.), which occur in cobble and small boulder habitat (DFO 2008b). In the sheltered shallow subtidal, filamentous brown, green and red algae, fucoids and kelp occur, and in deeper nearshore water, patches of kelp and short filamentous brown macroalgae occur. Important fish habitat in the Nearshore Study Area includes eelgrass beds, macroalgal (e.g., rockweed, kelp) beds and capelin spawning beaches (pebble beaches). These habitats provide refugia, spawning grounds, nurseries and food resources. Placentia Bay is known to be important for Atlantic cod in particular (Bradbury et al. 2000; Lawson and Rose 2000; Robichaud and Rose 2006). Placentia Bay also supports a diversity of ichthyoplankton, including cod, cunner, American plaice (*Hippoglossoides platessoides*) and capelin (Bradbury et al. 2003).

A survey by Christian and Lee (1998) characterized the benthic communities in Argentia Harbour as dominated by sea stars, sand dollars (*Echinarachnius parma*) and winter flounder (*Pseudopleuronectes americanus*); although sea urchins, toad crab (*Hyas* spp.), rock crab (*Cancer irroratus*), hermit crab, mussels, sea scallops (*Placopecten magellanicus*), ocean pout (*Marcrozoarces americanus*), sculpin, cunner and whelks were also present in lower numbers. The survey by JWEL (1997) reported that sand-silt substrate with little algal cover was the dominant habitat in Argentia Harbour at depths greater than 15 m. Steep, rocky slope with bedrock, boulder and cobble substrate was continuous along the northwestern shore of the harbour in the shallow subtidal zone between Cooper Cove and Low Room Point. At the base of this rocky slope was a silt-sand substrate region with moderate to dense algal cover. Other than cunner, no fish were observed during this survey (JWEL 1997). However, this habitat type potentially provides cover and feeding grounds for several species of finfish and shellfish.

Husky completed detailed marine habitat surveys (Stantec 2012b) within the Nearshore Project Area in the fall and winter 2011/2012. The survey used a remotely operated vehicle (ROV) to collect underwater video at sites that have been proposed to be dredged as part of the WREP in order to facilitate graving dock construction (Site A on Figure 8-1) near Argentia and tow-out of the CGS (Corridors 1 and 2) (Sites 1A and 1B, respectively on Figure 8-1).

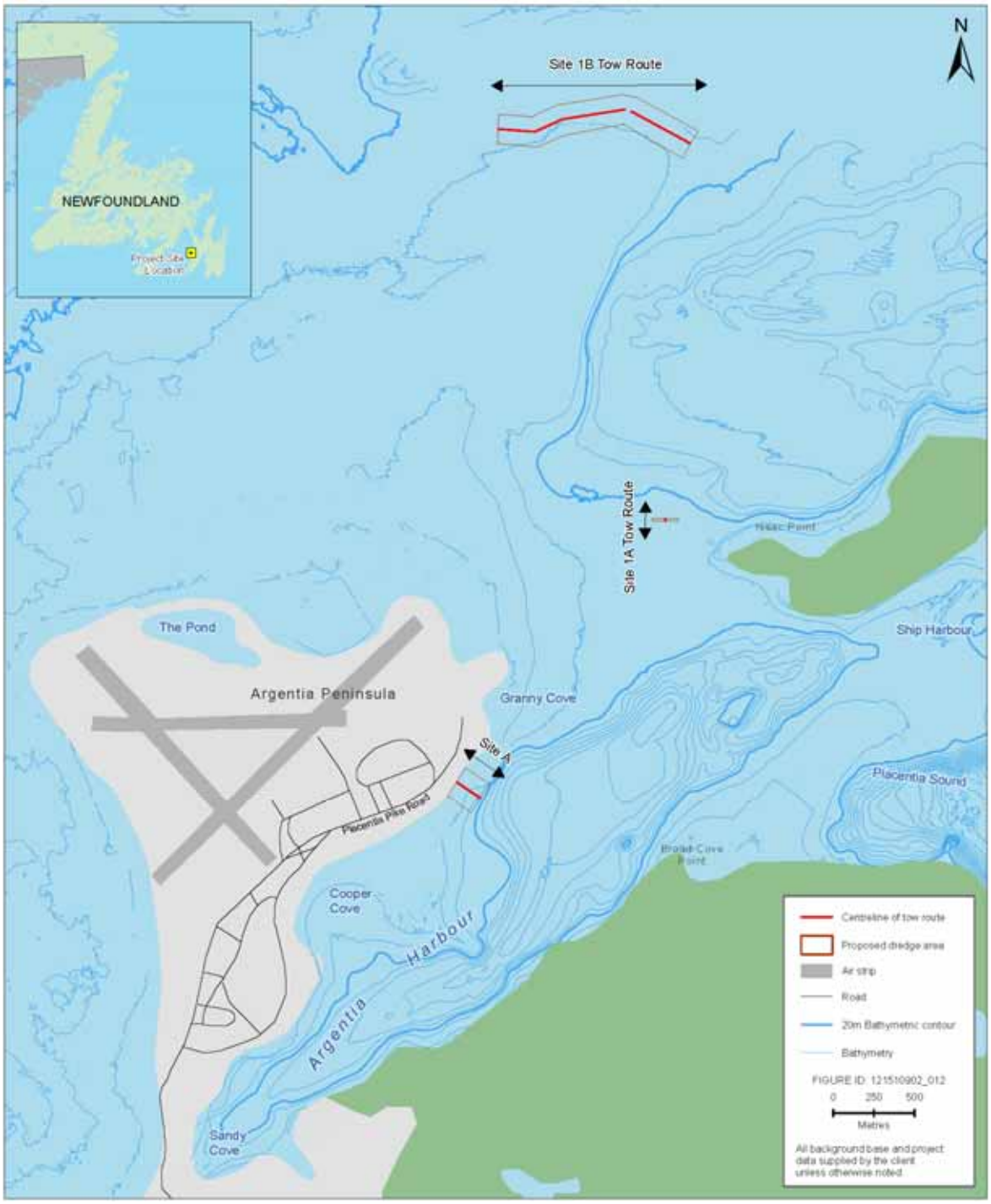
The nearshore of the graving dock location is characterized by a flat sandy beach. There are remnants of a slipway at the western edge of the shoreline at the graving dock location. From above the mean high tide mark to a subtidal water depth of 30 m, the following habitats were observed (Stantec 2012b):

- The backshore is comprised of sand dunes with grass and sedge vegetative cover and has an elevation of approximately 2 m above sea level.

- The backshore changes abruptly to the foreshore, which is marked by a sandy beach ridge.

- The intertidal zone is composed mostly of sand, with some cobble/gravel mix and trace rubble.

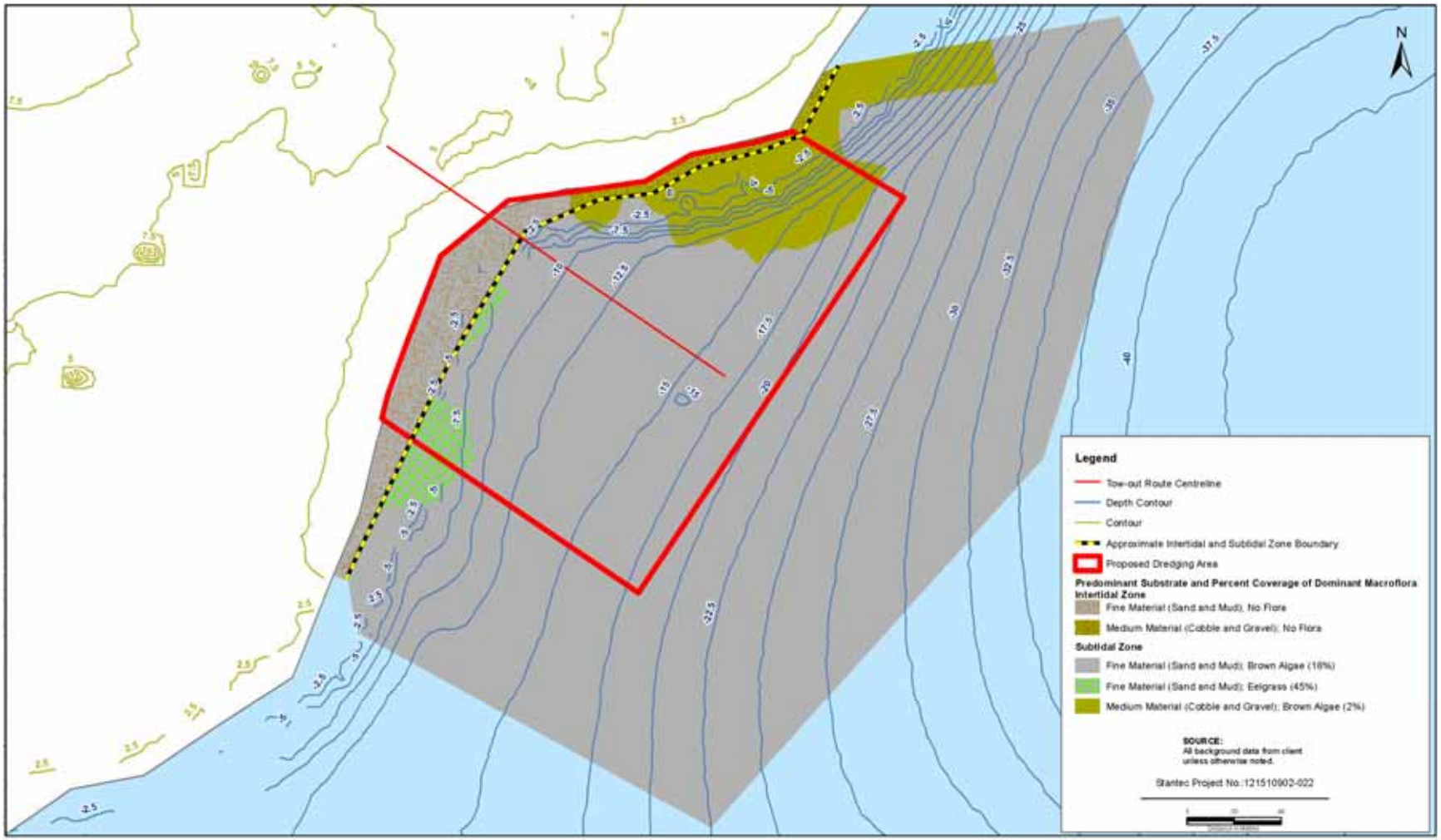
- The shallow subtidal zone extends from mean low tide to a depth of 30 m, and is routinely influenced by wave action. Substrate in this zone consisted mostly of sand and fines, with some rubble/cobble/gravel mix.




Source: Stantec 2012b

**Figure 8-1 Location of Proposed Dredge Sites In Nearshore Project Area**

ROV surveys were used to characterize the subtidal habitat near the graving dock. The most common substrate was sand (86 percent), with the remaining substrate being composed of cobble (5 percent), gravel (5 percent) and mud (4 percent) (Figure 8-2).




Source: Stantec 2012b
Note: Eelgrass indicated by green hatch line

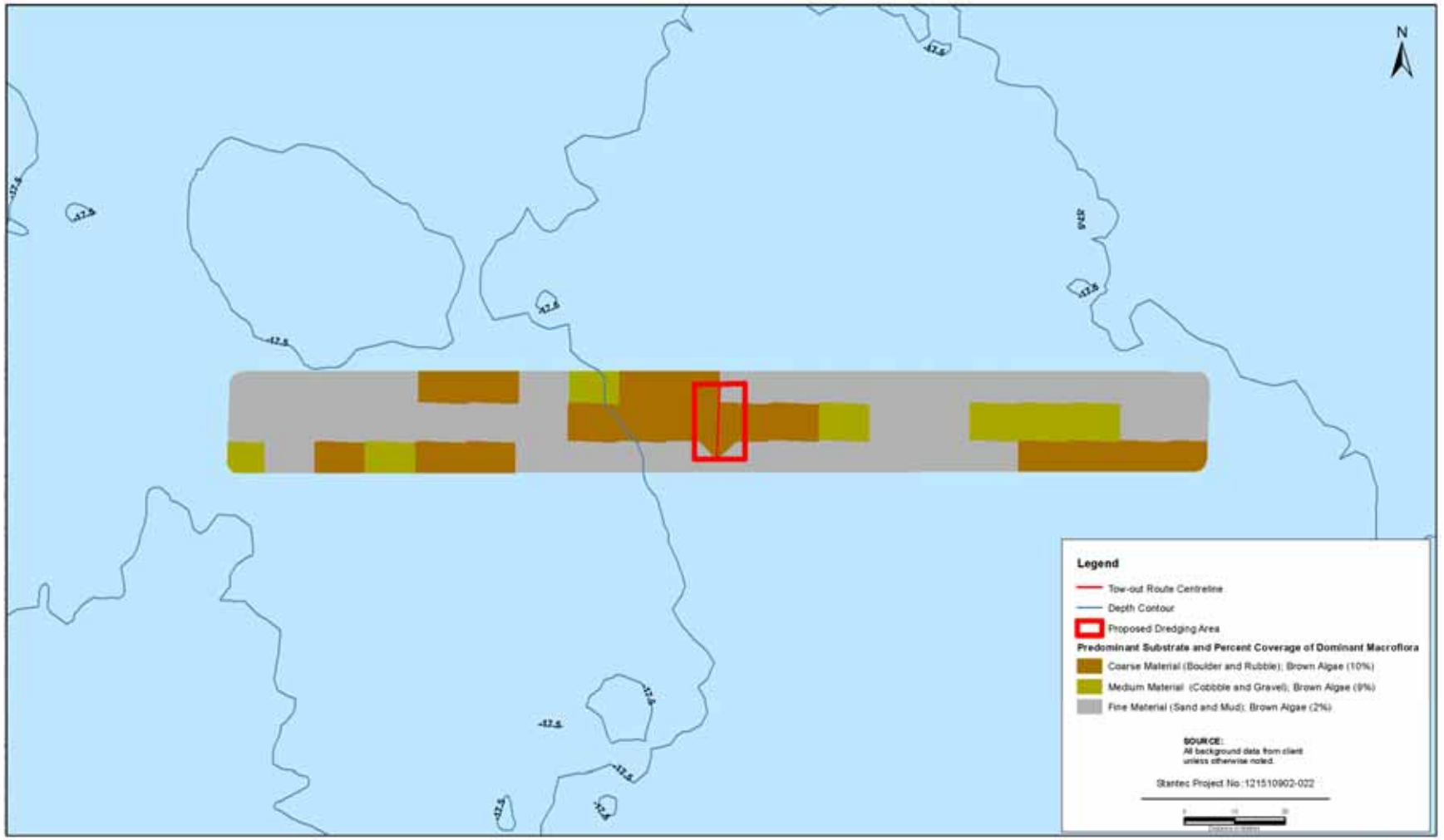
**Figure 8-2 Habitat Characterization in the Nearshore Area of the Graving Dock**

The average water depth recorded was 17.5 m. Kelp (*Laminaria longicruris*) and sour weed were the dominant species of vegetation and were estimated to cover approximately 10 percent and 3 percent of the area surveyed, respectively. The graving dock location also had rockweed present (1.5 percent) on large cobble and boulders in the nearshore. Eelgrass averaged approximately 8 percent of the macroflora species present in the vicinity of the graving dock and covered approximately 1 percent of the total surveyed seafloor area. Other vegetation observed in very low densities in the survey area included sea colander (*Agarum cribrosum*) at 0.8 percent, and smooth cord weed (*Chorda filum*), ribbon weed (*Punctaria* sp.) and dulse (*Palmaria palmata*) at less than 0.1 percent coverage each (Stantec 2012b).

Macrofaunal species observed included rock crab, snow crab (*Chionoecetes opilio*) and sea stars. Sea gooseberries (*Pleurobrachia pileus)* were common throughout the water column. Common periwinkle (*Littorina littorea*) was present but uncommon. Few fish were observed during the video survey. The graving dock location provided the highest number of fish observations (n=10) during the November 2011 survey, including five flounder, two longhorn sculpin (*Myoxocephalus octodecemspinosus*), one cunner, one little skate (*Raja erinacea*) and an unidentified fish. Flounder were observed most often on fine substrate. The 2012 survey of the same area resulted in no fish observations and this seasonal difference may be related to migration (Stantec 2012b).

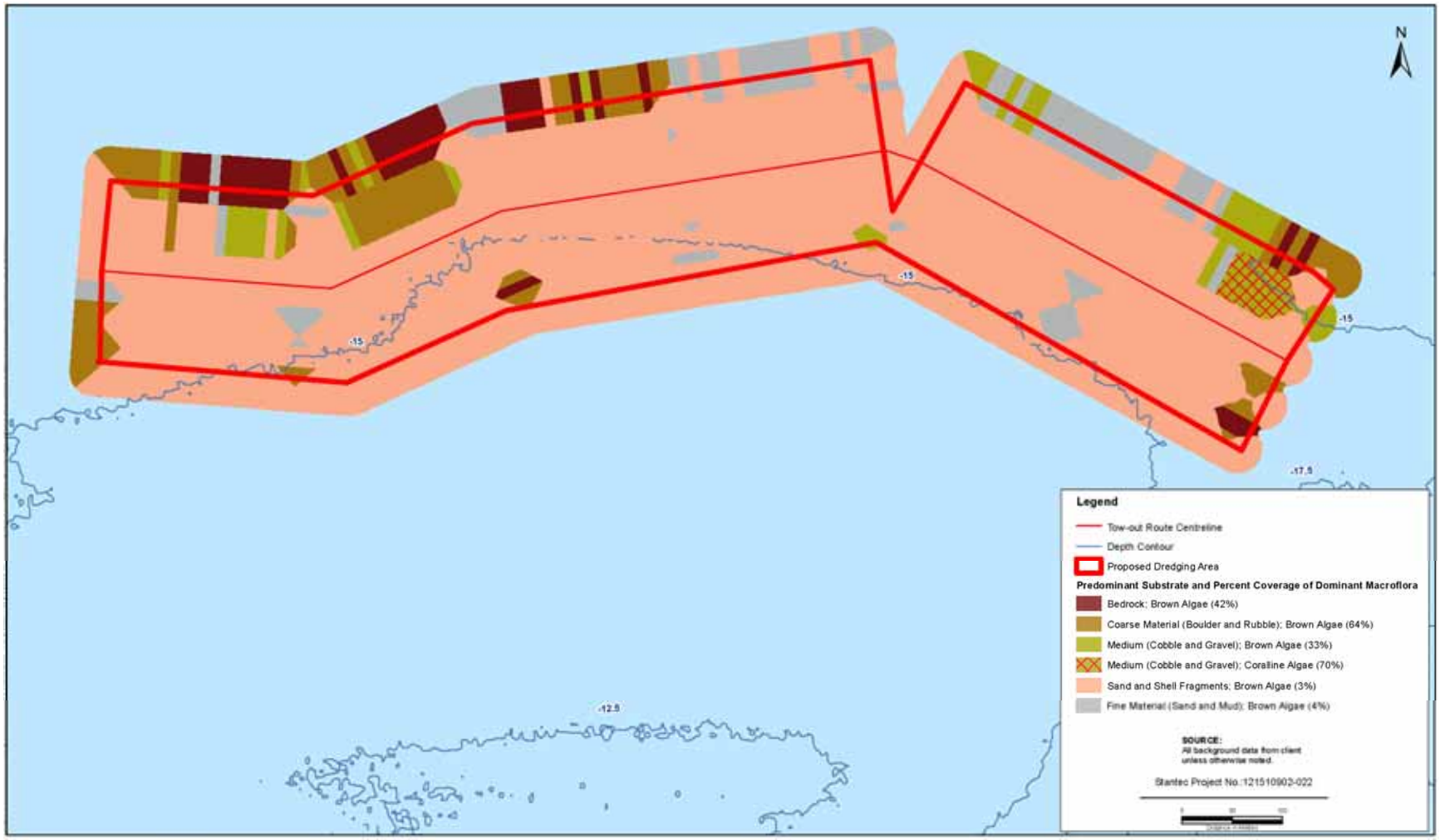
Corridor 1 is a small area (10 m wide by 15 m long along the centreline tow-out route) (Figure 8-3) with an average water depth of 18 m. Corridor 1 was surveyed with four transects; sand was the predominant substrate type, covering an estimated 62 percent of the seafloor in the survey area, followed by boulder (18 percent), cobble (10.7 percent) and rubble (8 percent) (Stantec 2012b). Wave-induced ripples in the sand were observed. Brown algae were the only group of macroalgae observed but occurred in very low densities. Sea colander was estimated to cover 4.8 percent of the area surveyed, sour weed covered 0.2 percent and kelp covered less than 0.1 percent. Eelgrass was not observed to occur in Corridor 1. A fine mixture of vegetation covered the bottom along two of the transects. The predominant macrofaunal species included green sea urchins (*Strongylocentrotus droebachiensis*), sea gooseberries, sea stars and frilled anemones (*Metridium senile*). Rock crab, snow crab, hermit crab, barnacles (*Balanus balanoides*) and one sun starfish were also recorded in low numbers. No finfish species were observed during the survey of Corridor 1 tow-out route (Stantec 2012b).

Corridor 2 measured 200 m wide by 1,250 m long along the centerline, and had the shallowest average water depth (16 m) of the three sites surveyed. Corridor 2 was surveyed with 38 transects averaging 200 m in length. Corridor 2 had the most diverse substrate types, including sand (77 percent coverage), shell fragments (8 percent), cobble (5 percent), bedrock (4 percent), boulder (3 percent) and rubble (3 percent). Due to high densities of macroalgae, it was difficult to characterize the substrate at times. Sea colander was the most abundant vegetation and had the highest percent coverage in Corridor 2 (8.4 percent). All other vegetation occurred in low densities: sour weed was estimated to have 1.5 percent coverage; kelp 0.3 percent, and rockweed less than 0.1 percent coverage (Figure 8-4). Coralline algae (thought to be a member of Genus *Lithothamnium*) were observed and covered a small proportion of the area surveyed (0.7 percent). Sand dollars were the most common fauna, followed by sea gooseberries, green sea urchin, sea stars, snow crabs and tube polychaetes. Fish observed during the survey (n=7) included six individual flounder (unknown species) and one little skate.




Source: Stantec 2012b

**Figure 8-3 Habitat Characterization of Corridor 1 in Nearshore Project Area**




Source: Stantec 2012b

**Figure 8-4 Habitat Characterization of Corridor 2 in Nearshore Project Area**

Overall, the surveys carried out at the graving dock location and in Corridor 1 and Corridor 2 indicated that substrate is typically sand. In the nearshore (the graving dock location) gravel and mud also occur, and in areas further away from the shoreline (Corridor 1 and Corridor 2), bedrock, boulder, shell and cobble were also observed in places. Vegetation was relatively sparse in survey areas. Kelp, sour weed and sea colander were the most common vegetation, with eelgrass and rockweed also occurring in some areas (Stantec 2012b). Eelgrass occurred in very low densities (approximately 1 percent) near the graving dock location in the shallow subtidal, but did not occur at the tow-out sites (Stantec 2012b), likely due to depth limitations. The survey occurred during late fall and winter (November 2011 and January 2012) and there may be seasonal differences in extent of eelgrass coverage and shoot density between winter and summer months due to variation in sunlight, water temperature and frequency and intensity of storms.

**Chemistry**

There have been several previous studies which characterized marine sediments in Placentia Bay (Kiceniuk 1992; NTT 1996; VBNC 2002; Ramey and Snelgrove 2003). During EEM programs, Kiceniuk (1992) collected surficial sediments to sample for aromatic hydrocarbons at four locations within inner Placentia Bay: Come By Chance refinery; Woody Island/Sound Island; Red Island; and Long Island. The highest levels were detected in sediments at Woody Island/South Island and on the west coast of Long Island (Kiceniuk 1992). Baseline sediment samples from Whiffen Head indicated metal concentrations were generally within normal range for marine sediments in the area and below Canadian Sediment Quality Guidelines (NTT 1996). However, concentrations of copper, arsenic and nickel at one nearshore station exceeded the threshold effects level (TEL) in 1996 and were likely influenced by a land-based source of metals. Concentrations above the TEL represent the point at which effects on aquatic life are occasionally observed. Marine sediments collected within and outside Argentia Harbour in 1998 by VBNC (2002) found elevated levels of arsenic, cadmium, chromium, copper, iron, lead, manganese, mercury, nickel and zinc that exceeded Environment Canada's maximum allowable levels (MALs). Concentration of metals was higher within the harbour than beyond the harbour. Sediment samples from within the harbour also typically had finer sediments and higher total organic levels, both of which would facilitate the inorganic and organic loading of the sediment.

As part of monitoring programs, samples of surface seawater have been collected at more than 16 locations around the Argentia Peninsula since 1997 (JWEL 1997; LGL 1998, 2007c; VBCN 2002). Surface seawater samples collected from Argentia Harbour in 1998 by VBNC (2002) were found to generally have higher concentrations of metals including cadmium, cobalt, copper, lead, manganese, nickel and zinc than those collected from sites outside the harbour. Cadmium was found to exceed Environment Canada MAL at one station near the mouth of Argentia Harbour. Higher than average levels of metals are expected in Argentia Harbour, as this area was formerly used as a naval base (and current activity includes a ferry terminal) and is considered a brownfield site.

LGL (2007d) carried out a review of information and collected baseline data on sediments and water quality in Long Harbour, Placentia Bay, on behalf of VBNC. Sampling occurred at four different time periods between October 2005 and September 2006. Water quality analysis from samples collected reported that maximum

concentrations of copper, iron, lead and zinc exceeded the CCME guideline value at times, with six of the seven CCME guideline exceedances occurring in samples that were collected in October 2005. Stations that exhibited the highest concentrations were located in inner Long Harbour. None of the surficial sediment samples collected exceeded any of the Probable Effect Level (PEL) guidelines; however, some exceedances of the Interim Sediment Quality Guidelines did occur for arsenic, barium, cadmium, copper, iron and lead.

Marine sediment sampling and chemical analyses were carried out at Argentia in January 2012 to characterize the sediment and assess the proposed dredge area for contamination (Stantec 2012b).

***Graving Dock Location***

The conclusions of an initial environmental investigation within the footprint of the graving dock site are summarized as follows:

- No free liquid phase petroleum hydrocarbons were observed at the site during the current investigation or the previous Phase II ESA (BAE Group Ltd. and SNC-Lavalin Environment Ltd. 1994; SNC-Lavalin 1998).

- Concentrations of TPH were detected in three of the soil samples, with concentrations ranging from 26 mg/kg in soil sample TP7 BS6 to 330 mg/kg in soil sample TP3 BS6. However, the detected concentrations of TPH in the soil samples were below the applicable Atlantic PIRI Tier I guideline of 450 mg/kg for gasoline impacts in soil on a commercial site. BTEX parameters were not detected in any of the seven soil samples analyzed.

- The estimated area with TPH concentrations in soil above 450 mg/kg in this area is approximately 45 $m^2$. Based on field evidence of impacts and soil laboratory it is expected that approximately 45 $m^3$ of impacted soil in the vicinity of BH-A5 exceeds the Atlantic PIRI Tier I guideline of 450 mg/kg for gasoline impacts in soil on a commercial site. This volume of impacted material also exceeds the 1,000 mg/kg threshold criteria for disposal at a municipal landfill and therefore any surplus material removed from the impacted area during construction excavation would require disposal at a licensed soil treatment facility, or treatment on site.

***Tow-out Routes***

Husky has conducted extensive sampling within the areas to be dredged to characterize sediment chemistry and to assess potential effects to fish habitat. A fish habitat report (Stantec 2012b) was submitted to DFO for review.

Ten surficial substrate samples were collected within dredge Corridors 1 and 2, and were found to be primarily sand with fractions of silt and clay. Each sample was tested for available metals, PAHs, PCBs, TPH and BTEX. BTEX compounds were not detected in the marine sediment samples. One sample reported detectable concentrations of hydrocarbons from dredge corridor 1 at a concentration of 24 mg/kg. Two samples from dredge corridor 2 reported TPH concentrations of 19 and 32 mg/kg. Each of these three reports of hydrocarbon were in the lube oil range ($>C_{21}<C_{32}$) and all were below applicable guidelines. PAHs were detected in both samples from Corridor 2, with total

PAH concentrations of 0.47 and 0.96 mg/kg, respectively. Individual PAHs were below CCME marine PEL guidelines and commercial/industrial SQG. In Corridor 1, PAHs were reported in three of eight samples, with phenanthrene being detected at concentrations of 0.013, 0.007, and 0.010 mg/kg. The phenanthrene CCME PEL is 0.544 mg/kg and for commercial/industrial SQG is 50 mg/kg. Total PCBs were not detected in either Corridor 1 or 2. Of the 26 metals tested, none were above the CCME PEL or Interim Sediment Quality Guidelines.

**Freshwater Input**

There are no major rivers draining into Argentia Harbour area, although there is a small stream that flows from Argentia Pond (locally called Arch Pond) to Argentia Harbour year-round. The stream is 2.4 to 3 m (8 to 10 feet) wide, fast-flowing and well-vegetated, with extensive riparian habitat on both sides. Approximately one-third of the stream is fenced with a chain-link fence that was put in place for safety reasons when the site was an active US naval base. Arch Pond is a popular fishing area but the stream is not used for fishing. The stream terminates in Salmon Cove at the southeast corner of Argentia Harbour. Brook trout (*Salvelinus fontinalis*) are reported regularly in Arch Pond and in the stream. Atlantic salmon (*Salmo salar*) are not known to use the stream (G. Temple, 2012, pers. comm.).

**The Pond**

The Pond is the only water body on the Argentia Peninsula. It extends east-west and is 775 m by 300 m wide, with a mean water depth of 7 m and a maximum depth of 14 m (Stantec 2012b). It contains brackish water, with probable seawater intrusion from Placentia Bay via the gravel ridge between The Pond and the ocean, as well as waves and spray entering during storm or spring tide events (ARG 1995). Groundwater is thought to enter through a groundwater stream at the southeast end of The Pond. The Pond substrate is primarily fines/clay (anoxic), with the bottom covering an estimated 148,300 $m^2$ (ARG 1995).

Sediment testing carried out in The Pond during winter 2012 (Stantec 2012b) found that moisture content in sediment samples ranged between 78 and 89 percent, with an average of 83 percent moisture. The substrate varied from mostly gravel in the northwest area of The Pond to predominately a sandy silt substrate with a high clay fraction. Total organic carbon (TOC) in the sediment ranged from a low of 72 to 179 g/kg. Redox values indicate that some areas of The Pond were anoxic, whereas other areas were not. There was no trend that could be observed for grain size and TOC with redox values (Stantec 2012b).

Recognizing the history of The Pond, Husky completed a recent investigation of water and sediment contamination in The Pond. The locations for eight sediment and water stations were randomly selected throughout The Pond and all samples were tested for available metals, PAHs, PCBs, TPH and BTEX. The PAH fluoranthene was found to exceed the CCME PEL (1.494 mg/kg) at 1 sediment station reporting a concentration of 2.6 mg/kg. As well, pyrene was reported at 1.8 mg/kg from the sediments at the same station, which exceeds the CCME PEL of 1.398 mg/kg. Total PCBs were reported from four of the eight sediment samples ranging from 0.25 to 0.38 mg/kg, which exceeds the CCME PEL of 0.189 mg/kg. The CCME PEL guideline for copper (108 mg/kg) was exceeded in the sediment of one station, reporting a concentration of 130 mg/kg.

Analysis of pond sediment samples for TPH revealed the presence of lube oil range hydrocarbons ($>C_{21}$-$<C_{32}$) at all eight stations, ranging from 170 to 500 mg/kg. One station reported fuel oil range hydrocarbons at 130 mg/kg ($>C_{10}$-$C_{16}$) and 54 mg/kg ($>C1_6$-$C_{21}$). BTEX compounds were not detected in any of the sediment samples. None of the TPH results exceed the Atlantic RBCA guidelines for commercial sites or the CCME soil quality guidelines.

Eight water samples were also taken at random locations throughout The Pond and all tested for available metals, PAHs, PCBs, TPH and BTEX. BTEX, TPH and PCBs were not detected in any of the eight water samples. Phenanthrene (a PAH) occurred in one sample at the reportable detection limit of 0.01 µg/L. Of the metals with guidelines, only mercury exceeded the CCME PEL guideline of 0.016 µg/L at two stations with concentrations of 1.2 and 0.14 µg/L. Eight additional samples were collected approximately two months after the initial eight and mercury was not detectable in either sample. The Pond water chemistry results were compared to the maximum content in Schedule A of the Newfoundland and Labrador *Environmental Control Water and Sewage Regulations (2003)*; none of the parameters exceeded the guidelines of these regulations.

There appear to be few, if any, marine or freshwater fish species present in The Pond (ARG 1995, JWEL 1996, Stantec 2012b). Aquatic plants and freshwater invertebrates typical of freshwater ponds in the area are not present in The Pond (JWEL 1996). Fish surveys of The Pond were completed in June and September 2012 using gangs of gillnets (3.5 and 5.5 inch mesh in June and 0.75-inch to 3.5-inch mesh in September), baited char and minnow traps (four each) in June and drop camera video in 30 locations in September (Figure 8-5). Three-spine stickleback (*Gasterosteus aculeatus*) was the only fish species observed in The Pond (one adult approximately 10 cm in length was caught in the gillnets and more than one thousand in the baited traps). The greatest concentration of this fish species was on the south side of The Pond, where the highest percentage of vegetation was also noted (Stantec 2012b). DFO was satisfied that this increased effort was "*…adequate in demonstrating that The Pond does not constitute fish habitat*". DFO has therefore determined that with appropriate mitigation measures, The Pond can be considered for the disposal of dredged material (C. Grant, DFO, 2012, pers. comm.).




Source: Stantec 2012b

**Figure 8-5 Fish Sampling in The Pond in 2012**

**Deep-water Mating Sites**

There is little existing information on fish habitat at the potential deepwater mating sites near Merasheen Island and Red Island. The site near Merasheen Island is over 200 m deep, and at Red Island ranges from 100 to 200 m. A study of ichthyoplankton in Placentia Bay reported capelin eggs were concentrated around southern Merasheen Island and Red Island. Capelin occurred at a range of sizes (development stages), and were the dominant taxa during the summer months (Bradbury et al. 2003). A survey of local knowledge identified known herring aggregation sites around northeast and northwest Merasheen Island (Sjare et al. 2003). A major study on sedentary macrofauna in muddy substrates in Placentia Bay was conducted in 1998 (Ramey and Snelgrove 2003) and included three sites around Merasheen Island (two in the Western Channel between the mainland and Merasheen Island and one in Central Channel between Merasheen Island and Long Island). Species richness (i.e., number of species per station) was lowest at the northernmost Western Channel station. The bivalve *Thyasira* sp. was most abundant at the more southern Western Channel station (Ramey and Snelgrove 2003).

### 8.3.1.3 Plankton

Plankton is a main component of primary production and is the dominant bottom-up factor influencing the distribution of fauna in marine systems (Li et al. 1993; Calbet and Landry 2004) and it can vary over both small and large spatial scales, depending on light and nutrient availability and the multitude of factors that drive those two variables (Barton et al. 2003; Townsend et al. 2006). Areas of persistent high primary production such as where eddies, fronts, or seamounts occur are often areas where faunal biomass is high due to the aggregation of primary consumers and predators (Worm et al. 2005; Hays et al. 2006; Morato et al. 2010). Ramey and Snelgrove (2003) collected water samples at seven locations in Placentia Bay in June and August 1998 and conducted chlorophyll *a* sampling in order to estimate the density of the phytoplankton standing crop. Samples were collected from surface waters (5 m depth) at six sites within inner Placentia Bay, and at one site in the outer bay. Results showed concentrations of chlorophyll *a* were higher in the inner bay than the outer site. These findings were consistent with those indicated by SeaWiFS in April, July and September of that same year. Overall, chlorophyll *a* concentration was highest in April (Ramey and Snelgrove 2003).

The Newfoundland Transshipment environmental assessment summarized water quality data for Come By Chance Bay and noted that chlorophyll levels were higher in deeper areas of the bay, indicating higher phytoplankton biomass than near the coastline (NTT 1996). The environmental assessment also noted low mean levels of turbidity (0.7 NTU) within the bay, but with considerable variation. The maximum turbidity (18 NTU) reported occurred during December (Swiss and Osbourne 1976). Turbidity can be expected to fluctuate in nearshore waters as a result of storm-induced re-suspension of sediments. The range of means reported for TSS measured within Come By Chance Bay was 23.6 to 30.1 mg/L (NTT 1996).

Zooplankton are also small, drifting organisms in the water column, but they are unable to photosynthesize and are the primary consumers in the marine environment. The reproduction of zooplankton is closely linked with the phytoplankton bloom and typically occurs simultaneously or soon after. Copepod, krill, amphipod and euphausiid species

dominate the zooplankton community, which is most abundant between mid-April and mid-June. Zooplankton also includes meroplankton (the planktonic egg and larval stages of fish and invertebrates) (Pepin et al. 2008). Bradbury et al. (2003) conducted ichthyoplankton surveys in Placentia Bay in June and August in 1997 and 1998. They found that the distribution of pelagic eggs and early larval stages were consistent with passive drift; but that later stages of larvae frequently concentrated on the western side of Placentia Bay, which suggests larger larvae may be actively swimming 'upstream' of smaller larvae to areas where food is more abundant. They also noted changes in size of recently hatched larvae from pelagic species, with size decreasing throughout the spawning season, likely in relation to seasonal decreases in egg diameter and fecundity. In contrast, larvae from demersally-spawned eggs increased in size over the spawning season (same time period), which may be due to increased retention and growth rates. The highest concentrations of American plaice and Atlantic cod eggs were on the western side of Placentia Bay, and near Bar Haven Island and southern Burin Peninsula (Bradbury et al. 2003). Stage I cod eggs were concentrated in three areas: Perch Rock; Bar Haven; and Oderin Bank. Stage II eggs of both cod and American plaice were also abundant southwest of Merasheen Island (Bradbury et al. 2003). Surveys of spawning and post-spawning season of 1997 and 1998 found that densities of Atlantic cod eggs were highest during early spring, and decreased as the year progressed (Bradbury et al. 2000). Cod was the least abundant of the larval species sampled (Bradbury et al. 2003).

There is growing concern about increased harmful algal blooms globally. In Newfoundland and Labrador, there were few known harmful algal blooms until the last 25 years (Bates 1997). By 2007, several harmful algal blooms and associated marine toxins were reported in nearshore and offshore areas around the Island of Newfoundland, including in Placentia Bay. Harmful algal blooms cause mortality of marine species, with potential to harm humans if consumed. However, relative to other areas globally, the incidence of harmful algal blooms in Newfoundland and Labrador waters remains moderate (Bates and Forbes, in prep.).

#### 8.3.1.4 Benthos

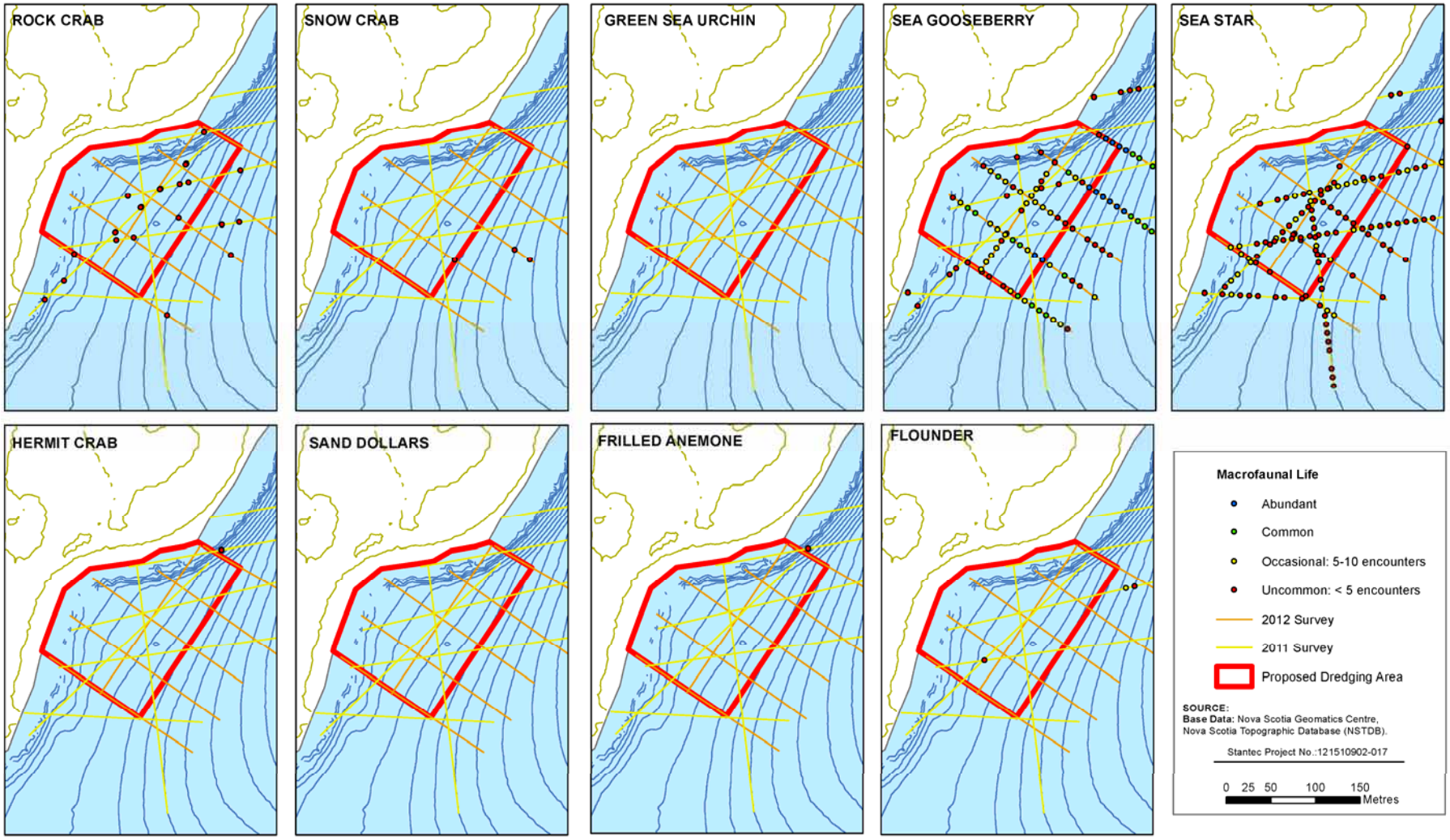
The benthic communities of the Placentia Bay marine ecosystem include intertidal, shallow subtidal and subtidal bottom-dwelling organisms (VBNC 2002, Ramey and Snelgrove 2003). Dominant fauna in intertidal and shallow subtidal habitat include blue mussel (*Mytilus edulis*), green sea urchin, common periwinkle, barnacle, frilled anemone, horse mussel (*Modiolus modiolus*), and various amphipods and isopods. In deeper areas of the bay, polychaetes, amphipods, sand dollar, sea urchins, sea stars, scallops, mussels and brittle stars (Class Ophiuroidea) dominate (VBNC 2002). In recent years, the invasive European green crab (*Carcinus maenas*) has also been observed in Placentia Bay (DFO 2011).

Soft-sediment benthic macrofauna studies were carried out in Placentia Bay in 1998 by Ramey and Snelgrove (2003). Benthic macrofauna were sampled at six deep water locations (210 to 230 m) and one other location at 67 m depth. Sampling occurred mainly within the inner bay at six locations: head of Placentia Bay (one site); Western Channel (two sites); Eastern Channel (two sites); and in Central Channel between Merasheen Island and Long Island (one site). The seventh sampling site was further out in the bay near Oderin Bank. Distinct infaunal communities occurred at each site, with the highest macrofaunal densities occurring at the Oderin Bank site. At all sites, densities of macrofauna were greatest in the upper 3 cm of the sediment (Ramey and

Snelgrove 2003). Species richness was also highest at Oderin Bank than at other sampling sites. Dominant taxa included polychaete species, a bivalve (*Thyasira* sp.) and various nemertean worms (ribbon worms); amphipods were also abundant at the Oderin Bank station but not at other sites. Ramey and Snelgrove (2003) suggested that broad-scale changes in the soft-sediment infaunal communities in Placentia Bay may be driven by characteristics of surface waters, including chlorophyll *a* concentrations. Sedimentary organic carbon was positively correlated with surface chlorophyll *a* concentrations in this study, with sedimentary organic carbon being the most important environmental predictor of infaunal abundance (Ramey and Snelgrove 2003).

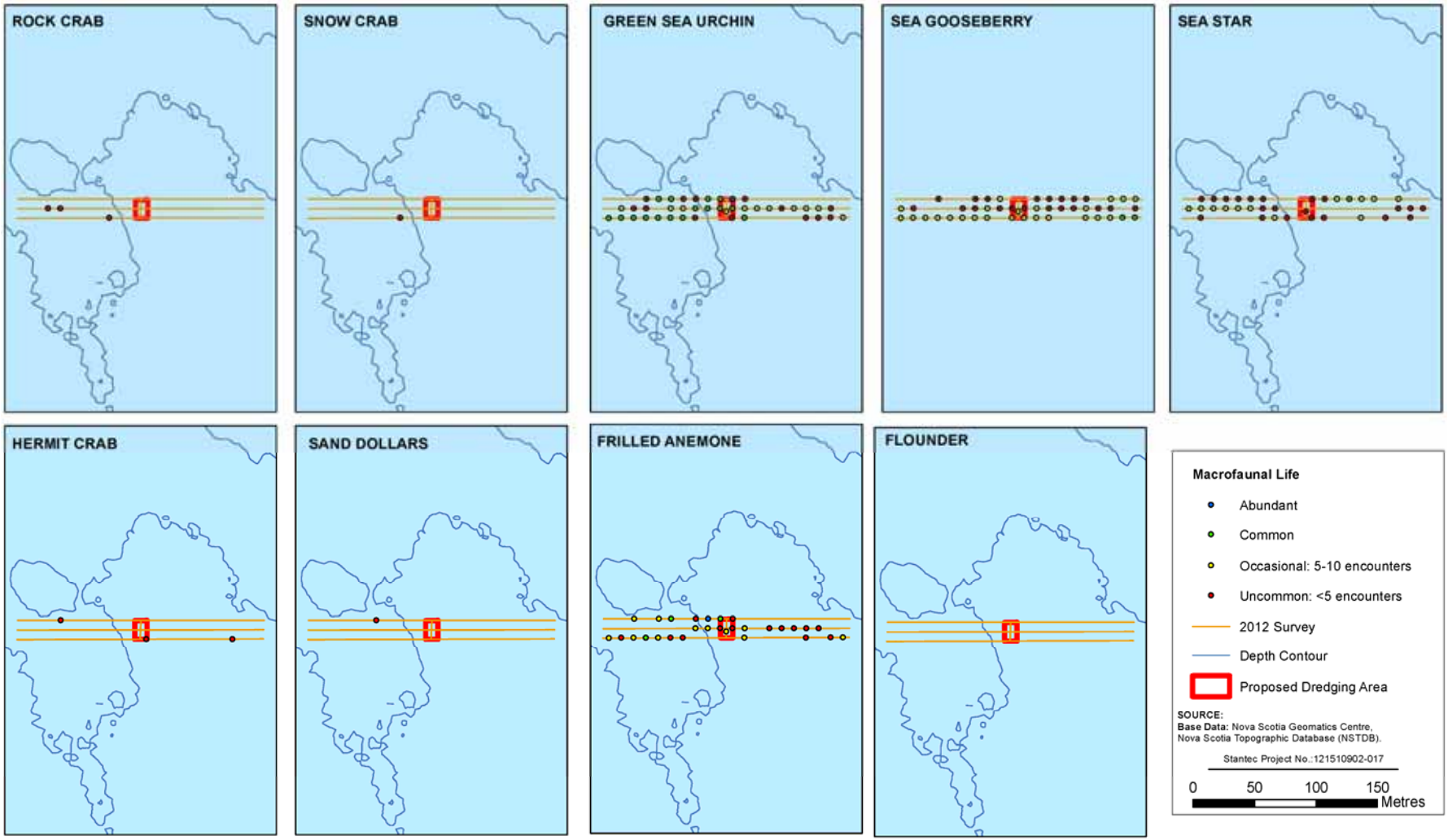
Underwater video collected during the fall and winter of 2011/2012 in the Nearshore Study Area using ROV (Stantec 2012b) indicated that sand dollars were very common in sandy habitats, and sea urchins characterized rocky habitat (Stantec 2012b). Rock crabs, hermit crabs, sea stars, barnacles, broken shells, sea gooseberries (planktonic) and frilled anemones were also observed. The relative abundance observed during the study is shown in Figures 8-6 (the graving dock location), 8-7 (Corridor 1) and 8-8 (Corridor 2) for the three areas surveyed. Most of the macrofauna occurred on sand and fine substrate. This was consistent with findings by JWEL (1997), in a review of the fish, shellfish and other invertebrates occurring within Argentia and Placentia Bay.

The body burden of blue mussels and rock crab were sampled inside and outside the harbour in 2001 (VBNC 2002). Metal concentrations in mussel tissue were highest in those collected at the head of Argentia Harbour. No differences in concentrations of organic parameters (hydrocarbons) were detected in blue mussel tissue collected from inside and outside the harbour. No clear spatial trend in analyte loading amongst rock crab tissue collected within and outside Argentia Harbour was indicated, although rock crab skeletal muscle did have arsenic levels above MAL, both within and outside Argentia Harbour (VBNC 2002).



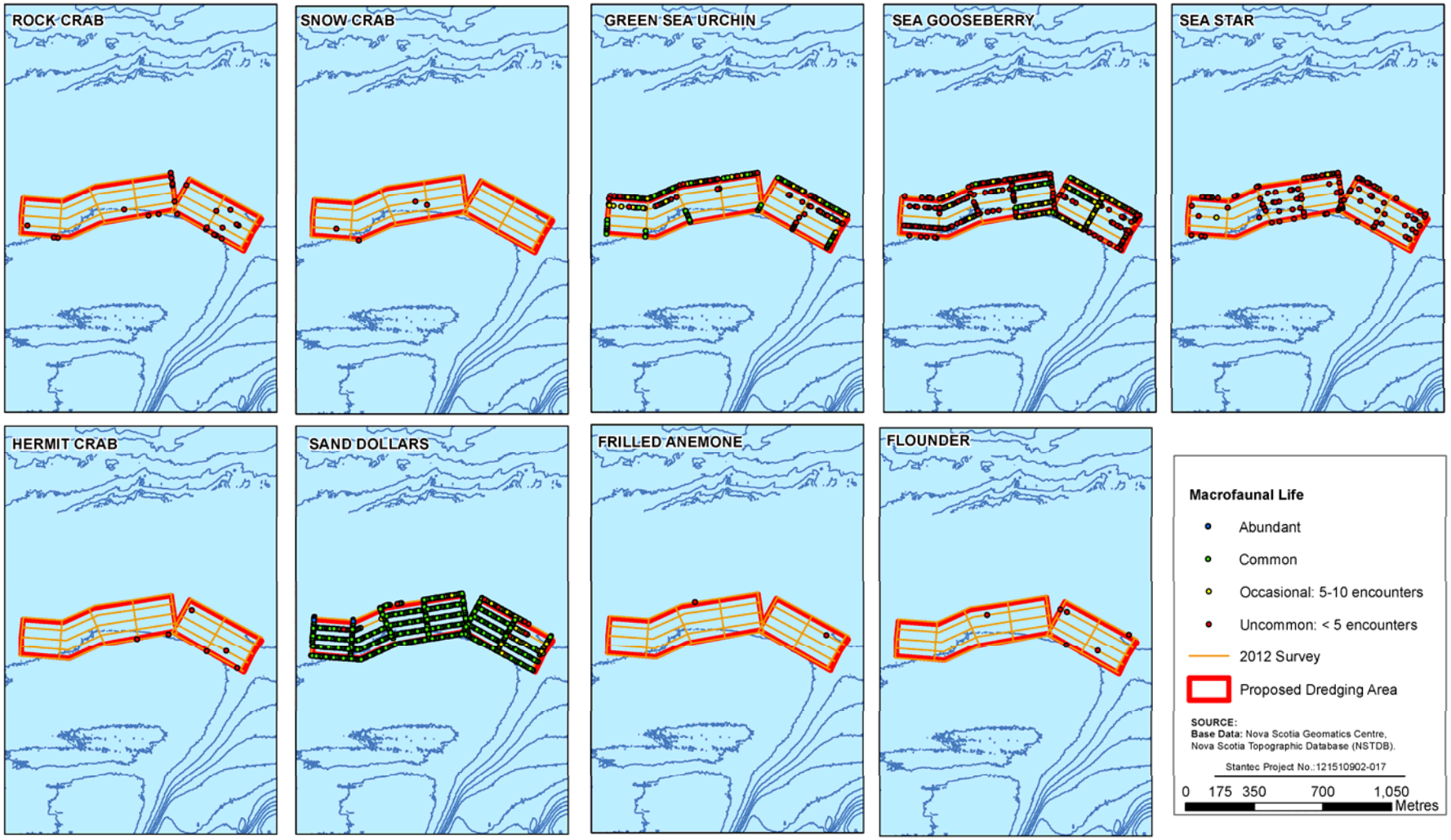

Source: Stantec 2012b

**Figure 8-6 Relative Abundance of Macrofauna at near the Graving Dock Location during Habitat Characterization Study**




Source: Stantec 2012b

**Figure 8-7 Relative Abundance of Macrofauna at Tow out Corridor 1 Observed During Habitat Survey**




Source: Stantec 2012b

**Figure 8-8 Relative Abundance of Macrofauna at Corridor 2 during Habitat Survey**

#### 8.3.1.5 Fish and Shellfish

Fish are commonly associated with particular habitat types. In the nearshore of Placentia Bay, species such as cod, cunner, winter flounder, lumpfish and herring (*Clupea harengus*) are frequently associated with habitats such as eelgrass, kelp beds or cobble (Gotceitas et al. 1997). In contrast, soft sediment habitat (e.g., sand or mud) provide refuge for benthic species such as American plaice and winter flounder (Scott and Scott 1988). Capelin, herring and sand lance form nearshore pelagic schools near the surface, particularly at night and are important forage fish species for higher trophic levels (Scott and Scott 1988). Several fish species migrate seasonally to Placentia Bay and the coastal area of Cape St. Mary's (Scott and Scott 1988; Lawson et al. 1998; Carew 2001; Bradbury et al. 2003; Sjare et al. 2003). In spring, this includes Atlantic herring, capelin and Atlantic cod. In autumn, Atlantic mackerel (*Scomber scombrus*) and possibly herring migrate into the bay. During summer months, Atlantic salmon, brook trout, brown trout (*Salmo trutta*) and American eel (*Anguilla rostrata*) migrate to and from rivers and feed in Placentia Bay. During winter, many of the species that use the shallow areas of Placentia Bay likely migrate to deeper waters, such as lobster (*Homarus americanus*), snow crab and winter flounder. American plaice, Atlantic cod, cunner, winter flounder, lumpfish, capelin, wolffish (*Anarhichas* spp.), herring, mackerel and sand lance all reproduce in Placentia Bay, and many of them rely on coastal habitats for spawning and refugia (Carew 2001; Bradbury et al. 2003; Sjare et al. 2003).

Data collected during the 2009 and 2011 DFO Research Vessel (RV) spring and fall surveys cover the Nearshore Study Area; the 2010 survey did not sample within the Nearshore Study Area. Although there is considerable annual variability, common species in 2009 and 2011 included Atlantic cod, American plaice, shrimp species, thorny skate (*Amblyraja radiata*) and basket stars. Species that were uncommon during the 2009 and 2011 DFO RV survey of the Nearshore Study Area included Atlantic halibut (*Hippoglossus hippoglossus*), Atlantic herring, capelin, fourbeard rockling (*Enchelyopus cimbrius*), Greenland halibut (*Reinhardtius hippoglossoides*), sculpin species (Superfamily Cottoidea), eelpout species (Family Zoarcidae), redfish (*Sebastes* spp.), snow crab, squid, witch flounder (*Glyptocephalus cynoglossus*) and yellowtail flounder (*Limanda ferruginea*). Many of these commercial species are uncommon in the nearshore, and pelagic species that may be common (such as capelin and herring) likely have low catchability with the shrimp trawl gear used.

Species that were caught at shallow depth (less than 60 m) included American plaice, Atlantic cod and wolffish species in 2009. The 2011 survey focused on deeper water areas (247 to 267 m), and therefore is more indicative of species at the deep-water mating sites. The primary species caught included alligatorfish (*Aspidophoroides monopterygius*), American plaice, Atlantic cod, Arctic cod (*Arctogadus glacialis*), capelin, basket star, Greenland halibut, northern shrimp (*Pandalus borealis*), seasnail (*Liparis atlanticus*), other shrimp species, snow crab, thorny skate, toad crab and wolffish.

During ROV surveys of fish and fish habitat in Argentia, few fish and shellfish were observed; flounder (likely winter flounder), longhorn sculpin, little skate, snow crab, rock crab and one unidentified species of fish occurred in very low numbers (Stantec 2012b).

Species profiles for those fish and shellfish species that commonly occur in the Nearshore Study Area are provided in the following sections. SARA-listed species at risk and COSEWIC assessed species are discussed in Section 12.3.1.

### Cunner

Cunner range from Newfoundland and Labrador to New Jersey and occur from the intertidal to 100 m (Scott and Scott 1988). Cunner are abundant in Placentia Bay, particularly in inshore areas. Abundance has been observed to be greater near structures that add complexity, such as wharves, shipwrecks, boulders and oyster beds. At night, cunner are known to move into crevices. In winter, they inhabit deep crevices or burrow under rocks, where they enter torpor and do not eat until spring (Green and Farwell 1971; Curran 1992).

Spawning is known to occur in late July and August in Nova Scotia (Tupper and Boutilier 1997), and likely occurs several weeks later in Placentia Bay. A study of ichthyoplankton by Bradbury et al. (2003) found that cunner larvae were most abundant in the inner part of the bay and off the southern Burin Peninsula. Cunner eggs were distributed widely, but primarily occurred between Marystown and Paradise Sound, off Cape Shore, offshore Paradise Sound and throughout the large islands of the inner bay. Recently settled cunner are abundant in shallow areas with rocky and/or shell substrates, with or without eelgrass (Tupper and Boutilier 1997). There is no evidence of active habitat selection by newly settled cunner (Auster 1989), and differences in population density among habitats are attributed to post-settlement mortality. In a study by Auster (1989), recruitment success was found to be highest among juveniles settling on rocky reefs, followed by cobble habitats and eelgrass. Cunner recruitment was absent from sandy substrate, patterns that have also been observed for adult cunner (greater than age 1+) (Auster 1989). Juvenile cunner feed on amphipods, isopods, zooplankton and small benthic epifauna (Levin 1994), and are mainly preyed upon by sculpin (Auster 1989). Juveniles tend to remain near their nursery area during winter, rather than migrate to deeper offshore waters as adults do. Adult cunner feed on benthic invertebrates including mussels, barnacles, soft-shelled clams (*Mya arenaria*), amphipods and juvenile lobster (Auster 1989).

### Capelin

Typically, capelin winter offshore and will undergo extensive migrations to coastal areas during spring to spawn (Carscadden and Nakashima 1997). Timing of the inshore spawning of capelin in coastal Newfoundland can be highly variable, with temperature one of the prime factors in explaining variability (Carscadden et al. 2001; Regular et al. 2009). During periods when colder than normal temperatures prevail, spawning is delayed. In late spring and summer, capelin move to shallower bays to spawn on beaches, or alternatively, migrate to deeper waters to spawn offshore at depths up to 125 m (likely when conditions for beach spawning are not ideal) (Nakashima and Wheeler 2002). Spawning may occur in a given location year after year, or only occur periodically in some locations (Nakashima and Wheeler 2002). Females may produce as many as 50,000 eggs at one time. Eggs attach to the substrate and remain in the sediment for 14 to 52 days, with hatching time triggered by temperature (Scott and Scott 1988). A survey of local knowledge was used to document the location of capelin spawning beaches in Placentia Bay (Sjare et al. 2003), and this is discussed in further detail in the chapter on Sensitive Areas (Section 13.3.1.4). The beach on the northside of the Argentia peninsula is a known spawning beach for capelin, and demersal spawning by capelin and herring is also known to occur in this area. Though this beach has been used in the past for spawning, it has not been known to be used in recent years (J. O'Rourke, pers. comm.). There are no reports of capelin spawning on the

beach adjacent to the graving dock construction site. The beach is not expected to be affected by activities associated with the WREP

After hatching, capelin larvae remain in the sediment for up to five days, until ideal conditions (particularly an onshore wind) occur and enable the larvae to enter the water (Nakashima and Wheeler 2002). If these conditions do not occur within five days, the yolk sac is depleted and there is a low rate of survival. Studies of juvenile capelin that remain in the shallow nearshore have shown capelin have a preference for eelgrass habitat in mud, sand, or gravel substrate. Adults are not known to have habitat preferences.

Adults undertake vertical migrations, staying in the lower water column during daylight, and migrating toward the surface at night, except in autumn, when they have a reverse vertical migration (migrate to the surface during the day) (Mowbray 2002). Acoustic surveys were used to determine abundance and distribution patterns in January, March, June and January 1999 in Placentia Bay (O'Driscoll and Rose 1999). Biomass was greatest in June 1998 (132,000 tonne), and much lower during the three other surveys. Seasonal differences in spatial and vertical distribution were noted (O'Driscoll and Rose 1999).

**Herring**

Herring in Placentia Bay are part of the St. Mary's Bay-Placentia Bay stock and are commercially fished during spring and fall (DFO 2005a; Wheeler 2010). Herring move into the bays during spring to spawn and feed, and generally migrate to deeper water to over-winter. Herring are demersal spawners, depositing their eggs on stable substrates in shallow, coastal waters (Stevenson and Scott 2005), although some spawning can occur on offshore banks at depths of 40 to 80 m. Masses of herring eggs attach to the hard bottom substrate nearshore or to kelp fronds. Eelgrass has been associated with spawning in some areas (DFO 2005a). Herring have been known to spawn north of the Argentia peninsula in previous years (John O'Rourke, pers. comm.).

Hatching of larvae occurs after approximately 10 to 30 days and is temperature dependent (Scott and Scott 1988). Spring recruits will remain in the water column during spring and summer, but fall recruits may be pelagic until the following spring. Tides may cause retention of eggs and larvae near the spawning ground, or eggs and larvae may passively drift with dominant currents (DFO 1984, in EMCP 2011). Herring primarily feed on euphausiids (DFO 2005a) and this species is an important prey item for other fish, seabirds and marine mammals.

Assessments of the St. Mary's Bay-Placentia Bay stock suggest a decline occurred from 2001 to 2004, and was stable from 2005 to 2008, but that the stock still remains low in comparison to levels in the 1970s. Herring are at the northern limit of their range in Newfoundland and a successful year-class depends on ideal environmental conditions, including warmer than average waters during the over-wintering period, and high salinities prior to spawning. A survey of local knowledge identified three known herring aggregation sites in Placentia Bay: coastal waters between Lamaline and St. Lawrence (southern Burin Peninsula); near Boat Harbour/Brookside/Little Harbour (west side of Placentia Bay); and on northeast and northwest Merasheen Island and southwest Long Island (refer to Section 13.3.1.4; Figure 13-5).

### Atlantic Cod

Atlantic cod are discussed in detail in marine fish Species at Risk (Section 12.3.1.3).

### Atlantic Mackerel

Two populations have been identified in the Northwest Atlantic; the northern stock resides in the Gulf of St. Lawrence and the southern stock in the Gulf of Maine. The northern stock migrates during summer months to the Gulf of St. Lawrence, along the coast of Nova Scotia and on the Grand Banks, and over-winters south of Georges Bank. Much of the spawning of this species occurs in the southern Gulf of St. Lawrence in June and July, which may be a result of changing oceanographic conditions (DFO 2006a). Rose (2005) has noted that it is not unusual for mackerel to alter their distribution during periods of warming historically.

After spawning, fertilized eggs will hatch within five to seven days depending on water temperature. Larvae grow rapidly and reach a size of more than 20 cm within their first year. Mortality of mackerel eggs and larvae are extremely high, and is estimated to reach 50 percent per day during the egg and larval stages.

Adult mackerel are both filter feeders (have gill rakers that filter small food particles from water) and carnivores of small organisms such as amphipods, small squid, eggs and larvae, capelin, shrimp and herring. Predators include porbeagle shark (*Lamna nasus*), spiny dogfish (*Squalus acanthias*), Atlantic cod, Atlantic bluefin tuna (*Thunnus thynnus*), swordfish (*Xiphias gladius*), porpoise (*Phocoena phocoena*) and harbour seal (*Phoca vitulina*).

### American Plaice

American plaice are discussed in detail in marine fish Species at Risk (Section 12.3.1.10).

### Winter Flounder

Winter flounder is an inshore shallow-water species, preferring soft to moderately hard substrates (Pereira et al. 2002). They occur at depths of 5 to 100 m, and are common at 40 m. Juveniles and young adults inhabit shallower water than older, large fish. Most winter flounder undergo a seasonal migration to deeper waters in the fall and return to nearshore shallow waters to spawn during May and June (Pereira et al. 2002). Mass movements of winter flounder have also been reported due to habitat disturbance (i.e., storms) (Van Guelpen and Davis 1979; Pereira et al. 1999).

Winter flounder are considered opportunistic feeders and use visual cues from moving benthic invertebrates to find prey. These flounder feed primarily on benthic invertebrates (especially polychaetes and amphipods) (Keats 1990; Carlson et al. 1997), but they also prey on molluscs, capelin eggs and fish (Scott and Scott 1988). Feeding migrations have also been reported from Newfoundland (Keats 1990).

Winter flounder reproduce in estuarine or coastal spawning areas throughout their range. Peak spawning has been observed from May to early June in Newfoundland (Kennedy and Steele 1971). Eggs are demersal and adhesive; in the nearshore eggs

settle in clumps on sandy substrate in less than 5 m of water (Pereira et al. 1999). Hatching occurs within two to three weeks, depending on temperature, and the pelagic larvae settle out approximately eight weeks after hatching (Fahey 1983). Spawning tends to occur in areas where dispersal by currents is limited and where habitat is suitable for larval settlement (Pereira et al. 1999). Highest densities of newly settled winter flounder have been found to occur on muddy substrates (Pereira et al. 1999).

**Lumpfish**

Mature female lumpfish are harvested for roe during the inshore spawning season in spring/summer. Mature fish are semi-pelagic, migrate inshore in the spring or early summer to spawn, and return to deeper waters in the fall (Scott and Scott 1988). Males arrive on the spawning grounds several weeks in advance of the females to establish their territories. The females lay two to three egg masses on rocks in shallow water at intervals ranging from 8 to 14 days. The eggs are guarded and fanned by the male until hatching occurs six to eight weeks later. Females return to deeper water after egg-laying. Egg masses may contain more than 100,000 to 130,000 eggs, with each egg measuring approximately 2 mm in diameter.

Larvae hatch during May to June. After settlement, juveniles commonly occur in shallow water among eelgrass and kelp blades, especially *Laminaria* spp. (DFO 2002). During early life stages, lumpfish attach to rocks, lobster traps and other solid objects with their pelvic adhesive disc. They are able to swim and feed approximately four to seven days after hatching, but may also feed from the attached position. Juvenile lumpfish appear to remain in the coastal area in the first year of their life cycle, before changing to a semi-pelagic mode and moving offshore (Scott and Scott 1988; DFO 2002).

Juveniles eat mainly copepods and amphipods, whereas adults tend to feed primarily on coelenterates, ctenophores, chaetognaths, amphipods, euphausiids, copepods, some molluscs, polychaetes and small fish such as herring and sand lance (Scott and Scott 1988; DFO 2002).

**Sand Lance**

Ichthyoplankton surveys in Placentia Bay reported that sand lance larvae were concentrated in waters off Cape Shore, in the central section of the outer bay and off the southern Burin Peninsula (Bradbury et al. 2003). Eggs are demersal and adhesive to the substrate. Sand lance are described in Section 8.3.2.5.

**Thorny Skate**

Thorny skate was assessed in May 2012 by COSEWIC as of special concern. Small thorny skate are relatively abundant in NAFO Division 3Ps and there has been a limited fishery for thorny skate within Placentia Bay in the past. Thorny skate are described in detail in marine fish Species at Risk (Section 12.3.1.18).

**Spiny Dogfish**

Spiny dogfish are discussed in detail in marine fish Species at Risk (Section 12.3.1.14).

### Atlantic Salmon

Atlantic salmon are discussed in detail in marine fish Species at Risk (Section 12.3.1.12).

### Lobster

Adult lobsters inhabit coastal waters during the summer, but migrate to warmer, deeper waters in the winter. Lobster have a continuous distribution around the island of Newfoundland, occupying a relatively narrow band of rocky habitat over an approximate depth range of 2 to 40 m (Ennis 1986; DFO 2003a). Populations tend to be localized in less than 50 m of water.

Mating can occur between July and September, depending on water temperature. If water temperature remains below 5°C, spawning will be later than usual, or may not occur at all (Aiken and Waddy 1986; DFO 2009a). Embryo development is also regulated by temperature and proceeds slowly when temperatures are below 6°C. On the south coast of Newfoundland, lobster larvae begin hatching in early summer (Ennis 1974, 1986), but may be delayed if the water temperature is low. Upon hatching, larvae are planktonic and the larvae moult through three pelagic stages until settling during the fourth state. Young lobster generally stay close to the coast in depths of 10 m or less, and do not migrate during the winter. During the pelagic phase, larvae are primarily drifting plankton, but can exhibit some control over distance travelled by undertaking vertical migrations (Katz et al. 1994; Ennis 1995, DFO 2009a).

Juveniles occupy self-dug tunnels or natural crevices under cobble to avoid predation by coastal predators such as cunner during their first two years (Harding 1992). According to Harding (1992), juveniles stay in their burrows feeding on passing plankton and detritus until they reach a size corresponding to a carapace length of greater than 30 mm (this corresponds to a two- to three-inch lobster); at that time, they leave the tunnels at night to feed. Wahle and Steneck (1992) report that juveniles are generally found occupying crevices and holes near small boulders or burrowing under rocks and eelgrass. Juvenile lobster usually remain within a few kilometres of where they settle, and can migrate over several kilometres only after reaching maturity.

In Newfoundland, it takes eight to ten years for a lobster to reach commercial size (DFO 2006b). Adult lobster are known to be solitary and appear to conform to the general pattern of diminishing predator avoidance with greater body size; however, lobster do continue to use refuge as adults but are more transient than smaller lobster. Shelter availability is a critical feature of adult lobster habitat, leading adults to select habitats where burrows can be dug or where they pre-exist under rocks or boulders. Lobster diet consists mainly of benthic invertebrates including rock crab, polychaetes, molluscs, echinoderms and fish (DFO 2009a). Adult lobster have few natural predators, with the commercial fishery accounting for most adult mortality.

### Sea Scallops

Sea scallop are distributed from the Strait of Belle Isle to Cape Hatteras throughout shallow (less than 20 m) coastal regions on sand/gravel or gravel/pebble substrate. They occur at depths of 35 to 120 m in large aggregations, referred to as scallop beds. Sea scallop do not migrate, but are capable of limited ‘swimming’ by clapping their shells

together. Scallop are filter feeders, and filter plankton and small particles from the water column (Hart and Chute 2004). They are most abundant in shallow sheltered sandy locations, such as western Placentia Bay.

The primary spawning event for scallop generally occurs in late September/early October in Newfoundland and occurs for two to four weeks. The first two larval stages of the scallop are pelagic, with larvae remaining planktonic for over a month after hatching and typically settling to the seabed by December (Hart and Chute 2004). Settlement is dependent on the larvae detecting a suitable substrate (Pearce et al. 2004). Larvae settle on hard surfaces, preferring substrates with shell fragments and small pebbles including existing scallop beds (Hart and Chute 2004). After larvae settle, they develop a 'foot' to attach to the bottom. Once attached, the larvae develop into juveniles and remain attached using byssal threads. After the juvenile scallop attains a large enough size, the byssal threads are lost and the scallops remain on the seafloor as they develop to adult stage.

Sea scallop have been identified as a key organism in the 'scallop bed habitat type' characterized by Catto et al. (1999) as one classification of marine coastal habitat for Newfoundland and Labrador. The entire marine area of Placentia Bay from Point Crewe to Cape St. Mary's has been designated a Fisheries Management Area in order protect scallop stocks and manage gear use conflicts. Since 1992, there have been designated area closures and gear restrictions in place (CPAWS 2009). The area from Point Verde to Red Harbour Head is closed to recreational scallop fisheries. There are also areas within Placentia Bay that are closed to otter trawling and where commercial scallop fishing by vessels 45' and larger is prohibited. These closed areas were initiated by local fishers and harvesters, and are administered by DFO under the *Oceans Act* (CPAWS 2009).

**Snow Crab**

Snow crab occur in Newfoundland waters at depths usually between 60 to 400 m, on mud and gravel substrate. In the nearshore environment, snow crab are common in all major bays surrounding Newfoundland and Labrador. Snow crab feed on fish, clams, polychaete worms, brittle stars and other crustaceans (DFO 2011b). Information on snow crab is provided in Section 8.3.2.5.

**Blue Mussel**

The blue mussel has a circumpolar distribution in boreal and temperate waters and can occur in habitats ranging from slightly brackish shallow estuaries to highly saline deep offshore environments. The blue mussel is most commonly found in the intertidal and shallow subtidal zones (DFO 2003b).

Spawning typically occurs from May to August, peaking sometime between mid-May and late June. Time of spawning appears to be closely linked to environmental triggers including sufficiently high water temperature, suitable planktonic food supply, spring tidal currents and physical disturbance during storm events (Starr et al. 1990). External fertilization results in benthic fertilized eggs, followed by the subsequent larval hatch. The free-swimming larvae remain planktonic for three to four weeks prior to settlement (mid-June to late September in Atlantic Canada). Settlement appears to be most successful on hard substrate with surface irregularities and in areas with some

protection from strong wave action. Once the larvae settle and attach to the substrate by byssal threads, they metamorphose into young juveniles commonly referred to as spat. Spat eventually develop to the adult stage (DFO 2003).

Blue mussel have been a successful aquaculture species, particularly in the Canadian Maritimes (DFO 2003b), and are in relatively high demand within food markets. Blue mussel are farmed in Placentia Bay at five commercial aquaculture operations and wild stocks are also harvested recreationally.

**Sea Urchin**

Green sea urchin are the dominant herbivore in the shallow, rocky subtidal in Atlantic Canada and have the potential to drive the distribution and coverage of macroalgae and associated taxa (Mann 1977; Meidel and Scheibling 1998; Feehan et al. 2012). Main predators of urchins in Atlantic Canada include lobster, rock crab, wolffish, ocean pout, sculpin species, flatfish, sea stars, other urchins and a variety of birds (Scheibling and Hamm 1991; Guillemette et al. 1992), although predation did not appear to be sufficient to limit urchin abundance during the Newfoundland study. Sea urchin larvae are preyed upon by zooplankton and planktivorous fish; however, the larval stage is short. Diet studies in Atlantic Canada (Himmelman and Steele 1971; Hooper et al. 1996; Minor and Scheibling 1997; Vadas et al. 2000) found that perennial macroalgae including fucoids and sugar kelp (*Alaria esculenta*) were the main species consumed by urchins, although coralline algae and ephemeral algal species were consumed in smaller amounts when available.

Spawning occurs in March or April each year, and appears to be stimulated by favourable environmental conditions such as warming water temperatures and sufficient phytoplankton availability (Himmelman 1978; Keats et al. 1987; Starr et al. 1990).

**Squid**

Juvenile short-finned squid (*Illex illecebrosus)* migrate from the edge of the continental shelf to the Grand Banks and elsewhere on the shelf between April and June. Abundance on the shelf and nearshore peaks in September and then declines as the larger, maturing squid leave the shelf and migrate to the southwest, possibly to spawning grounds at Cape Hatteras.

Spawning females create large, clear, nearly neutrally buoyant egg masses. After spawning short-finned squid die, and it is believed they likely do not live longer than 12 to 18 months in total (Cargnelli et al. 1999). Hatching times for the larvae are variable, with peak hatching occurring between March and May. A spawning site has been identified at the Mid-Atlantic Bight (Hendrickson 2004). Short-finned squid tend to be demersal during the day and migrate upwards in the water column at night. Juveniles feed on small crustaceans such as euphausiids. Adults have a more varied diet that includes larger crustaceans, fish (e.g., young-of-the-year cod, capelin, sand lance, Arctic cod, herring, redfish, hake), and other squid. Squid are preyed upon by fish (e.g., tuna, swordfish, haddock, cod, pollock (*Pollachius virens*), shark), marine birds and marine mammals.

Long-finned squid are distributed along continental shelf and slop waters from Newfoundland to the Gulf of Venezuela, but occur in abundances to support fisheries

from Georges Bank to Cape Hatteras (Jacobson 2005). This species does occur in Newfoundland but are at the northern limit of their range and are less abundant in comparison to waters further south. Spawning of this species does not appear to occur in Newfoundland waters (Dawe et al. 1990).

The Arctic squid is an Arctic-boreal circumpolar squid distributed in the offshore Arctic and subarctic and as far south as Newfoundland and Labrador (Nesis 2001) and may extend to the Scotian Shelf and Georges Bank (Stephen 1982). This species typically occurs between the surface and 500 m depth. Juveniles feed mainly on zooplankton and adults consume fish and squid. Arctic squid are prey for several marine mammal, marine birds and demersal fish species (Nesis 2001).

### 8.3.2 Offshore

This section focuses on fish and fish habitat of the Offshore Study Area and how they may interact with WREP activities. The main fish habitat components include phytoplankton, zooplankton (including meroplankton), the water column, macroinvertebrates and benthic habitat. Fish and fish habitat data collected from the Offshore Study Area during previous White Rose EEM surveys were also consulted (Husky 2009, 2011). This information is complemented by environmental monitoring data collected by nearby oil and gas operators. These data have been collected on the Jeanne d'Arc Basin since 1997. Data from DFO RV surveys in NAFO Division 3L have also been reviewed, in addition to primary literature on fish and fish habitat in the Offshore Study Area.

The offshore environment as it pertains to fish and fish habitat is described in the following sections.

#### 8.3.2.1 Physical Environment

The Offshore Project Area is located on the northeastern edge of the Grand Bank in the area around Jeanne d'Arc Basin, at the site of the existing White Rose field. The Offshore Study Area encompasses a larger area over the Grand Bank (Figure 5-4).

The physical environment of the White Rose field has been described in detail in previous environmental assessments of the Grand Banks (i.e., Husky 2000, 2001, 2007; LGL 2006, 2007a, 2012; Jacques Whitford Limited 2009). A detailed review of the oceanography of the Offshore Study Area is provided in Section 4.3.2.

#### 8.3.2.2 Habitat

A preliminary geophysical investigation at the proposed WHP site (FGI 2012) was undertaken using sub-bottom profiling and multibeam bathymetry to collect geological and bathymetric data. The seafloor in the area was found to be generally flat, with low relief undulations and depressions. Depth is approximately 118 m relative to Chart Datum. The seafloor is relatively featureless except for ice scouring. Scour depths are typically less than 0.3 m, although pits may be as deep as 1.3 m; a low-relief iceberg scour that is 0.25 m deep and 25 m wide passes through the proposed WREP site. Slope is less than 1° to the northeast. The seabed consists of surficial fine- to medium-grained sand, with shell, coarse-grained sand and gravel in places. Thickness of surficial sediment varies from near-zero to approximately 3 m and a maximum thickness of

6.5 m, with change in thickness occurring over small spatial scales (less than 10 m). The surficial sands cover an underlying, irregular, ice-scoured glacial sediment surface. The underlying sediment is between 4 and 13 m thick and is interpreted as mainly gravel to sandy gravel, with occasional cobble and possibly boulders. These findings suggest these sediments are glacially derived. In addition to scouring from icebergs (furrows, berms pits), there are markings made by the dragging of otter trawl 'doors' during trawl fishing, anchor chain marks and well sites created by previous drilling activities (FGI 2012).

Sediment chemistry and quality parameters (i.e., dissolved oxygen, trace metal, suspended particulate matter, inorganic nutrients and hydrocarbons) were measured during White Rose EEM programs since 2002 (Husky 2009; 2011). To date, this sampling program has found elevated levels of hydrocarbons, barium and sulphur/sulphides within 0.5 to 2 km of the drill centre, relative to the 2000 baseline studies (Husky 2010).

#### 8.3.2.3 Plankton

The greatest abundance of phytoplankton on the Grand Banks typically occurs in late April to early May within the top 30 to 50 m of the water column (Pepin and Parajape 1996). The spring bloom on the Grand Banks is dominated by diatoms. A second peak in phytoplankton abundance occurs on the northern Grand Bank in fall, when dinoflagellates and other microflagellates dominate the plankton community (Myers et al. 1994). In years with extensive ice cover, the spring phytoplankton bloom may be delayed until there is enough warming of the surface layer to provide vertical stability and promote phytoplankton growth (Pepin et al. 2011). Data collected by Continuous Plankton Recorder sampling from 1958 to 2006 (Head and Pepin 2010) suggested the main zooplankton components have changed. The abundance of the copepods *Calanus glacialis* and *C. hyperboreus* also increased, and *C. finmarchicus* decreased since the early 1990s, likely in response to the freshening of the upper water column and changes in temperature (Head and Sameoto 2007; Head and Pepin 2010).

Ichthyoplankton also constitutes a portion of the zooplankton that is collected during surveys on the Grand Banks. Common species observed in the meroplankton during surveys include Atlantic cod, American plaice, sand lance, redfish, capelin, lanternfish (*Nannobrachium achirus*), alligatorfish, sculpin, seasnail, white hake (*Urophycis tenuis*), haddock (*Melanogrammus aeglefinus*), wolffish, witch flounder, yellowtail flounder and Greenland halibut (Dalley et al. 2000).

Although warming of sea surface temperatures have been observed in the North Atlantic since the late 1990s, there has not been an observed corresponding change in the seasonal cycle of most phytoplankton and zooplankton species (Maillet et al. 2006).

#### 8.3.2.4 Benthos

Due to a range of depths and substrate types, the Offshore Project Area is known to support a variety of infaunal and epifaunal benthic species including sand dollars, anemones, clams, sea cucumbers, bryozoans, coral, ascidians, urchins, hydroids, polychaete worms, and several crab species. Images of the seabed from the West White Rose area are consistent, showing varying densities of sea stars, brittle stars and bivalves (FGI 2012).

Spatial variability in benthic invertebrate communities occurs over small scales (within metres) on the Grand Banks (Schneider and Haedrich 1991). This spatial heterogeneity is largely driven by differences in microhabitat (e.g., depth, grain size, water mass properties), as well as disturbance, and the temporal variability in abundance of some macrofaunal species (Kenchington et al. 2001). When disturbance events (i.e., storms, fishing gear) alter the seafloor, epifaunal and infaunal organisms are exposed and vulnerable to predation by larger organisms (e.g., snow crab). After a disturbance event, the community will undergo a process of ecological succession as it rebuilds and matures over time.

Grain size has been strongly correlated with abundance, species richness and diversity for several benthic communities at other nearby sites such as the Terra Nova field (DeBlois et al. 2005). For example, in areas with coarser grain size (sandy substrate), there were fewer short-lived polychaetes, amphipods, cumaceans (crustaceans), brittle stars and soft-shell coral (Kenchington et al. 2001). Because the sandy substrate is very dynamic and unstable on the Grand Banks, there are fewer sessile species. Most species on sandy substrate are mobile or burrowers, with some tube-building species present. The estimated benthic biomass for NAFO Division 3LNO, which includes the Offshore Study Area, is 230.6 tonnes/km$^2$ (Table 8-2), in comparison to a total benthic biomass of 98.5 tonnes/km$^2$ in the less productive areas of 2J and 3K, which are located further north.

**Table 8-2 Estimates of Mean Benthic Biomass in NAFO Divisions**

| Benthic Group | 3LNO Biomass (t/km$^2$) | 2J3K Biomass (t/km$^2$) |
|---|---|---|
| Echinoderms | 144.8 | 70.6 |
| Molluscs | 62.2 | 16.4 |
| Polychaetes | 11.9 | 8.8 |
| Other | 11.8 | 2.7 |
| Total Biomass | 230.7 | 98.5 |
| Source: Bundy et al. (2000)<br>Note: Total biomass does not include bivalve shell weight | | |

Commercial fish surveys during Husky EEM programs have found that northern shrimp was the most abundant epibenthic species, followed by sea urchin and sand dollar (Husky 2009). Less common but present were soft-shelled clams, snow crab, toad crab (*Hyas araneus* and *Hyas coarctatus*), Iceland scallop (*Chlamys islandica*) and sea stars. These surveys found minor differences in the benthic communities that occur in mainly sandy substrate and communities occurring in mainly gravel substrate, particularly for the less abundant taxa.

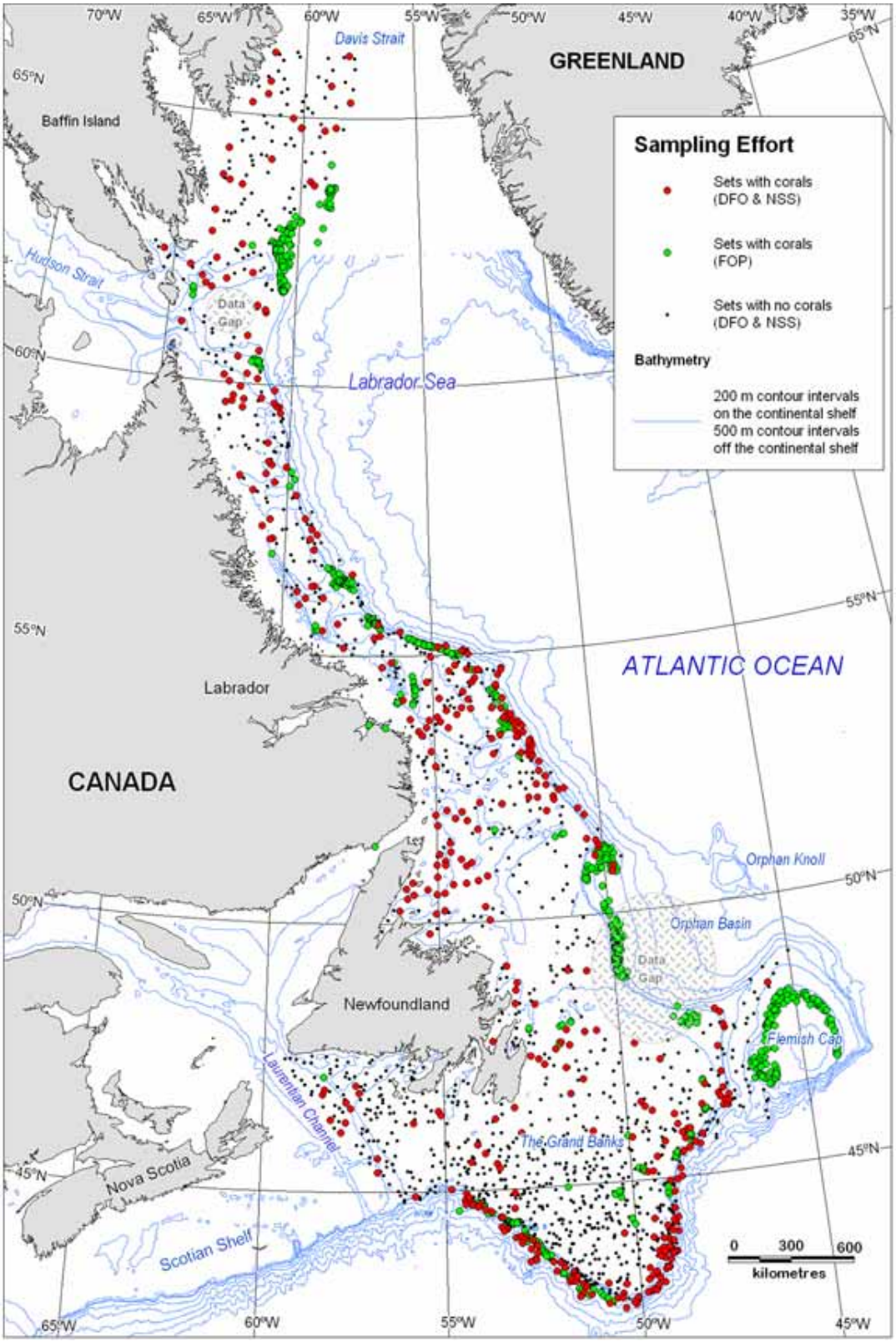
In terms of mean relative abundance (percent of total), polychaetes were found to be the most abundant benthic invertebrate on the Grand Banks during EEM programs conducted since 2004 (Husky 2005, 2006, 2007, 2009, 2011). Many of these polychaetes are deposit feeders (e.g., Spionidae, Cirratulidae families), although there are also predatory polychaetes such as *Exogene hebes*. Sand dollars were the most common echinoderm and occur in densities as high as hundreds per square metre in areas with suitable habitat (i.e., loosely packed sediment, grain size less than 230 µm,

high turbulence). Green sea urchins and brittle stars were also common. Common bivalves included the propeller clam (*Cyrtodaria siliqua*) and the chalky macoma (*Macoma calcarea*). Gammarid amphipods, cumacea and isopod species were the most common crustaceans.

Two important habitat-forming taxa in the Offshore Study Area are deep-water corals and sponges (Kenchington et al. 2010). Corals are long-lived, slow-growing, fragile species and are considered to be an important habitat component in deep waters (Buhl-Mortensen and Mortensen 2005; Edinger et al. 2007; Wareham and Edinger 2007; Wareham 2009; Baker et al. 2012). Cold-water corals increase habitat complexity (e.g., provide vertical relief and expand available niches) and provide important deep-water habitat to a variety of demersal fishes and benthic invertebrates. Cold-water corals occur mainly below the 200 m depth contour, along the continental slope edge, in canyons, or in channels between banks (Figure 8-9) (Edinger et al. 2007; Wareham and Edinger 2007; Murillo et al. 2011).

Soft coral species can occur at shallower depths on the Newfoundland continental shelf, as discovered during DFO RV surveys (Edinger et al. 2007; Gilkinson and Edinger 2009). Reviews of deep-sea corals in Newfoundland and Labrador waters were published by Gilkinson and Edinger (2009) and Wareham (2009). Identified corals in the vicinity of the Offshore Study Area include Alyconancean (*Anthomastus grandiflorus*; *Capnella flordia*; *Gersemia rubiformis*), Neptheid (unknown species), Pennatulidacea (*Pennatulidae* species) and Gorgonians (*Paragorgia arborea*; *Acanella arbuscula*; *Acanthogorgia armata*; *Keratoisis ornate*; and *Paramuricae* spp., *Radicipes gracilis*) (Gilkinson and Edinger 2009).

Edinger et al. (2010) assessed whether there were associations between cold-water corals and fish and invertebrates species based on ROV surveys and DFO research surveys. No strong relationship was evident for the ten groundfish species included in the study, but there were weak statistically significant positive correlation between coral species richness and fish species richness (Edinger et al. 2009). Corals in the deep sea may support fish communities by providing higher prey abundance, increasing habitat complexity and resting places and increasing water turbulence locally (Auster et al. 2005; Edinger et al. 2009). Large gaps remain in current knowledge of benthic systems in offshore Newfoundland and Labrador, since much of what is known is limited to specific locations and particular species.




Source: Wareham and Edinger 2007

**Figure 8-9 Distribution of Corals in Newfoundland and Labrador**

### 8.3.2.5 Fish and Shellfish

Fish and shellfish species common to the Offshore Study Area include both pelagic and demersal finfishes, elasmobranchs (sharks, skates and rays), as well as commercially important macroinvertebrates such as shrimp and crab. Other species common to the Offshore Study Area include demersal fish species such as yellowtail flounder, American plaice, Atlantic cod, thorny skate, winter skate (*Leucoraja ocellata*), roundnose grenadier (*Coryphaenoides rupestris*), roughhead grenadier (*Macrourus berglax*), alligatorfish, sculpin species, Arctic cod, Greenland halibut and redfish. Important prey for demersal fish species include sand lance, capelin, brittle stars, clams, sea urchins and sand dollars (Methven 1999), as well as smaller prey such as polychaete and amphipod species (Link et al. 2002). Other common invertebrates include Stimpson's surf clam (*Spisula polynyma*), cockles and toad crab. Common pelagic fish include capelin, sand lance and Arctic cod. These forage fish are particularly important for higher trophic levels such as marine mammals, larger pelagic fish (e.g., tuna, swordfish) and marine birds.

Atlantic cod and American plaice were historically the most abundant fish species on the Grand Banks; however, in recent decades cod have become uncommon in NAFO 3L, and American plaice have been reduced but remain common. Both species have been assessed by COSEWIC and are discussed further in marine fish Species at Risk (Sections 12.3.1.3 and 12.3.1.10, respectively). Uncommon species on the Grand Banks include white hake, Atlantic halibut, monkfish and winter skate (Kulka and Miri 2003; Simon et al. 2003; Kulka et al. 2004).

Data from the 2006, 2008 and 2010 White Rose EEM program indicated that American plaice, snow crab, shrimp, mailed sculpin, hookear sculpin, alligatorfish, capelin, toad crab, and sand lance were the most abundant species at the EEM Study Area (Husky 2007, 2009, 2011). These results agree with data collected during the 2010 and 2011 DFO RV surveys in NAFO Division 3L were used to assess the potential for underutilized species, as well as the most abundant species (catch weight) in the Offshore Study Area (Tables 8-5 and 8-6). The dominant species in 2010 were deepwater redfish (36 percent by wei**g**ht), capelin (9.6 percent), American plaice (4.9 percent), sand lance (4.2 percent), yellowtail flounder (3.3 percent), Atlantic cod (2.1 percent) and Greenland halibut (2.6 percent). Landings were similar in 2011; deepwater redfish accounted for the greatest amount of landings (22 percent) and capelin (14.5 percent), American plaice (7.9 percent), yellowtail flounder (6.4 percent), shrimp (*Natatia* spp.) (5.2 percent), Atlantic cod (4.1 percent) and Greenland halibut (2.3 percent) were also common. Among the least abundant species was snow crab, thorny skate, wolffish, eelpout, longfin hake (*Phycis chesteri*) and alligatorfish (Table 8-3), though snow crab data may be subject to sampling gear biases.

**Table 8-3 Species with the Highest Catch Weights during Fisheries and Oceans Canada Research Vessel Surveys in the Offshore Study Area**

| Year | 2010 | | 2011 | |
|---|---|---|---|---|
| **Total Weight Landed (kg)** | **4,669,641** | | **2,965,411** | |
| **Species** | **Weight Caught (kg)** | **Percent of Total (kg)** | **Weight Caught (kg)** | **Percent of Total (kg)** |
| Alligatorfish | 2,194 | 0.05 | 1,587 | 0.05 |
| American plaice | 228,586 | 4.90 | 234,674 | 7.91 |
| Atlantic cod | 101,982 | 2.18 | 120,792 | 4.07 |
| Atlantic halibut | 2,989 | 0.06 | 1,797 | 0.06 |
| Atlantic herring | 3,538 | 0.08 | 524 | 0.01 |
| Atlantic wolffish | 24,794 | 0.53 | 14,274 | 0.48 |
| Arctic cod | 13,111 | 0.28 | 7,795 | 0.26 |
| Capelin | 452,443 | 9.69 | 431,144 | 14.5 |
| Greenland halibut | 121,255 | 2.60 | 70,005 | 2.36 |
| Longfin hake | 6,706 | 0.14 | 4,909 | 0.17 |
| Marlin spike | 11,738 | 0.25 | 4,492 | 0.15 |
| Eelpout species | 703 | 0.02 | 4,900 | 0.17 |
| Northern wolffish | 15,301 | 0.33 | 15,539 | 0.52 |
| Redfish | 1,718,635 | 36.80 | 656,411 | 22.14 |
| Roughhead grenadier | 63,929 | 1.37 | 38,116 | 1.29 |
| Sand lance | 197,548 | 4.23 | 38,336 | 1.29 |
| Shrimp (*Pandalus* spp.) | 22,069 | 0.47 | 72,864 | 2.46 |
| Shrimp (*Natatia* spp.) | 40 | <0.001 | 156,167 | 5.27 |
| Shorthorn sculpin | 1,293 | 0.03 | 6,478 | 0.22 |
| Snow crab | 80,819 | 1.73 | 61,938 | 2.09 |
| Spotted wolffish | 18,044 | 0.39 | 11,371 | 0.38 |
| Thorny skate | 0 | 0 | 591 | 0.02 |
| Witch Flounder | 33,547 | 0.72 | 26,333 | 0.89 |
| Yellowtail flounder | 154,556 | 3.31 | 189,567 | 6.39 |

Notes: collected using a Campelen 1800 Shrimp Trawl (lined)
Large proportion of total weight is due to stones
Source: DFO (March 2012, pers. comm.)

Species that occurred at shallow depths during the DFO RV survey included yellowtail flounder, sand lance, capelin, Atlantic herring, and shorthorn sculpin. Species that occurred in deeper water during the DFO RV survey included deepwater redfish, roughhead grenadier, shrimp (*Natatia* spp.), Atlantic halibut, longfin hake and wolffish. Fish and shellfish species that commonly occur in the Offshore Study Area are described in the following sections. Marine fish Species at Risk are discussed in Chapter 12. The spawning times for species are listed in Table 8-4.

**Table 8-4 Spawning Time and Location of Fish Potentially Occurring near the Offshore Project Area**

| Species | Spawning Period | Spawning Location | Timing of Pelagic Eggs/Larvae | Reference |
|---|---|---|---|---|
| American Plaice (A) | April to June | Throughout the Grand Banks; most intensive in Northern Grand Banks | American plaice eggs float near the surface and hatch within 11 to 14 days at temperatures of 3.9°C. Larvae are concentrated near the thermocline, at approximately 20 m | Scott and Scott 1988; Morgan et al. 2011; Ollerhead et al. 2004 |
| Yellowtail Flounder | April to June | Central and southern Grand Banks | Unknown | Ollerhead et al. 2004 |
| Witch Flounder | March to June | Southern Grand Banks (3O) during peak spawning; northern 3L and in 3N later in summer | Unknown | Ollerhead et al. 2004 |
| Thorny Skate | Fall to Winter | Edge of Grand Banks, especially in 3Ps | Unknown | Kulka et al. 2004 |
| Redfish (A) | June | Northeastern edge of Grand Banks in >200 m of water | Larval extrusion typically occurs in late spring/summer months | Ollerhead et al. 2004 |
| Capelin | June and July | Coastal beaches of Newfoundland (including Placentia Bay); some spawning in offshore waters | Unknown | Carscadden 2001 |
| Snow Crab | | The developing fertilized eggs are carried by the female | Larvae hatch in late spring and summer. Larvae remain planktonic for three to four months | DFO 2011b |
| Northern Shrimp | June and July | Flemish Cap, eastern and northern edges of Grand Banks in 3LN, and near the south coast in 3P | Eggs remain attached to females from late summer and fall until larvae hatch the following spring/summer. Larvae remain planktonic in upper water column for a few months | Ollerhead et al. 2004 |
| Stimpson's Surf Clam | June to October | Eastern edge of the Grand Banks in 3N | Unknown | Ollerhead et al. 2004 |
| (A) Species at Risk, described in detail in Section 12.3.1 | | | | |

## Yellowtail Flounder

Yellowtail flounder are distributed from Labrador to Chesapeake Bay, and are most frequently found on sandy substrates at depths less than 100 m (Walsh 2000). Yellowtail flounder declined from the late 1980s to early 1990s, but since that time has shown stable and increasing population trends (Walsh et al. 2000; Maddock-Parsons 2009). Yellowtail flounder are most densely distributed in the warmer waters of the Tail of the Grand Banks and also along the Laurentian Channel slope (Kulka et al. 2003), although historically their distribution also included the northern Grand Banks. This species is relatively sedentary and does not undergo migrations. Spawning occurs primarily on the central and southern portion of the Grand Banks, although it can occur in the northern portion, and spawning is thought to occur between April and June (Ollerhead et al. 2004; Maddock-Parsons 2009). Yellowtail flounder eggs are deposited on the bottom and float

to near the surface once fertilized (Scott and Scott 1988). Newly settled juveniles select mud- and sand-dominated substrate, and the Southeast Shoal of the Grand Banks is known to be an important nursery area for yellowtail flounder.

The yellowtail flounder diet on the Grand Banks is composed mainly of polychaetes and amphipods (Walsh 1992; Methven 1999). As yellowtail flounder historically occurred on the northern Grand Banks, it is likely they do occur in the Offshore Project Area, although it is not known to be a critical habitat area (Walsh et al. 2000). The Southeast Shoal and Tail of the Grand Banks EBSA is known to provide spawning area and critical nursery habitat for yellowtail flounder (DFO 2007b), and occurs in the Offshore Study Area (Section 13.3.2.1).

**Sand Lance**

Sand lance are known to be an important forage fish for many groundfish and pelagic fishes (e.g., capelin, cod, other sand lance, American plaice), as well as higher trophic levels (e.g., whales, harp seals, seabirds) (Bundy et al. 2000). Despite this, little is known about the biology and life history of sand lance. Sand lance are distributed from West Greenland to Cape Hatteras, but are concentrated on the Grand Banks, where they are abundant, particularly on gravel substrate (Anderson et al. 1999).

EEM sampling in the Project Area has indicated sand lance are relatively abundant (5.1 to 7.1 percent of catch) at reference sites (Husky 2009), and sand lance larvae have been found to be abundant during pelagic surveys in August and September on the Grand Banks

**Greenland Halibut**

Greenland halibut (turbot) are large, demersal flatfish that are distributed in Canadian waters from northern Labrador to the Grand Banks and also occur in the Gulf of St. Lawrence (Healey 2010). Greenland halibut show a preference for temperatures between -0.5°C and 3°C (Healey 2010). They occur within the Offshore Study Area and are known to concentrate along the northeast edge of the Grand Banks and on the northeast Newfoundland Shelf. The Northeast Shelf and Slope EBSA in the Offshore Study area is known to support high concentrations of Greenland halibut in spring (DFO 2007b) (see Section 13.3.2.1). Greenland halibut also occur less commonly along the southeast and southwest slopes of the Grand Banks and the Laurentian Channel (Bowering 2000; Kulka et al. 2003; Healey 2010). Greenland halibut are relatively common in the Offshore Project Area during the fall, but are distributed at the edge of the Grand Banks during spring.

During the late 1970s and much of the 1980s, this species was relatively abundant along the deep slopes, particularly in NAFO Division 2G, and also in deep channels between banks (NAFO Division 2H, 2J, and 3K) (Healey 2010). Stocks reached a low in the 1990s and large, older fish were largely absent from catches. Several strong successive year-classes from 1993 to 1995 facilitated some recovery by the late 1990s. More recent surveys suggest there have been weaker year-classes since that time, driving average or lower than average population estimates. The 2009 spring survey had the lowest estimates of biomass and abundance of Greenland halibut to date in NAFO Division 3LNO (Healey 2010).

Eggs and larvae remain pelagic over deep waters until settling. As juveniles (less than 20 cm), Greenland halibut mainly feed on small crustaceans and squid, and as they grow (20 to 69 cm) they mainly feed on capelin. As large (greater than 69 cm) adults, Greenland halibut feed mainly on demersal fish (Bowering and Lilly 1992).

**Witch Flounder**

In the Offshore Study Area, witch flounder are concentrated in deep waters at the edge of the Grand Banks, and also occur on the southwestern Grand Banks (Kulka et al. 2003; Maddock-Parsons 2006). They occur at low densities within the Offshore Project Area during the spring and fall surveys, and are not known to undertake extensive migrations so may occur in this area year-round (Kulka et al. 2003).

Biomass and abundance estimates from DFO spring surveys in Division 3N have been at very low levels since 1984 (Maddock-Parsons 2006). Fall survey estimates are also low but lack a clear trend. There has been a moratorium on the harvest of this species since 1994 due to the low stock levels (Maddock-Parsons 2006).

Witch flounder spawn on the Grand Banks between March and June (Maddock-Parsons 2006). Spawning has been reported near the Offshore Study Area in June (Ollerhead et al. 2004). Eggs are pelagic and hatch in seven to eight days at 8°C. Witch flounder larvae may be pelagic for up to a year, before settling to the seafloor. The primary prey for witch flounder is decapod crustaceans and polychaetes (Methven 1999).

**Thorny Skate**

Thorny skate has recently been assessed by COSEWIC as of special concern and is described in the marine fish Species at Risk (Section 12.3.1.18).

**Lumpfish**

In the Offshore Study Area, lumpfish occur at low abundances throughout the Grand Banks, and may undertake a north-south migration each year from St. Pierre Bank in spring to the Grand Banks in fall (Kulka et al. 2003). Abundance surveys suggest lumpfish are increasing overall (Kulka et al. 2003). Refer to Section 8.3.1.5 for more detailed information on the life history of lumpfish.

**Capelin**

Capelin may occur within the Offshore Project Area during spring or fall (Lilly and Simpson 2000). Capelin spend most of their time offshore, but the 3KL stock of capelin migrate to the coastal beaches of Newfoundland to spawn in June and July (see Section 13.3.1.4 for further information on capelin spawning beaches in Placentia Bay). The NAFO Division 3LK capelin stock is concentrated on the northern Grand Banks and straddles the 3L and 3K Divisions for much of the year (Carscadden 2001), and is concentrated in 3K during fall (Lilly and Simpson 2000). Refer to the Section 8.3.1.5 for further information on capelin.

The Southeast Shoal and Tail of the Grand Banks EBSA is the only known offshore spawning site for capelin in the PBGB-LOMA (DFO 2007b; CPAWS 2009).

### Arctic Cod

Arctic cod are distributed from the Arctic to the Gulf of St. Lawrence. They were formerly common on the Grand Banks, but their range has shrunk since the 1990s. Arctic cod now occur north of the Grand Banks, likely in response to warming waters.

After age one, Arctic cod are semi-demersal and feed mainly on zooplankton (copepods, hyperiid amphipods) and also juvenile capelin (Bundy et al. 2000). Arctic cod are an important forage species and are preyed upon by other fish (e.g., Atlantic cod, Greenland halibut), marine mammals and marine birds.

### Redfish

Redfish are discussed in detail in marine fish Species at Risk (Section 12.3.1.8).

### Northern Shrimp

Although several species of shrimp (Family Penaedae and infraorder Caridean) occur in the Offshore Study Area, the predominant species is northern or pink shrimp. Northern shrimp occur from Labrador to the Grand Banks and occur at depths of 150 to 350 m (DFO 2011c). Northern shrimp prefer temperatures between 0°C and 4°C (Colbourne and Orr 2004). Northern shrimp are known to congregate during winter and spring, and to disperse in summer and early fall. This species are most abundant in the deeper slope waters of the Grand Banks during spring and migrate to shallower waters during the fall.

Larvae are released into the water column in April and May, and settle to the bottom from July to September. The reproductive cycles of most northern shrimp stocks are synchronous with the local spring phytoplankton bloom (Greene et al. 2009; Koeller et al. 2009). Spawning occurs in late summer and fall and females retain the fertilized eggs until the following spring, when the eggs are released. The eggs hatch and larvae remain pelagic for a few months before settling to the benthos. Adult shrimp are benthic during the day and feed on detritus, phytoplankton and small invertebrates. At night the shrimp migrate vertically in the water column to feed in surface waters (Bundy et al. 2000). Shrimp are preyed upon by several species of predator fish such as Greenland halibut and Atlantic cod.

### Snow Crab

In the offshore, snow crabs are most common on mud and sand-mud substrate at temperatures of -0.5°C to 4.5°C, and depths of 20 to 2,000 m (DFO 2005b; Dawe et al. 2010). Depth, temperature and bottom substrate have all been correlated with densities of adult and juvenile crab.

Spawning occurs in spring and early summer. Mating is thought to occur at the end of the winter or in the spring. Females carry fertilized eggs on their underbelly until water temperatures are suitable for release (Moriyasu and Lanteigne 1998). Larvae are pelagic and may be planktonic for months until settlement. The eggs are carried until the following year. Newly hatched larvae are approximately 3 mm long. They immediately rise to the surface, where they are carried by the currents before they settle back on the bottom, most probably at a different place than where they hatched. During this period,

they go through three different larval stages before adopting the regular shape of crabs and settle to the sea floor at 3 mm wide across the shell. Larvae complete development on the seafloor (DFO 2005b). Benthic snow crab feed on polychaetes, echinoderms, and molluscs.

Snow crab are not known to undertake migrations and are thought to have a small range, owing to their relatively sedentary life style. Analyses of the spatial distribution of snow crab catches during annual fall DFO surveys indicated that there have been gradual spatial shifts of densities for most size groups, as well as annual and area-specific changes in survey catch rates (Dawe et al. 2010). Large and small crabs overlap in spatial distribution. Snow crab occur in the Offshore Study Area but are more common along the slope of the Grand Bank on fine substrate (Dawe and Taylor 2003). Snow crab is collected as part of the existing White Rose EEM biological sampling program. They were uncommon during DFO RV in 2010 and 2011 in NAFO Division 3L (northern Grand Banks). DFO RV surveys suggest the exploitable (i.e., mature) biomass of snow crab has declined since 1996, and the pre-recruit index is expected to remain low (DFO 2005b).

**Greenland Shark**

The Greenland shark (*Somniosus microcephalus*) is the largest member of the dogfish family and can grow to over 6 m in length. Greenland shark occur in the North Atlantic Ocean and in the western Atlantic, ranges from Greenland and Baffin Island south to Newfoundland, Gulf of St. Lawrence and the Scotian Shelf. It occurs near mouths of rivers such as the St. Lawrence and Saguenay (Canadian Shark Research Laboratory website). This species commonly occurs at depths ranging from surface waters to below 200 m (reported up to 1,280 m) (Yano et al. 2007) and prefers temperatures between 0.6°C and 12°C. In winter months, the Greenland shark is common in shallow surface waters, estuaries and bays, but moves into deeper, cooler waters during summer (Scott and Scott 1988; Stokesbury et al. 2005). It is distinctive in appearance with small dorsal fins (with no spines), small pectoral fins and a rounded stout shape, with a rounded snout.

There is little information available on the reproduction, life span and growth of Greenland shark as they are rarely sighted. They are known to be ovoviviparous. Females are thought to mature at approximately 450 cm and males at 300 cm (Yano et al. 2007). The diet of Greenland shark is diverse, and includes capelin, halibut, herring, lumpfish, redfish, salmon and marine mammals, including carrion. It is thought this species has few natural predators (Yano et al. 2007).

## 8.4 Project-Valued Environmental Component

WREP activities with similar potential effects on Fish and Fish Habitat have been grouped into three categories (change in habitat quality, change in habitat quantity or potential mortality) rather than assessing each WREP activity separately. This permits a complete and comprehensive environmental effect analysis, including a cumulative environmental effects assessment of within-WREP activities.

These potential environmental effects are discussed in terms of activities associated with the WREP that occur in the Nearshore Project Area (associated with the WHP option only and including accidental events in the Nearshore Study Area) and the Offshore

Project Area (associated with both the WHP and subsea drill centre options, potential future activities and including accidental events in the Offshore Study Area).

### 8.4.1 Nearshore

The activities assessed in the Nearshore Project Area include graving dock construction and CGS construction and installation. There are no nearshore activities associated with the subsea drill centre option. Project-related accidental events could also occur in the Nearshore Study Area.

#### 8.4.1.1 Graving Dock Construction

During construction of the graving dock (see Section 2.6.3), the nearshore activities that have the potential to interact with marine fish and fish habitat include discharge of water from The Pond, dewatering of the graving dock, noise from construction activities (i.e., sheet pile driving and potential grouting) and lighting.

#### 8.4.1.2 Concrete Gravity Structure Construction and Installation

During CGS construction and installation, the nearshore activities that have the potential to interact with marine fish and fish habitat includes lighting, operation of vessels, nearshore surveys (i.e., multibeam, sonar, environmental), dredging and dredge spoils disposal, ballasting/deballasting of the CGS; towing to the deep-water mating site; noise from topsides mating; and the establishment of a no-fishing safety zone.

### 8.4.2 Accidental Events in the Nearshore

The primary accidental events that could potentially interact with marine fish and fish habitat in the Nearshore Study Area include a marine diesel fuel spill from a vessel or a graving dock breach.

### 8.4.3 Offshore

The activities assessed in the Offshore Project Area that have the potential to interact with fish and fish habitat include those associated with operation and maintenance (of the WHP or subsea drill centre) and decommissioning and abandonment. Potential future activities may include installation of up to two additional subsea drill centres. Accidental events could also occur in the Offshore Study Area.

#### 8.4.3.1 Wellhead Platform or Subsea Drill Centre Installation/Commissioning

The offshore activities that could potentially interact with marine fish and fish habitat during installation and commissioning phases include: clearance surveys (e.g., sidescan sonar); operation of helicopters and vessels; installation of flowlines, pipelines and other subsea equipment; potential installation of rock berms; lighting; drilling-associated seismic (VSPs and wellsite surveys); dredging; and establishment of no-fishing safety zone.

#### 8.4.3.2 Production/Operation and Maintenance

The offshore activities that could potentially interact with marine fish and fish habitat during production/operation and maintenance phases include: the presence of the structure (WHP or subsea drill centre); noise from drilling from a MODU and WHP, WBM cuttings (from either WHP or MODU); SMB cuttings (from MODU only); lighting; operation of seawater systems; waste water generation (domestic waste, sanitary waste); operation of helicopters and vessels; cementing and completing wells; surveys (geotechnical, geophysical and environmental), oily water treatment; and presence of no-fishing safety zone.

#### 8.4.3.3 Offshore Decommissioning and Abandonment

The decommissioning and abandonment activities that could potentially interact with marine fish and fish habitat include: removal of the WHP; plugging and abandoning of wells; operation of vessels; lighting; surveys (geotechnical, geophysical and environmental); and the presence of a safety zone.

#### 8.4.3.4 Potential Future Activities

Potential future activities that could potentially interact with marine fish and fish habitat include: excavation of drill centres (including dredging and dredge spoil disposal); surveys (geotechnical, geotechnical, environmental, ROV, diving); noise from MODU drilling operations; WBM and SBM cuttings; installations of pipelines and flowlines and testing from subsea drill centres to *SeaRose FPSO* including flowline protection; and chemical use and management.

#### 8.4.3.5 Accidental Events

The primary accidental events that could potentially interact with marine fish and fish habitat include a marine vessel incident resulting in a diesel fuel spill, SBM whole mud spill, subsea hydrocarbon blowout, hydrocarbon surface spill, or other spill (e.g., fuel, waste materials) in the Offshore Study Area.

### 8.4.4 Summary of Potential Environmental Effects

The potential environmental effects that could result from WREP-VEC interactions for fish and fish habitat are provided in Table 8-5, including planned future activities and potential accidental events.

**Table 8-5 Potential White Rose Extension Project-Related Interactions – Fish and Fish Habitat**

| Potential WREP Activities, Physical Works, Discharges and Emissions | Change in Habitat Quality | Change in Habitat Quantity | Potential Mortality |
|---|---|---|---|
| **Nearshore (WHP only)** | | | |
| **Graving Dock Construction** | | | |
| Lighting | x | | |
| Water discharge from The Pond | x | | |
| Construction of graving dock (include sheet pile driving, potential grouting) | x | | |
| Dewater graving dock | x | | |

| Potential WREP Activities, Physical Works, Discharges and Emissions | Change in Habitat Quality | Change in Habitat Quantity | Potential Mortality |
|---|---|---|---|
| ***CGS Construction and Installation*** | | | |
| *Onshore (Argentia Construction Site)* | | | |
| Lighting | x | | |
| *Marine (Argentia and Deep-water Mating Site)* | | | |
| Operation of vessels | x | | |
| Additional nearshore surveys (e.g., multibeam, sonar, environmental) | x | | |
| Dredging | x | x | x |
| CGS solid ballasting (which may include disposal of water containing fine material) | x | | |
| CGS water ballasting and de-ballasting | x | | |
| CGS towing to deep-water mating site | x | | |
| Noise from topsides mating | x | | |
| Lighting | x | | |
| Safety zone | | | + |
| **Offshore** | | | |
| ***Wellhead Platform Installation/Commissioning*** | | | |
| Clearance surveys (e.g., sidescan sonar) prior to installation of WHP or pipelines/ flowlines | x | | |
| Operation of helicopters and vessels/barges | x | | |
| Installation of flowlines and pipelines between WHP, subsea drill centre(s) and existing infrastructure | x | | |
| Potential rock berms for flowline protection | | x/+ | |
| Lighting | x | | |
| Safety zone | | | + |
| Drilling-associated seismic (VSPs and wellsite surveys) | x | | |
| ***Subsea Drill Centre Installation/Commissioning*** **(Previously assessed; LGL 2007a)** | | | |
| Dredging and disposal of dredge material | x | x | |
| Clearance surveys (e.g., sidescan sonar) prior to installation of pipelines/flowlines | x | | |
| Operation of helicopters and supply, support, standby and tow vessels/barges | x | | |
| Lighting | x | | |
| Safety zone | | | + |
| Installation of subsea equipment, flowlines and tie-in modules to existing subsea infrastructure | x | | |
| Drilling-associated seismic (VSPs and wellsite surveys) | x | | x |
| ***Production/Operation and Maintenance (Wellhead or Subsea Drill Centre)*** | | | |
| Presence of structure | x | x/+ | |
| Safety zone | | | + |
| Noise from drilling from a MODU and WHP | x | | |
| WBM (from either WHP or MODU) and SBM (from MODU only) cuttings [(A)] | x | x | x |
| Lighting | x | | |
| Operation of seawater systems (cooling, firewater) | x | | |
| Operation of helicopters, supply, support, standby and tow vessels/barges/ROVs | x | | |
| Surveys (geotechnical, geophysical and environmental) | x | | x |
| Cementing and completing wells | x | | |
| Oily water treatment [(B)] | x | | |
| ***Decommissioning and Abandonment (WHP or Subsea Drill Centre)*** | | | |
| Removal of WHP | | x/+ | |
| Plugging and Abandoning Wells | x | | |
| Operation of Vessels (supply/support/standby/tow vessels/barges/diving/ROVs | x | | |
| Lighting | x | | |
| Safety zone | | | x |
| Surveys (geotechnical, geophysical and environmental) | x | | x |
| **Potential Future Activities** | | | |
| Surveys (e.g., geophysical, geological, geotechnical, environmental, ROV, diving) | x | | |
| Excavation of drill centres (including disposal of dredge spoils) | x | x | |

| Potential WREP Activities, Physical Works, Discharges and Emissions | Change in Habitat Quality | Change in Habitat Quantity | Potential Mortality |
|---|---|---|---|
| Noise from drilling from MODU at potential future subsea drill centres | x | x | |
| WBM and SBM Cuttings | x | x | x |
| Installation of Pipeline(s)/Flowline(s) and Testing from Drill Centres to FPSO, including Flowline Protection | x | x | |
| Chemical Use and management (e.g., BOP fluids, well treatment fluids, corrosion inhibitors [(C)]) | x | | |
| **Accidental Events** | | | |
| Marine diesel fuel spill from support vessel | x | | x |
| Graving dock breach | x | x | |
| SBM whole mud spill | x | | |
| Subsea hydrocarbon blowout | x | | x |
| Hydrocarbon surface spill | x | | x |
| Other spills (e.g., fuel, waste materials) | x | | x |
| Marine vessel incident including collisions (i.e., marine diesel fuel spill) | x | | x |
| **Cumulative Environmental Effects** | | | |
| Commercial fisheries (nearshore and offshore) | x | | x |
| Marine traffic (nearshore and offshore) | x | | |
| White Rose Oilfield Development (including North Amethyst and the South White Rose extension drill centre) | x | x | x |
| Terra Nova Development | x | x | x |
| Hibernia Oil Development | x | x | x |
| Hibernia Southern Extension Project | x | x | x |
| Hebron Oil Development | x | x | x |
| Offshore Exploration Seismic Activity | x | | x |
| Offshore Exploration Drilling Activity | x | x | |

Notes:
(A) Water-based drilling fluids and cuttings will be discharged overboard. Husky will evaluate best available cuttings management technology and practices to identify a waste management strategy for spent non-aqueous fluid and non-aqueous fluid cuttings from the MODU. SBM cuttings will be re-injected into a dedicated well from the WHP, pending confirmation of a suitable disposal formation
(B) Water (including from open drains) will be treated prior to being discharged to the sea in accordance with the *Offshore Waste Treatment Guidelines* (OWTG) (National Energy Board (NEB) et al. 2010)
(C) Husky will evaluate the use of biocides other than chlorine. The discharge from the hypochlorite system will be treated to meet a limit approved by the C-NLOPB's Chief Conservation Officer

## 8.5 Environmental Effects Analysis and Mitigation Measures

Potential environmental effects of WREP activities on fish and fish habitat are discussed for each phase and summarized at the end of this section. Change in habitat quality, habitat quantity and potential mortality of fish could result from WREP activities that cause noise, sedimentation, contamination or disturbance due to lighting.

### 8.5.1 Nearshore

In the Nearshore Study Area, the WREP activities that could affect marine fish and fish habitat include those associate with graving dock excavation, CGS construction, CGS tow-out and topsides mating. The potential environmental effects from these activities include change in habitat quality, change in habitat quantity and potential mortality.

#### 8.5.1.1 Graving Dock Construction

**Change in Habitat Quality**

The potential change in marine fish and fish habitat quality in the Nearshore Study Area during graving dock construction include lighting, discharges from The Pond, dewatering of the graving dock and noise from pile driving. The potential environmental effects include increased light, sedimentation and underwater noise.

***Lighting***

Lighting has the potential to disturb or alter behaviour fish in the vicinity of the site. Increases in light levels and lighting at night may interrupt the normal circadian rhythm of fish and shellfish, although studies to date have found responses are very species-specific (Nightingale et al. 2006; Brüning et al. 2011). Increased exposure to light has the potential to result in changes in behaviour, spatial distribution, migration and reproduction (Nightingale et al. 2006), as well as cause physiological stress, as has been observed during experimental studies of Atlantic cod (Hemre et al. 2002) and trout (Leonardi and Klempau 2003). Light is also known to attract or repel species and species distributions may be altered in artificially lighted areas, particularly for pelagic fishes (e.g., herring, sand lance) and squid that are known to be attracted to light (Pascoe 1990). Many planktonic species are phototaxic and float toward the surface during the day but settle in deeper water at night. Consequently, this natural vertical movement may be altered by artificial light over long periods of time. The environmental effects of light attraction are expected to be temporary (i.e., during the construction period) and reversible, and best practices (i.e., lighting design to reduce spill over light) will be used to reduce the effect of lighting where practical without affecting safety or operations (minimum lighting requirements are stipulated in the *Petroleum Occupational Safety and Health Regulations*).

***Sedimentation***

Water discharges from The Pond and the settling pond will be treated to comply with applicable federal and provincial water quality standards; however, discharges may result in a short-term change in marine habitat quality due to sedimentation. Potential effects of sedimentation on organisms include direct effects such as smothering (decreased gas exchange), toxicity (exposure to anaerobic sediment layers or contaminated sediment), reduced light intensity, and physical abrasion, as well as indirect effects such as changes in substrate characteristics (Wilber et al. 2005). The WREP will comply with the total suspended solids discharge limit of 30 mg/L (Newfoundland and Labrador *Environmental Control Water and Sewage Regulations, 2003*) and therefore, water discharges are not expected to result in any smothering effects. The discharge of water at these levels is also not expected to create a suspended solids level that would exceed the *Canadian Water Quality Guidelines for the Protection of Aquatic Life* (CCME 2002). The CCME guidelines specify that during clear flow periods, anthropogenic activities should not increase suspended sediment concentrations by more than 25 mg/L over background levels during any short-term exposure period (24 hours). Since these levels are not expected to be exceeded during dredging operations (see Section 8.5.1.2), then CCME suspended solids levels would not be exceeded while discharging water within regulated limits.

Increased levels of suspended sediment can reduce the availability of light in the photic zone and may reduce local primary production, particularly if sediment loading occurs just prior to, or during, a phytoplankton bloom. This could have effects on higher trophic levels including fish and shellfish if the sediment is suspended over large areas for extended duration. Benthic primary production can also be reduced due to decreased light attenuation caused by sediment loading over extended periods (Aumack et al. 2007).

Plankton and sessile invertebrates are unable to actively avoid areas with high sediment loads. Mechanical damage has been observed in herring larvae at TSS levels of 1,000 mg/L (Boehlert and Yoklavich 1984). Further harm to fish and invertebrates may result from respiratory and feeding problems associated with high sediment levels. The severity of environmental effects of the suspended sediment increases as the volume and duration of exposure increase. Mobile fish and invertebrates may avoid an area completely during the period of construction (Robinson and Cuthbert 1996). Shellfish are typically more likely to experience adverse effects of increased sediment load than fish because they are often sessile and filter feeders, and may reduce or stop feeding until sediment loading decreases to suitable levels (Peddicord 1980). Eventually, suspended sediment will settle on the seafloor, and the rate at which this occurs is dependent on sediment grain size and the water currents in the area. Fine sediment such as silt and mud will drift over longer distances in the water column than coarser sediments.

In an effort to minimize the discharge of suspended sediments, water discharged from The Pond will be extracted from the surface prior to any spoils being deposited into The Pond. The discharge will be tested routinely for compliance with the Newfoundland and Labrador *Environmental Control Water and Sewage Regulations, 2003*. If there is indication that the water is close to the discharge limit of 30 mg/L, the water will be diverted to a settling pond or through a filter to ensure compliance before discharge. Water pumped from the graving dock will be directed to a settling pond and tested for compliance prior to discharge into Argentia Harbour.

### *Noise*

Underwater noise from land-based pile driving is expected to be negligible. Pile driving, either vibratory or impact, may be required during bund wall construction. Impact pile driving produces strong impulsive sounds. Sound levels typically recorded during impact pile driving in-water activities do not exceed 180 dB re 1 µPa (rms) beyond several hundred metres from the source JASCO (2010).

Underwater noise has the potential to affect fish and fish habitat in a variety of ways depending on source levels, duration of exposure, proximity of sound source, species sensitivities and environmental conditions, among other factors. There are both natural and anthropogenic sources of noise that exist in the marine environment, including storms, wave action, oceanic turbulence, animal communication, vessel traffic and fishing activities. For example, large tankers moving at full speed may produce a source noise level of 170 dB re 1 µPa at 1 m. Typical peak levels of ambient noise in shallow water environments are from 110 to 120 dB re 1 µPa; however, this varies depending on shipping traffic, other anthropogenic sources and oceanographic conditions (Richardson et al. 1995). Placentia Bay has relatively high marine traffic (oil tankers, ferry, fishing vessels), with highest traffic occurring in spring to early fall.

Fish are generally most sensitive to low-frequency sound (10 to 500 Hz), a range that overlaps with the most intense sound produced by vessels. Some studies suggest noise is thought to be the main cause of vessel avoidance by some fish (Mitson 1995; Mitson and Knudsen 2003; Popper 2003; De Robertis et al. 2008). However, a study by Davis et al. (1998) suggests that most schools of fish do not show avoidance behaviour when in the path of an approaching vessel, although fish may move laterally or to a greater depth as the vessel passes over. Furthermore, a study by Røstad et al. (2006) found evidence that fish fauna may be attracted to vessels at times. Observed responses to vessels are dependent on species, stage in life cycle, time of day, vessel sound, local conditions and whether fish have fed (Davis et al. 1998). Studies by DFO (2004a) concluded that the most likely response is a startle response, a change in swimming pattern, and/or a change in vertical distribution. For Atlantic cod, a startle response would most likely be observed at ranges of 160 to 188 dB re 1 μPA (Turnpenny and Nedwell 1994). Literature to date suggests the effect of noise is typically temporary and is not expected to cause biological or physical effects if experienced outside critical reproductive periods.

There is also potential for underwater noise to have effects on communication and environmental sensing (e.g., masking). Over 800 fish species are known to produce sounds and much of the sounds produced have broadband signals concentrated at less than 500 Hz. Distinct variation in spectral and temporal characteristics can be related to species, populations and sex (Slabbekoorn et al. 2010), which suggests that sounds can serve as information carriers amongst fish (Tavolga 1971; Ladich 2004). Fish are known to produce sounds in spawning aggregations (Saucier and Baltz 1993; Aalbers and Drawbridge 2008) and courtship interactions (Myrberg et al. 1986; McKibben and Bass 1998). Sounds could serve in aggregating reproductive groups, and may contribute to a synchronized release of eggs and sperm (Myrberg and Lugli 2006). Recent experimental evidence has shown that sounds can modify mate choice decisions in fish. An acoustic effect on sexual preferences was also inferred for Atlantic cod, in which the male drumming muscle mass was correlated with mating success (Rowe et al. 2008).

Hearing may also be used for prey location and predator avoidance. Although sharks and other cartilaginous fish (skates and rays) have relatively poor hearing sensitivity as compared to other fishes, they were reported to approach irregularly pulsed broadband sounds, which could be indicative for the presence of struggling prey (Myrberg 2001). Surface-feeding fish can localize prey accurately by listening to the surface waves produced when prey fall into the water (Hoin-Radkovsky et al. 1984). Broad hearing bandwidths have been correlated with predator avoidance. Herring species (Clupeidae) of the genus *Alosa* are capable of detecting ultrasound (up to 180 kiloHertz (kHz)), which could allow detection and avoidance of echo-locating whales (Popper at al. 2004; Doksæter et al. 2009).

Fish have also been observed to congregate, seek shelter or forage for food at places with artificially high sound levels. There are numerous anecdotal observations of fish under noisy bridges or near noisy vessels, indicating that adverse environmental effects are not necessarily overt and obvious, but such observations are unable to indicate whether fish experience any negative consequences related to the noise (Slabbekoorn et al. 2010).

#### 8.5.1.2 Concrete Graving Structure Construction and Installation

There is potential for change in marine fish habitat quality and habitat quantity as well as potential mortality of marine fish in the Nearshore Study Area due to WREP activities during the construction of CGS, possible dredging and tow-out and mating of the CGS.

**Change in Habitat Quality**

Potential effects from WREP activities during CGS construction and installation include a reduction in fish habitat quality due to sedimentation, contamination, noise and lighting.

***Sedimentation***

Dredging in the Nearshore Study Area will occur to allow for removal of the CGS from the graving dock and tow-out to the deep-water mating site. Dredging will occur at three sites in the Nearshore Study Area. At the shoreline of the graving dock, 200,300 $m^3$ of sediment will be removed using a backhoe dredge (BHD) or a cutter suction dredge (CSD) to allow for removal of the CGS from the graving dock. Although, the dredged material will be disposed of onshore in The Pond, there is potential for plumes and some sedimentation to occur in the marine environment, as dredging occurs over an estimated six to eight weeks.

There will also be dredging in Placentia Bay at two locations (Corridor 1 and Corridor 2) to allow for tow-out of the CGS to the deep-water mating site. Bathymetric studies have been carried out to select a suitable tow-out route and reduce the footprint of the dredged area. At Corridor 1, 25 $m^3$ of sediment will be dredged and at Corridor 2, 165,400 $m^3$ will be dredged. However, sediment suspension modelling by AMEC (2012a) showed that suspended sediment levels will not exceed the *Canadian Water Quality Guidelines for the Protection of Aquatic Life* (CCME 2002). Maximum plume concentrations above 25 mg/L are expected to persist for no more than four hours. Concentrations above 10 mg/L would persist for approximately six hours, and levels above 5 mg/L would last for approximately 10 hours for a single dredging operation. Plume concentrations above 25 mg/L are expected to occur within limited areas of approximately 0.7 $km^2$. See Section 3.3 for a detailed summary of the WREP-specific sedimentation model.

Reviews by Berry et al. (2003) and Wilber et al. (2005) summarize existing knowledge of sedimentation from dredging in marine areas. Within dredged areas there will be changes to the quality and quantity of benthic habitat for some taxa. Effects on soft-bottom communities can range from measurable, long-term effects (Harvey et al. 1998) to few or no observable effects (Smith and Rule 2001). In general, the observed effects include reductions in abundance and diversity of invertebrates relative to reference sites (Harvey et al. 1998) due to disturbance and startle responses. As the dredge material settles, opportunistic invertebrate and fish species will move in from adjacent areas and re-colonize the site. There is often also a temporary loss of benthic productivity within the dredged area (Van Dalfsen et al. 2000).

Some species such as polychaetes will re-colonize relatively quickly (within a year) (Van Dalfsen et al. 2000), while others species such as scallop may require several years to return to baseline levels. Nematodes have been found to be sensitive indicators of change at dredge disposal sites in the United Kingdom and may be useful for assessing

recovery (Boyd et al. 2000). Shifts in dominance patterns may occur (Harvey et al. 1998; Roberts et al. 1998; De Grave and Whitaker 1999), and this may also cause shifts in the trophic balance of the affected community (De Grave and Whitaker 1999). However, this habitat disturbance is temporary and highly reversible, and studies have found that abundance, diversity and biomass of the benthic community return to baseline levels within two to four years after dredging ceases (Sardá et al. 2000; Van Dalfsen et al. 2000). The magnitude of the alteration will be reduced if the dredged material is similar to the existing substrate (Chandrasekara and Frid 1998; Harvey et al. 1998).

The larval stage of fish and all stages of shellfish are more susceptible to the effects of sedimentation than adult fish because they have no or little ability to leave the area affected. However, the localized effect and high potential for reversibility will limit the magnitude of effects caused by sedimentation.

***Contamination***

In January 2012, marine sediments were collected from 32 sites within the Nearshore Study Area (Stantec 2012b) at the three proposed dredging locations. Sediment samples were analyzed for available metals (including mercury), total PCBs, total organic carbon, particle size analysis, PAHs, and TPH including BTEX. The concentration of chemical parameters were compared to the CCME *Sediment Quality Guidelines for the Protection of Marine Life*, and the CCME *Soil Quality Guidelines for Commercial and Industrial Use* screening criteria.

For the graving dock location, laboratory results found that PAHs were generally below the reportable detection limit (RDL). However, three samples were slightly above the marine PEL CCME guideline for the PAH phenanthrene (0.544 mg/kg), returning concentrations of 0.550, 0.580 and 0.570 mg/kg, respectively. PCBs were detected at one station at a concentration of 0.19 mg/kg, which is marginally above the CCME PEL sediment screening criteria of 0.189 mg/kg, but not above the CCME Soil Quality Guideline of 33 mg/kg for commercial and industrial use. Of the metals tested, only available cadmium marginally exceeded CEPA Disposal at Sea sediment screening criteria of 0.6 mg/kg with a concentration of 0.66 mg/kg. BTEX compounds were not detected in any of the sediment samples. None of the TPH results exceed the Atlantic RBCA guidelines for contaminants on commercial sites or the CCME soil quality guidelines (Stantec 2012b).

For Corridor 1, PAH levels were below the RDL and no samples exceeded the CCME *Soil Quality Guidelines for Commercial and Industrial Use.* PCBs were not detected in samples from Corridor 1. None of the tested metals were above CCME guidelines, and BTEX compounds were not detected. Individual TPH were detected but were below Atlantic RBCA guidelines for commercial sites and the CCME soils guidelines.

For Corridor 2, results indicated that samples were mostly below the RDL; however, phenanthrene was detected at a level slightly above the RDL at three stations. No samples exceeded the CCME PEL or CCME *Soil Quality Guidelines for Commercial and Industrial Use*. PCBs were not detected in samples from Corridor 2. None of the tested metals were above CCME guidelines, and BTEX compounds were not detected. Individual TPH were detected but were below Atlantic RBCA guidelines for commercial sites and the CCME soils guidelines.

### *Noise*

Results of acoustic modelling (JASCO 2012) for two different types of dredgers indicated that sound levels greater or equal to 180 dB re 1 µPa (rms) (un-weighted) occur at $R_{95\%}$ distances of 7 m or less. However, sound levels of 160 dB re 1 µPa (rms) occur within 248 m ($R_{95\%}$) of the dredging site, depending on dredge type and season.

Behavioural effects (i.e., avoidance) are expected to have a negligible effect on populations of fish and shellfish as they are predicted to be short-term and highly reversible.

The environmental effects of sonar sound on several fish species was studied by Halversen et al. (2006) and Popper et al. (2007). These studies were conducted using a sonar transducer and exposing fish to received sounds as high as 193 dB re 1 µPa (rms) continuously for up to 216 seconds. The results indicated no mortality and no damage to auditory and non-auditory tissues but demonstrated temporary threshold shift in test species. Hearing loss recovered within 48 hours in channel catfish (*Ictalurus punctatus*) (Halversen et al. 2006) and there were not enough data to determine recovery time in rainbow trout (*Oncorhynchus mykiss*) (Popper et al. 2007). Data for other marine fish have demonstrated that exposure to moderately loud noises can result in temporary threshold shift in a few species that have been studied, including goldfish among others specialized for hearing (Scholik and Yan 2001; Amoser and Ladich 2003; Smith et al. 2004).

### Change in Habitat Quantity

There is potential for change in habitat quantity in the Nearshore Project Area due to dredging. Dredging activities will be done to allow for an 18 m deep tow-out area for the CGS. Dredging will remove approximately 200,300 $m^3$ over an area approximately 55 m by 200 m from the nearshore area adjacent to the proposed graving dock construction area (the graving dock location). Approximately 25 $m^3$ will be removed from Corridor 1 over an area approximately 10 m x 25 m and approximately 165,400 $m^3$ will be removed from Corridor 2 over an area approximately 1,250 m by 200 m. Eelgrass beds were observed in the area at the graving dock location and estimated to account for 1 percent of the area to be dredged along the shoreline of the graving dock (Stantec 2012b). Dredging is expected to occur over a six to eight week time period.

Benthic production may decrease temporarily due to smothering under the disposed sand and gravel. For Corridor 1 and Corridor 2, suspended sediment concentrations are expected to initially have plume concentrations of 1,490 to 4,330 mg/L within 100 m, and to decrease to approximately 1 mg/L relatively quickly (within 30 hours) if using the BHD option. For the graving dock location, models suggested that for the BHD option, concentrations would range from 5.5 to 28.5 mg/L and fall below 1 mg/L within 230 m to 1 km from the graving dock location. Much of the sediment plume is expected to be transported away by currents. Local effects of the CSD equipment option would be higher, with predicted sediment concentrations to range from 291 to 718 mg/L within 10 m of the graving dock location. In both cases, maximum sediment plume concentrations are expected to decrease to below 10 mg/L within six hours and below 5 mg/L within 10 hours after ceasing dredging operations. Re-colonization of seagrass in dredged areas may require several years of non-disturbance (Sheridan 2004; Erftemeijer and Lewis 2006).

Given the very small area to be dredged and short time-frame, and TSS levels below CCME thresholds for *Canadian Water Quality Guidelines for the Protection of Aquatic Life* (CCME 2002), the magnitude of dredging the graving dock location, Corridor 1 and Corridor 2 are predicted to be low, and the effects are expected to be limited in extent and highly reversible. Proper planning and equipment design will reduce the duration of dredging activities and hence the environmental effect on marine fish and fish habitat. The loss to fish habitat will be mitigated through compliance with the *Fisheries Act*, including potential requirements for habitat compensation, if required.

**Potential Mortality**

Mortality of marine fish and shellfish during WREP nearshore activities could result from dredging and geophysical surveys. Larval stages of fish and shellfish are the most vulnerable to the effects of these activities.

Dredging could result in removal and mortality (smothering) of benthic species, particularly epibenthic invertebrates. This could include shellfish or species that fish species prey upon or rely upon for habitat. Dredging activities will be relatively limited in extent and duration and suspended sediment levels are predicted to be below *Canadian Water Quality Guidelines for the Protection of Aquatic Life* (CCME 2002).

Kosheleva (1992) reports no obvious physiological effects were observed for fish beyond 1 m from a source of 220 to 240 dB re 1µPa. Hastings (1990) reports the lethal threshold for fish beginning at 229 dB and a stunning effect in the 192 to 198 dB range. Turnpenny and Nedwell (1994) found that blindness can occur in fish exposed to air gun blasts on the order of 214 dB.

With mitigation in place, the potential effects of mortality due to dredging and dredge spoils disposal are expected to be low in magnitude, limited in extent and durations and highly reversible. The presence of a safety zone will reduce the area that can be fished in the Nearshore Study Area for the duration of the nearshore activities and may potentially reduce fishing-related mortality during the time frame of the safety zone, therefore resulting in a positive effect.

**Summary of Nearshore Environmental Effects Assessment from Pre-construction and Construction**

The environmental effects of the WREP during the pre-construction and construction phases in the Nearshore Study Area and the mitigations to be implemented are summarized in Table 8-6. Significant adverse residual environmental effects on fish and fish habitat from routine pre-construction and construction activities are not predicted. Environmental effects are generally low in magnitude, of limited geographic extent and reversible.

**Table 8-6 Potential Environmental Effects Assessment Summary for Fish and Fish Habitat – Construction and Installation**

| WREP Activity | Potential Positive (P) or Negative (N) Environmental Effect | Mitigation Measure | Evaluation Criteria for Assessing Environmental Effects [A] | | | | | | Significance Rating | Level of Confidence |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | Magnitude | Geographic Extent | Frequency | Duration | Reversibility | Ecological/Socio-cultural/Economic Significance | | |
| Water discharge from The Pond | Change in habitat quality (N) | • Compliance monitoring and treatment as required before discharge<br>• Settling pond or filtration | L | 1 | 1 | 2 | R | 2 | NS | H |
| Construction of graving dock (include sheet pile/ driving) | Change in habitat quality (N) | • Use of industry best practices | L | 2 | 1 | 2 | R | 3 | NS | H |
| Dewater graving dock | Change in habitat quality (N) | • Compliance monitoring and treatment as required before discharge<br>• Settling pond | L | 1 | 1 | 3 | R | 3 | NS | H |
| Lighting | Change in habitat quality (N) | • Investigate solutions to reduce the amount of light at night near the water | N | 1 | 6 | 3 | R | 3 | NS | H |
| Additional nearshore surveys (e.g., multibeam, sonar, environmental) | Change in habitat quality (N) | • Best management practices.<br>• Attain necessary permits | L | 3 | 1 | 1 | R | 3 | NS | M |
| Dredging | Change in habitat quality (N)<br>Change in habitat quantity (N)<br>Potential mortality (N) | • Use of in-water sound control measures, if practical<br>• Fish habitat compensation, if required (dredging) | M | 1 | 1 | 2 | R | 3 | NS | H |
| CGS solid ballasting (Noise) | Change in habitat quality (N) | • Use of industry best practices | L | 1 | 1 | 1 | R | 3 | NS | H |
| CGS water ballasting and de-ballasting | Change in habitat quality (N) | • Use of fish screens on water intake pipes<br>• Adherence to DFO's Freshwater Intake *End-of-Pipe Fish Screen Guideline*<br>• Use of industry best practices | L | 1 | 1 | 1 | R | 3 | NS | H |
| CGS towing to deep-water mating site | Change in habitat quality (N) | • Use of industry best practices | N | 2 | 1 | 1 | R | 3 | NS | H |
| Noise from topsides mating | Change in habitat quality (N) | • Use of industry best practices | N | 1 | 1 | 1 | R | 3 | NS | H |
| Operation of barges and vessels | Change in habitat quality (N) | • Use of industry best practices | L | 1 | 6 | 3 | R | 3 | NS | H |

| WREP Activity | Potential Positive (P) or Negative (N) Environmental Effect | Mitigation Measure | Evaluation Criteria for Assessing Environmental Effects [A] | | | | | | Significance Rating | Level of Confidence |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | Magnitude | Geographic Extent | Frequency | Duration | Reversibility | Ecological/Socio-cultural/Economic Significance | | |
| Safety zone | Potential decrease in mortality (P) | | L | 1 | 6 | 2 | R | 3 | NS | H |

Key:

**Magnitude:**
N = Negligible (essentially no effect)
L = Low: <10 percent of the population or habitat in the Study Area will be affected
M = Medium: 11 to 25 percent of the population or habitat in the Study Area will be affected
H = High: >25 percent of the population or habitat in the Study Area will be affected

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

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

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

**Reversibility** (population level):
R = Reversible
I = Irreversible

**Ecological/Socio-cultural/Economic Significance:**
1 = Relatively pristine area not affected by human activity
2 = Evidence of existing adverse activity
3 = High level of existing adverse activity

**Significance Rating:**
S = Significant
NS = Not Significant
P = Positive

**Level of Confidence:**
L = Low level of confidence
M = Medium level of confidence
H = High level of confidence

#### 8.5.1.3 Accidental Events in the Nearshore

There is the possibility of an accidental event occurring in the Nearshore Study Area during graving dock construction or CGS construction and installation phases. The scenarios with the greatest potential environmental risk considered in this section are a breach in the graving dock or an accidental release of marine diesel fuel from a vessel as a result of a collision or other incident.

The collapse of the bund wall could result in a sudden increase in sedimentation in the immediate vicinity of the breach. A breach in the bund wall surrounding the graving dock would result in an influx of water into the dry graving dock. Water could become contaminated with cement, lube oils and other chemicals contained within the graving dock.

In the unlikely event there is a spill of marine diesel fuel in the nearshore, oil spill response plans will be initiated to contain and clean-up the spill to mitigate potential environmental effects. Nearshore oil spill modelling (Section 3.7) suggests that in the unlikely worst-case scenario, the maximum possible volume of a batch fuel spill (350 $m^3$) would be released. The tug boats, accommodation vessel and supply vessels that will be used in the Nearshore Study Area will use marine gas oil, which is similar in composition and spill behaviour to diesel fuel. Modelling of an unmitigated nearshore oil spill scenarios found that a high proportion (55 to 94 percent) of the modelled slicks reach the shoreline due to the close proximity of the spill sites modelled to shore (near Argentia and the two possible deep-water mating sites) and due to the prevailing westerly and southwesterly winds in Placentia Bay. The minimum time to shore ranged from two to five hours if there was no spill response (SL Ross 2012). During the months of March and July, over 55 percent of the modelled spills (diesel slick) reached the shore within less than 24 hours, and more than 75 percent of the modelled spills reached the shoreline within 48 hours. Survival time of the diesel fuel that did not reach the shoreline ranged from a minimum of 0.5 days to 8 days (SL Ross 2012). The average summer and winter conditions were modelled based on wind speed and water temperature. There are few differences in the fate of the spills between the two seasons. The nearshore oil spill model is discussed in detail in Section 3.7 and SL Ross (2012). The potential effects of diesel fuel reaching the identified Sensitive Areas in the Nearshore Study Area (e.g., coastal habitats) are discussed in Section 13.5.2.1. Marine fish species at risk and the potential effects of the accidental release of diesel fuel are discussed in Section 12.4.2.1. The majority of information summarized below is from studies on crude oil spills, but may be relevant to marine diesel spills in the nearshore, and is also applicable to the Offshore Study Area.

**Change in Habitat Quality**

Studies of marine diesel oil spills to date have focused on the physical properties and fate of diesel, as well as the effects diesel has on marine organisms (Hooper and Morgan 1999). Diesel is known to have an immediate toxic effect on many intertidal organisms, including periwinkle, limpet, gastropods, amphipods and many meiofaunal organisms (Stirling 1977; Simpson et al. 1995; Cripps and Shears 1997), with exposed eggs and larvae most at risk since they are not able to actively avoid the fuel. If marine diesel is released into the environment, coastal habitats that fish and shellfish depend on as part of their life cycle, such as eelgrass beds, could be affected and result in a decrease in habitat. However, literature to date suggests coastal habitats such as

eelgrass beds and salt marshes are relatively resilient to effects of oiling and recovery typically occurs within one year. The effects on coastal sensitive habitats (including eelgrass beds, salt marshes and scallop beds), are discussed in detail in Section 13.5.2.1.

There is also potential for diesel fuel to reduce habitat quality through contamination from hydrocarbons, including potential effects on plankton. In the vicinity of a hydrocarbon spill, phytoplankton may have limited or inhibited air-sea gas exchange and light penetration and may experience reduced productivity and growth (González et al. 2009; Abbriano et al. 2011). The PAHs within oil may also affect phytoplankton growth, with growth stimulation possibly occurring at low concentrations (1 mg/L) and growth inhibition occurring at higher concentrations (100 mg/L) (Harrison et al. 1986). The main effects expected to be observed on phytoplankton following an oil spill include a change in phytoplankton community structure due to adverse effects of contamination, and increases in biomass due to decreased predation by zooplankton (Teal and Howarth 1984; Abbriano et al. 2011). Phytoplankton communities in estuaries were also studied to assess short-term effects of oil on phytoplankton (Gilde and Pinckney 2012). In this study, crude oil obtained from the *Deepwater Horizon* oil spill and a mixture of Texas crude oils were experimentally applied to phytoplankton communities in the North Inlet Estuary near Georgetown, South Carolina, at concentrations of 10, 50 and 100 µL/L. Total phytoplankton biomass (as measured by chlorophyll *a* concentrations) declined with increasing concentration of crude oil. The phytoplankton community was also altered as phytoplankton taxa had varying responses to crude oil, with diatoms, cyanobacteria, euglenophytes and chlorophytes being relatively resistant to contamination, while cryptophyte abundance decreased (Gilde and Pinckney 2012).

Zooplankton are also sensitive to oil and associated chemicals. Copepods in direct contact with oil have been observed to experience increased mortality, decreased feeding and decreased reproduction (Suchanek 1993; Seuront 2011). Zooplankton responses to hydrocarbons vary by species, with mortality being more dependent on exposure time than the concentration of oil at the site (Lee and Nicol 1977; Abbriano et al. 2011). Copepods also show some ability to sense and avoid oil spills, which may reduce contact and mortality rates (Seuront 2010). Recently, the mating behaviour and mating success of copepods was assessed following exposure to three concentrations of the water-soluble fraction of hydrocarbons (Seuront 2011). Mating success of copepods relies on chemoreception to find mates, and the experiment showed that exposure to hydrocarbons altered swimming velocity, complexity of swimming path, mating behaviour and mating success, with varying results between males and female copepods (Seuront 2011). Full recovery of zooplankton communities are expected to occur soon after a spill due to their short generation time, high fecundity and ability to avoid oil patches (Seuront 2010). In previous oil spills such as the *Prestige*, zooplankton abundance and community structure returned to normal within days to several weeks of the spill (Davenport 1982; Johansson et al. 1980; Varela et al. 2006).

Models have suggested bacterial respiration may cause oxygen depletion and lead to hypoxia in areas near an oil spill site (Adcroft et al. 2010). However, following the April 20, 2010, *Deepwater Horizon* spill in the Gulf of Mexico, there was no evidence of hypoxia, although oxygen drawdown did occur (Kessler et al. 2011). Studies of microbial respiration in surface waters (Edwards et al. 2011) two months after the *Deepwater Horizon* spill began found that even in the phosphorus-limited waters of the Gulf of Mexico, microbial respiration was rapid and that the enhanced respiration was driven by

degradation of hydrocarbons. An increase in microbial abundance or biomass was not observed in the oil slick, suggesting that microbial growth (though not respiration) was nutrient-limited (Edwards et al. 2011).

Bioaccumulation of hydrocarbons at the base of the food web from biodegradation of oil by bacteria and uptake and transfer of oil components through the planktonic food web is possible (Graham et al. 2010) and may increase exposure of higher trophic levels (Wolfe et al. 1996). However as phytoplankton, zooplankton and fish are able to metabolize hydrocarbons, bioaccumulation to higher trophic levels should be limited.

The release of hydrocarbons also has the potential to affect the quality of benthic habitat and affect invertebrates. Hydrocarbons have been found to be able to persist in marine sediments for several years in the absence of disturbance. Even low levels of hydrocarbons may have sub-lethal effects on invertebrates (including economically important shellfish species). Crustaceans appear to be the most sensitive taxa to hydrocarbons among benthic communities (Sanders et al. 1980; Jewett et al. 1999). A study of arthropod communities in salt marshes in Louisiana and Mississippi following the *Deepwater Horizon* oil spill (McCall and Pennings 2012) found that during 2010 surveys, intertidal crabs and terrestrial arthropods (insects and spiders) were suppressed by oil exposure, whereas *Littoraria* snails were unaffected. Within a year, crab and terrestrial arthropods had recovered to former levels (McCall and Pennings 2012).

Collisions with other vessels or incidents where the vessel becomes grounded are unlikely, but to avoid such accidents, WREP vessels will be in regular communication with Placentia Bay Traffic Committee and the Marine Communications and Traffic Services Centre, and obey the regulations of the Placentia Bay Routing System. Standard vessel safe practices will be in place.

**Potential Mortality**

A primary concern is the potential effect of hydrocarbons on fish eggs and larvae because they are sensitive life stages and are not able to actively avoid polluted areas (Rice 1985). In Placentia Bay, capelin spawn at both intertidal pebble beaches and at subtidal sites, and the release of marine diesel has the potential to interact with capelin eggs during the spawning season (May to July) and with larval stages in the following months. Paine et al. (1988) carried out a study of capelin embryos obtained from running-ripe capelin during June and July 1987 in Bryant's Cove, Newfoundland and Labrador, exposing them to five concentrations (0, 0.5, 1.3, 2.7 and 5.3 ppm total hydrocarbons) of the water-soluble fraction of crude oil (from Hibernia) between day 0 and day 5 after fertilization. At age 0 days, lethal effects were observed at 2.7 ppm and at age 5 days, lethal effects were observed at 5.3 ppm. For embryos exposed to sub-lethal concentrations, embryos were statistically significantly smaller at hatch and had larger yolks than the control embryos, and eye pigmentation also declined. No other deformities or differences were observed. These results suggest the water-soluble fraction components of Hibernia crude oil act as general stressors and inhibit metabolism. This suggests that early life stages of capelin may be particularly sensitive to exposure to hydrocarbon pollution; however, an accidental release of diesel may not cause the same effects (Paine et al. 1988). Frantzen et al. (2011) also investigated the potential effects of hydrocarbons on capelin embryos that were spawned on a Norway beach and exposed to oil compounds (water soluble fraction of crude oil, or pyrene) until

hatching (32 days). This study also suggests that an oil spill in the area of capelin spawning may result in adverse environmental effects on the capelin eggs that occur in the footprint of a spill (Frantzen et al. 2011).

Studies of Pacific herring (*Clupea pallasi*) larvae following the 1989 *Exxon Valdez* oil spill in Alaska found larvae that hatched from demersal adhesive eggs at oil-affected sites had statistically significantly higher incidences of morphological deformities and cytogenetic abnormalities than those at unaffected sites (Hose et al. 1996). Bue et al. (1996) also found higher levels of mortality of pink salmon (*Oncorhynchus gorbuscha*) embryos. Experimental studies of the effects of hydrocarbons on early life stages for a variety of other fish species (e.g., herring, salmon, minnow, mummichog) have demonstrated toxic effects, including pericardial and yolk sac oedema, small jaws, hemorrhages, spinal deformities, body axes defects and inhibited growth in response to exposure to petroleum products (Marty et al. 1997; Peterson and Kristensen 1998; Carls et al. 1999; Heintz et al. 1999; Couillard 2002; Pollino and Holdway 2002; Colavecchi et al. 2004; Incardona et al. 2004; Hendon et al. 2008).

Samples (n=278) of seafood species (fish, crab, shrimp, oyster) were collected from the closed fishing grounds along the Mississippi Gulf Coast following the 2010 *Deepwater Horizon* oil spill. The seafood samples were analyzed for 25 different PAH contaminants one month after the spill began (Xia et al. 2012). The samples were collected and analyzed weekly from May 27, 2010, to October 2010, and then monitored monthly until August 2011. Higher levels of PAHs were detected in all four taxa groups during the early period of sampling in comparison to later months. The PAH levels in the tested seafood samples were similar to those detected in commonly consumed processed foods and overall, the levels of PAHs in all the tested seafood samples collected within the one-year period were far below allowable levels (Levels of Concern) (Xia et al. 2012).

Fodrie and Heck (2011) studied potential effects of the *Deepwater Horizon* oil spill on early life stages of coastal fishes using seagrass habitat in the northern Gulf of Mexico and found that there were no immediate, large-scale losses of 2010 fish cohorts and that no shifts in composition of coastal fish communities occurred (Fodrie and Heck 2011), although they acknowledge potential longer-term effects as a result of chronic exposure and delayed effects are possible.

In the unlikely case of a graving dock breach, fish in the immediate vicinity could be swept into the graving dock and become exposed to contaminants, sedimentation or injury. Potential mortality in this case is expected to be very low and not significant.

**Summary of Nearshore Environmental Effects Assessment from Accidental Events**

The environmental effects resulting from an accidental event in the Nearshore Study Area and the mitigations to be implemented are summarized in Table 8-7.

**Table 8-7 Potential Environmental Effects Assessment Summary for Fish and Fish Habitat – Accidental Events in the Nearshore**

| WREP Activity | Potential Positive (P) or Negative (N) Environmental Effect | Mitigation Measure | Evaluation Criteria for Assessing Environmental Effects (A) | | | | | | Significance Rating | Level of Confidence |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | Magnitude | Geographic Extent | Frequency | Duration | Reversibility | Ecological/Socio-cultural/Economic Significance | | |
| Hydrocarbon spill from vessel (marine diesel) due to collision or accidental release | Change in habitat quality (N)<br>Potential mortality (N) | • Training, preparation, equipment inventory, prevention, and emergency response drills<br>• Oil Spill Response Plan<br>• Vessels will not be re-fueled in the Nearshore Project Area<br>• Adhere to MARPOL | H | 3 | 1 | 2 | R | 3 | NS | M |
| Graving dock breach | Change in habitat quality (N)<br>Potential mortality (N) | • Design<br>• Use of best practices and continual improvement programs | L | 1 | 1 | 1 | R | 3 | NS | H |

Key:

**Magnitude:**
N = Negligible (essentially no effect)
L = Low: <10 percent of the population or habitat in the Study Area will be affected
M = Medium: 11 to 25 percent of the population or habitat in the Study Area will be affected
H = High: >25 percent of the population or habitat in the Study Area will be affected

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

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

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

**Reversibility** (population level):
R = Reversible
I = Irreversible

**Ecological/Socio-cultural/Economic Significance:**
1 = Relatively pristine area not affected by human activity
2 = Evidence of existing adverse activity
3 = High level of existing adverse activity

**Significance Rating:**
S = Significant
NS = Not Significant
P = Positive

**Level of Confidence:**
L = Low level of confidence
M = Medium level of confidence
H = High level of confidence

(A) Where there is more than one potential environmental effect, the evaluation criteria rating is assigned to the environmental effect with the greatest potential for harm

Spill prevention will be incorporated into the design and operations for all WREP activities as part of contingency planning. Measures to reduce the likelihood of an accidental event in the Nearshore Study Area include routine maintenance of vessels, the use of good communication and standard navigation procedures, CCG requirements, regular inspections and audits of vessels and equipment, ice management planning, and employee awareness training. Vessels will not be re-fueled in the Nearshore Project Area, and vessels will adhere to Annex I of the *International Convention for the Prevention of Pollution from Ships* (MARPOL 73/78). In the unlikely case of a spill, an EEM program would be implemented according to the standards for offshore spill EEM programs. Spill response planning is described in detail in Section 16.9.

A worst case accidental event in the nearshore is not expected to cause an adverse effect on Fish and Fish Habitat resulting in a decrease in abundance or alteration in distribution of the population over more than one generation or so that natural recruitment would not reestablish the population(s) to baseline conditions within several generations. Significant adverse environmental effects on fish and fish habitat from nearshore accidental events are therefore not predicted.

### 8.5.2 Offshore

In the Offshore Study Area, the primary WREP activities that could affect fish and fish habitat include those associated with installation of the WHP or excavation of a subsea drill centre, installation of flowlines and sub-sea equipment, operation of the WHP and/or MODU and decommissioning of the facilities.

The potential environmental effects on Fish and Fish Habitat from activities associated with these phases include change in habitat quality, change in habitat quantity and/or potential mortality due to resulting sedimentation, contamination, increased noise and/or lighting. Mitigation measures to reduce adverse environmental effects include: continuous improvement program; treatment of all waste streams and adherence to OWTG (NEB et al. 2010); reinjection of SBM cuttings for the WHP development option, and treatment and proper discharge of SBMs from the MODU in accordance with OWTG guidelines.

#### 8.5.2.1 Wellhead Platform or Subsea Drill Centre Installation/Commissioning

Activities that will occur in the Offshore Project Area during the WREP installation (in case of either WHP or subsea drill centre option) phase include: clearance surveys (e.g., sidescan sonar); operation of vessels and barges; installation of flowlines and pipelines; possible use of rock berms on WHP; lighting; drilling-associated seismic surveys; dredging and dredge spoils disposal; and presence of a safety zone.

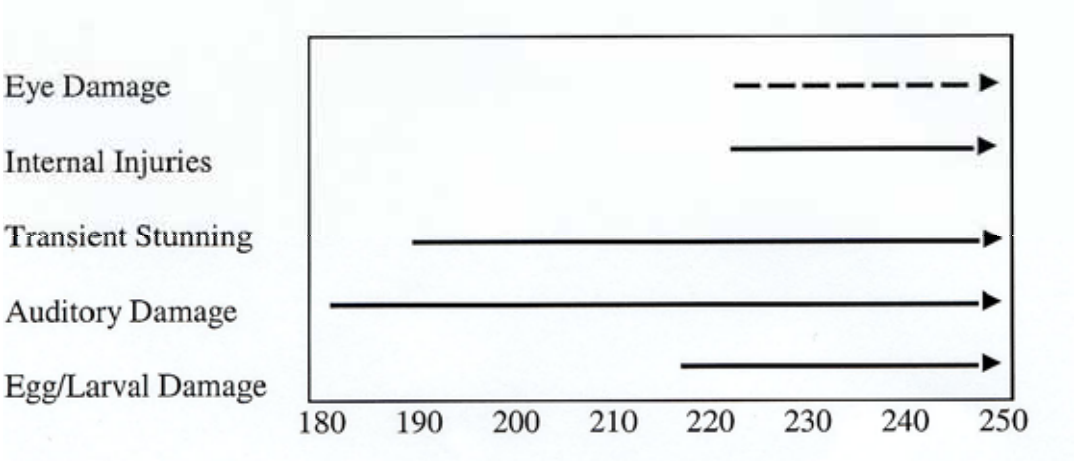
**Change in Habitat Quality**

Habitat quantity may be reduced as a result of lighting, discharges, sedimentation and increased noise occurring due to the above activities. The potential effects of lighting and sedimentation from dredging activities on fish and fish habitat are discussed in Sections 8.5.1.1 and 8.5.1.2.

The use of drilling-associated seismic energy, clearance surveys (e.g., sidescan sonar) and operation of vessels will result in increased noise in the Offshore Project Area. Wellsite surveys and VSP activities have a much smaller geographic extent, magnitude and duration than standard exploratory 2-D or 3-D seismic surveys. The underwater noise associated with wellsite surveys and VSP activities are described in Section 3.2. A summary of literature to date on the potential environmental effects of seismic noise on fish and shellfish is provided below. However, wellsite surveys and VSP activities are much lower in magnitude and extent.

The response to seismic sound by fish can range from no observed change in behaviour, to a startle response (Wardle et al. 2001), to temporary changes in movements for the duration of the sound, to larger changes in movements or behaviour that might displace fish from their normal locations (Slotte et al. 2004) for short or long periods of time. To date, there are no documented cases of fish mortality from 2-D and 3-D seismic noise (under field operating conditions), although it is possible that fish kills have occurred and not been observed (DFO 2004a). Under laboratory conditions, mortality or injury to eggs and larvae have only been observed at close range and at high intensity sound. A laboratory experiment by Payne et al. (2009) to determine potential environmental effects of seismic noise on monkfish eggs and larvae found that the difference between eggs and larvae exposed to sound pressure levels at 205 dB peak to peak and that of the control group was not statistically significant 48 to 72 hours after exposure. Payne et al. (2009) concluded that seismic surveys are unlikely to pose any threat to monkfish eggs or larvae that may float in veils at the surface during monkfish spawning. Behavioural effects such as a startle response or change in direction are well-documented in fish exposed to underwater sound (McCauley et al. 2000a, 2000b; Løkkeborg 2010). Such responses most commonly occur within the area of a seismic program, but have been observed to occur in fish located tens of kilometres away from the site (Engås et al. 1996). Studies suggest that normal behaviour patterns commonly return within 30 minutes of the seismic response (McCauley et al. 2000a, 2000b); therefore, behavioural effects are expected to be short-term. There is well-documented evidence of immediate changes in behaviour such as a startle response and avoidance behaviour (e.g., change in swimming direction, movement out of area of sound) of both fish and shellfish (McCauley et al. 2000a, 2000b; LGL 2005b; Løkkeborg 2010). Adverse effects stemming from behavioural responses could include: leaving preferred feeding and spawning grounds; increased energy expenditure; disruption of migration; suppression of spawning behaviour; or making or blocking of sound reception (CEF 2011). Although seismic energy is well understood, less is known about marine species in terms of their distribution, life history and potential long-term or sub-lethal effects from seismic noise.

A summary of fish injuries caused by exposure to sound pressure is given in Figure 8-10. Auditory damage starts at 180 dB, transient stunning at 192 dB and internal injuries at 220 dB. Source levels during seismic surveys are usually in excess of the noise levels that elicit a response in fish, so the area in which fish react to the noise may extend several kilometres in the open ocean. The expected distance for fish to react to a typical peak source level of 250 to 255 dB re 1 µPa is from 3 to 10 km (Engås et al. 1996).




Source: adapted from Turnpenny and Nedwell 1994.
Note: Dotted line indicates an assumed sound level rather than an estimated one.

**Figure 8-10 Sound Pressure Threshold (dB) for the Onset of Fish Injuries**

Application of a 'worst-case scenario' mathematical model to investigate the effects of seismic energy on fish eggs and larvae concluded that mortality rates caused by exposure to seismic energy are so low compared to natural mortality, the environmental effect of seismic activity on recruitment to a fish stock would be negligible (Saetre and Ona 1996).

For shellfish, there have been no documented cases of invertebrate mortality due to seismic noise, although there have been accounts of mass giant squid strandings on two occasions that corresponded to periods of seismic activity (Guerra et al. 2004; Worcester 2006). Literature reviews (Moriyasu et al. 2004) and workshops (DFO 2004b; CEF 2011) to date suggest that information is lacking to evaluate the likelihood of sub-lethal or physiological effects on crustaceans during molting stages, and that the potential for seismic sound to disrupt communication, orientation, locomotion, or detection of predators and prey has not been studied. However, a review by DFO (2004a) concluded that it is expected that the overall effect of seismic sound on invertebrates is low, unless it can adversely affect reproduction or growth.

Benthic macroinvertebrates are less likely to be affected by seismic activity than pelagic or planktonic invertebrates because few benthic invertebrates have gas-filled spaces that would make them sensitive to changes in pressure, and also because benthic species are usually more than 20 m away from the seismic source as they occur on the seafloor. Christian et al. (2003) found no apparent effects on adult crab behaviour, health, or catch rates from seismic exposure, but there was an effect on egg development for a female exposed to seismic energy at very close range (2 m). Similarly, reviews by LGL (2005b) also found that mortality of eggs and larvae have only been reported when exposed at very close range to seismic sources. Many invertebrates are sessile or have very limited ability to move, or are planktonic during larval stages, and would be unable to avoid seismic sound. Behavioural responses (i.e., change in swimming patterns, startle response) have been observed for some invertebrate species.

To mitigate the potential effects of wellsite and VSP surveys in the offshore all surveys will adhere to the *Statement of Canadian Practice on Mitigation of Seismic Noise in the Marine Environment*, as referenced in the *Geophysical, Geological, Environmental and Geotechnical Program Guidelines* (C-NLOPB 2012d).

**Change in Habitat Quantity**

A change in habitat quantity may result from dredging and dredge spoil disposal. The footprint of the flowline will be mitigated by a rock berm covering the flowlines near the WHP and drill centres.

The installation of the WHP or subsea drill centre and installation of flowlines will create a footprint on the seafloor that may result in loss of benthic habitat or restrict access to fish and shellfish in some areas. However, the presence of rock berm-protected flowlines are expected to create habitat by increasing the amount of habitat available to be colonized, thereby providing a reef effect for fish in an otherwise flat, homogenous soft-sediment environment. Artificial structures in the water column and on the seafloor can increase the amount of available habitat (i.e., settling areas) and increase vertical complexity (Hueckel et al. 1989; Rilov and Benayahu 1998; Ponti et al. 2002; Kaiser et al. 2005). Fish and invertebrates associated with rocky habitat and crevices such as Atlantic cod, wolffish species, ocean pout species, flounder, shrimp and sponges may increase in abundance on this artificial habitat, whereas species associated with fine sediment habitat may decrease in abundance as this type of habitat will shrink in the WREP footprint. In addition to providing more complex, rocky habitat, the construction and installation activities may create a reef effect, by drawing higher trophic levels to the Offshore Project Area to feed on lower trophic levels or use habitat provided by settling sponge, coral and other epifauna (Clynick et al. 2007). It remains unclear whether artificial reefs have increases in fish abundance due to recruitment or attraction (i.e., movement from elsewhere) (Brickhill et al. 2005).

As with the Nearshore Study Area, WREP activities will occur in accordance with the *Fisheries Act*. A fish habitat compensation agreement (Authorization No. 07-01-002) has been in place with DFO since 2007 to compensate for the excavation of up to five subsea drill centre sites, of which only two have been excavated to date (the NADC and SWRX). The construction of a subsea drill centre for the West White Rose pool was one of the potential subsea drill centres assessed and compensated for in 2007.

**Potential Mortality**

Mortality of fish and invertebrates may occur in the offshore due to dredging or due to seismic surveys. Mortality may also decrease in the safety zone where fishing activities are prohibited.

At the offshore dredge spoil disposal site, benthic production may decrease temporarily due to smothering under the disposed sand and gravel (expected to be several centimetres). On the surface of the disposal pile, infauna will emerge and a new food source will be available to local benthic predators such as snow crab, skate and flounder species. At the edges of the dredge disposal site, sessile (or slow moving) epifauna (e.g., barnacles, bryozoans, sponge, sea stars, brittlestars, urchins) will be smothered, whereas infaunal species are capable of burrowing and can be expected to resurface and have little effect from the disposal of dredge material. Studies suggest potential

effects from dredging and dredge spoils disposal activities are highly site-dependent and vary depending on mitigation and procedures used, as well as characteristics of material disposed (i.e., material grain size). Environmental effects on faunal communities can range from minimal impacts (Roberts and Forrest 1999; Simonini et al. 2005) to considerable effects (Boyd et al. 2000). Wilbur and Clark (2001) have reported some uncertainty with respect to the effects of sedimentation on fish and fish habitat. Based on knowledge to date of existing operations, it is anticipated the geographic extent and magnitude of dredging and spoils disposal will be low with high reversibility.

There is also potential for mortality of fish and shellfish (particularly egg and larval stages) to occur during seismic surveys. A startle response, change in swimming pattern, or change in vertical distribution are the expected responses of adult marine fish to seismic noise (DFO 2004a). These effects are expected to be short-term and negligible. The greatest concern would apply to egg and larval stages of fish that occur near the surface during the survey periods. Reviews of studies on the effects of seismic sound on marine life (DFO 2004a, 2004b; Payne et al. 2008; CEF 2011) report no direct evidence of mortality of fish or shellfish in response to seismic sound exposure at field operating levels. Survey activities will adhere to the *Statement of Canadian Practice on Mitigation of Seismic Noise in the Marine Environment*, as referenced in the *Geophysical, Geological, Environmental and Geotechnical Program Guidelines* (C-NLOPB 2012d), and will obtain required permits. The potential effects of mortality resulting from offshore surveys are predicted to be low in magnitude, frequency and duration and are considered reversible.

**Summary of Environmental Effects Assessment from Installation**

The environmental effects of the WREP during the installation phase in the Offshore Study Area and the mitigations to be implemented are summarized in Table 8-8. Significant residual adverse environmental effects on Fish and Fish Habitat from installation activities are not predicted.

#### 8.5.2.2 Production/Operation and Maintenance

WREP activities occurring in the Offshore Project Area during operations and maintenance that could affect fish and fish habitat include: clearance surveys (e.g., sidescan sonar); operation of vessels and barges; installation of flowlines and pipelines; possible use of rock berms on flowlines; lighting; chemical use and management; drilling-associated seismic surveys; presence of safety zone; presence of the structure; noise from WHP or MODU drilling; WBM and/or SMB cuttings; operation of seawater systems for cooling and firewater; surveys (geotechnical, geophysical, environmental); operation of vessels; cementing and completion of walls; and oily water treatment.

**Change in Habitat Quality**

There is potential for operational activities to affect habitat quality through operational discharges (e.g., SBM and WBMs, seawater discharges, drill cuttings, grey and black water) as well as noise. SBM and WBM discharges and vessel and helicopter noise were modelled and are discussed in detail in Chapter 3.

**Table 8-8 Potential Environmental Effects Assessment Summary for Fish and Fish Habitat –Wellhead Platform or Subsea Drill Centre Installation**

| WREP Activity | Potential Positive (P) or Negative (N) Environmental Effect | Mitigation Measure | Evaluation Criteria for Assessing Environmental Effects (A) | | | | | | Significance Rating | Level of Confidence |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | Magnitude | Geographic Extent | Frequency | Duration | Reversibility | Ecological/Socio-cultural/Economic Significance | | |
| Lighting | Change in habitat quality (N) | • Use only lights as necessary for safe operations | N | 1 | 6 | 3 | R | 3 | NS | H |
| Safety zone | Potential mortality (P) | | N | 2 | 6 | 5 | R | 3 | NS | H |
| Dredging | Change in habitat quality (N)<br>Change in habitat quantity (N)<br>Potential mortality (of benthos) (N) | • Compliance with *Fisheries Act*. | L | 1 | 1 | 2 | R | 3 | NS | H |
| Clearance surveys (e.g., sidescan sonar) prior to installation of WHP or pipelines/ flowlines | Change in habitat quality (N) | • Use of best practices and improvement programs | N | 1 | 1 | 1 | R | 3 | NS | H |
| Operation of vessels and barges | Change in habitat quality (N) | • Adhere to *Canada Shipping Act, 2001* and industry best practices<br>• Follow marine traffic rules and regulations | N | 4 | 6 | 5 | R | 3 | NS | H |
| Installation of flowlines and pipelines between WHP, subsea drill centre(s) and existing infrastructure | Change in habitat quantity (N) | • Minimize seabed disturbance<br>• Compliance with *Fisheries Act*<br>• Use of best practices and improvement programs | N | 1 | 1 | 2 | R | 3 | NS | H |
| Installation of subsea equipment, flowlines and tie-in modules to existing subsea infrastructure | Change in habitat quantity (N) | • Minimize seabed disturbance<br>• Use of best practices and improvement programs | N | 1 | 1 | 2 | R | 3 | NS | H |
| Potential rock berms for flowline protection | Change in habitat quality (N)<br>Change in habitat quantity (P) | • Compliance with *Fisheries Act* | N | 1 | 6 | 5 | R | 3 | NS | H |
| Drilling-associated seismic (VSPs and wellsite surveys) | Change in habitat quality (N)<br>Potential mortality (N) | • Adherence to the *Geophysical, Geological, Environmental and Geotechnical Program Guidelines* (C-NLOPB 2012d) | L | 2 | 1 | 1 | R | 3 | NS | M |

| WREP Activity | Potential Positive (P) or Negative (N) Environmental Effect | Mitigation Measure | Evaluation Criteria for Assessing Environmental Effects [A] | | | | | | Significance Rating | Level of Confidence |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | Magnitude | Geographic Extent | Frequency | Duration | Reversibility | Ecological/Socio-cultural/Economic Significance | | |

Key:

**Magnitude:**
N = Negligible (essentially no effect)
L = Low: <10 percent of the population or habitat in the Study Area will be affected
M = Medium: 11 to 25 percent of the population or habitat in the Study Area will be affected
H = High: >25 percent of the population or habitat in the Study Area will be affected

**Geographic Extent:**
1 = <1 km radius
2 = 1 to 10 km radius
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4 = 101 to 1,000 km radius
5 = 1,001 to 10,000 km radius
6 = >10,000 km radius

**Frequency:**
1 = <11 events/year
2 = 11 to 50 events/year
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**Duration:**
1 = <1 month
2 = 1 to 12 months
3 = 13 to 36 months
4 = 37 to 72 months
5 = >72 months

**Reversibility** (population level):
R = Reversible
I = Irreversible

**Ecological/Socio-cultural/Economic Significance:**
1 = Relatively pristine area not affected by human activity
2 = Evidence of existing adverse activity
3 = High level of existing adverse activity

**Significance Rating:**
S = Significant
NS = Not Significant
P = Positive

**Level of Confidence:**
L = Low level of confidence
M = Medium level of confidence
H = High level of confidence

(A) Where there is more than one potential environmental effect, the evaluation criteria rating is assigned to the environmental effect with the greatest potential for harm

### *Noise*

Noise will be generated from operation of vessels and helicopters as well as during drill-related surveys (wellsite surveys and VSP) and drilling operations. Sounds levels of 160 to 180 dB re 1 µPA (rms) have been estimated to occur within less than 5 to 22 m of an offshore vessel, respectively (JASCO 2012). The sounds levels of a helicopter at an altitude of 91 m hovering over water were modelled by JASCO (2012) and received levels are not expected to exceed 157 dB re 1 µPA at depths greater than 3 m. Sound transfer to the marine environment from helicopters is likely minimal. Continuous noise from the drilling operations at the White Rose field is predicted to be 160 dB re 1 µPA (rms) at distances less than 5 m from the drill. The potential effects of noise on fish are discussed in Sections 8.5.1.1 and 8.5.1.2.

### *Operational Discharges*

Results from the ongoing White Rose EEM program have confirmed original assessment predictions (Husky Oil 2000; LGL 2007a) of no significant environmental effect on the marine environment as a result of contamination due to operational discharges. American plaice and snow crab are collected for the commercial fish component of the White Rose EEM program and results to date indicate that no existing White Rose field-related activities have resulted in tissue contamination for these species. Plaice and snow crab samples were analyzed for chemical body burden and taint and analyses were also performed on American plaice for a variety of fish health indices. Metal and hydrocarbon concentrations in American plaice and snow crab tissue continue to show that body burden in these species is unaffected by existing White Rose field activities. The results of taste tests carried out at the Marine Institute in St. John's, NL, demonstrated that the taint was not detectable by the taste panel. Indicators of fish health used to evaluate potential effects on America plaice showed that the general health and condition of this species was similar in the Study and Reference Areas (Husky 2009, 2011).

As part of operations, WBM and SBM cuttings will be discharged. WBM is sometimes considered less harmful to the environment, as it contains mainly water and cannot form surface sheens. SBM can form sheens on the surface, but on the other hand, does not disperse as widely as WBMs. The main component of SBM is a synthetic-based oil called Pure Drill IA-35. This fluid has been shown to be non-toxic (acutely or chronically) through both operator testing and government testing (Payne et al. 2000). The main component of WBM is water or seawater. Both WBM and SBM include bentonite (clay) and/or barite. Other chemicals that are used include potassium chloride, caustic soda soda ash, viscosifiers, filtration-control additives and shale inhibitors, added to control mud properties. The potential effects of drilling muds and cuttings have been assessed previously in Husky environmental assessments (Husky 2000, 2001; LGL 2002, 2005a, 2006).

The C-NLOPB regulates the release of WBMs and associated cuttings and these cuttings do not require treatment prior to discharge under OWTG regulations. The discharge of WBM can increase metals in the area where discharges concentrate (usually within 500 m of drill site), and include barium, arsenic, cadmium, copper, mercury, lead and zinc. However, these metals are not typically bioavailable (CAPP 2001). WBM cuttings will be discharged overboard regardless of the development option selected. Modelling of WBM cuttings deposition (AMEC 2012b) reports that cuttings from

drilling will be released close to the seafloor, via a chute release under the WHP option, or with MODU riserless drilling under the subsea drill centre option. The drift of cuttings under the WHP option is predicted to be within a range of 2 to 4 km for up to 40 wells, with a maximum extent of 5 km to the southeast and northeast. WBM cuttings are expected to be less than 1 mm over this area. Cuttings thicknesses directly under the WHP are modelled to be 1.8 m; however, from 200 to 500 m from the discharges source, thicknesses are predicted to average 1.8 mm (AMEC 2012b)

For the subsea drill centre option, where drilling would be conducted by MODU, the footprint of WBM cuttings is predicted to be smaller than for the WHP option described above due to fewer wells drilled (16 in comparison to 40 wells under the WHP option), as well as reduced volume of cuttings released (267 $m^3$ per well in comparison to 295 $m^3$) (AMEC 2012b). In comparison to the WHP option, the subsea drilling centre (MODU) option would result in WBM cuttings thicknesses that are predicted to be one-third to one-quarter less than that of WHP drilling within 100 m from site, with little difference in cuttings thickness between the two options beyond 100 m (AMEC 2012b). The range of WBM deposition under the subsea drill centre option is expected to be within 2 km, and cuttings directly under the MODU are expected to be 72 cm deep. Within 100 m of deposition, MODU drilling is expected to result in mean WBM cuttings thicknesses of 5 mm on average, with maximum of approximately 19 mm. From 100 to 200 m, cuttings thicknesses are predicted to be approximately 3 mm on average, with a maximum of nearly 10 mm, and from 200 to 500 m, cuttings thicknesses are predicted to be 2 mm on average, with a maximum of 5.5 mm.

SBM will be used for drilling of the deeper intermediate and main hole sections for both the WHP and subsea drill centre options. If the WHP development option is selected, then SBM cuttings will be re-injected; this option is not technically feasible for MODU drilling. EEM programs to date suggest that reinjection of SBMs reduces the footprint of contaminants associated with the release of SBM (Hibernia Management Development Company 2008). In the case of the subsea drill centre option, SBM cuttings resulting from MODU drilling will be discharged overboard after treatment in accordance with the OWTG. Discharge of whole SBM is prohibited. All SBM cuttings must be analyzed for toxicity and results sent to the C-NLOPB. Biological effects from SBM are typically limited to within 250 to 500 m from the discharge site (CAPP 2001; Husky 2001; NEB et al. 2002; Hurley and Ellis 2004). Within 100 m of the drill centre, initial SBM cuttings thicknesses are predicted to be 11.7 cm on average. Thicknesses are predicted to be 1.0 mm average 100 to 200 m out from the drill centre and 0.1 mm average from 200 to 500 m (AMEC 2012b).

To test the effects of sedimentation from WBM cuttings on benthic fauna, Trannum et al. (2010) added natural sediment particles and water-based drill cuttings to benthic communities in layer thicknesses of 3 to 24 m and monitored changes for six months. Observed effects included a substantial reduction in number of taxa, abundance, biomass and diversity of macrofauna with increasing thickness of drill cuttings, which was not observed for the natural sediment particles (Trannum et al. 2010). The drill cuttings were also found to affect oxygen consumption and oxygen penetration depth in the sediment, and an organic compound in the drill cuttings initiated a eutrophication response (Trannum et al. 2010).

Literature suggests that changes in the diversity and abundance of benthic organisms in areas where wells are drilled and/or discharging SMB and WBMs is typically detected within 1,000 m of drill sites, and most commonly within 50 to 500 m (Hurley and Ellis 2004). Beyond the footprint where the benthos is covered by cuttings, benthic communities typically return to baseline conditions within a year after drilling discharges end (Hurley and Ellis 2004). Ellis et al. (2012) reviewed the effects of drilling waste on benthic environments from 72 production or exploration sites. The footprint of water-based drilling fluids (determined by sediment barium concentration) was larger (2 to 20 km) than for synthetic-based fluids (200 to 2,000 m). Biological effects on benthic community diversity and abundance ranged from 100 to 1,000 m for both water and synthetic fluids. The observed biological changes included reductions in benthic species diversity and abundance and alterations to community structure. Suspension-feeding species were reduced or removed in the zone of influence and deposit feeders and polychaetes increased (Ellis et al. 2012).

Some synthetic-based drilling fluids have been found to be toxic to benthic communities, while others appear to cause no or few effects (Khan and Payne 2004). Typically, noticeable effects may be observed within 250 to 500 m of the drilling fluid release site, and subtle effects observed up to 5,000 m away (Olsgård and Gray 1995). In offshore Newfoundland, Puredrill IA-35LV is used in the offshore oil and gas industry, and to date, toxicity studies of plankton, fish larvae, scallop and winter flounder suggest this drilling fluid has a low potential for acute toxicity (Cranford et al. 2000; Armsworthy et al. 2005; Payne et al. 2001). Microtox and amphipod bioassays have also suggested Puredrill IA-35LV has low acute potential for toxicity (Payne et al. 2001), with extrapolations indicating little or no risk associated with the SBM as close as 1,000 m or less from release site.

Organic matter associated with discharges will disperse quickly in an open ocean environment and be quickly degraded by bacteria.

To mitigate potential environmental effects on benthic communities and fish from discharges in the Offshore Project Area during the WREP activities, the following guidelines will be implemented:

- All chemicals used will be screened as per the *Offshore Chemical Selection Guidelines* (NEB et al. 2009) and Husky's chemical management system and chemical screening program

- The Transportation of Dangerous Goods and Workplace Hazardous Materials Information Systems regulations govern the handling, use, storage, transport and disposal of hazardous materials; the regulations and best practices will be followed

- All routine discharges will be in accordance with the OWTG, *Regulations for the Prevention of Pollution from Ships and for Dangerous Chemicals* under the *Canada Shipping Act, 2001* and the *International Conventions for the Prevention of Pollution from Ships* (MARPOL)

- Sanitary waste will be treated and discharged as per the OWTG

- Waste-water discharge is treated and tested for compliance with the OWTG

- Domestic garbage will be transported to shore for disposal (garbage is segregated as required and hazardous waste is disposed of separately and incompliance with waste disposal requirement and Husky Waste Management Plan)

- SBM cuttings will be re-injected from the WHP.

**Potential Mortality**

Potential mortality may be reduced by the presence of a safety zone, which will limit the area that can be commercially fished in the Offshore Project Area; this may potentially reduce mortality of fish and shellfish targeted (or caught incidentally) by commercial fisheries.

There is potential for mortality of fish and shellfish (particularly larval stages) if wellsite surveys and VSP surveys occur during sensitive periods and overlaps with spawning areas. However, DFO (2004a) report that there has been no evidence of mortality of any fish species exposed to seismic noise under field operating conditions. The potential effects of seismic noise on fish and shellfish are discussed in detail in Section 8.5.1.2. Seismic activities will adhere to the *Statement of Canadian Practice on Mitigation of Seismic Noise in the Marine Environment*, as referenced in the *Geophysical, Geological, Environmental and Geotechnical Program Guidelines* (C-NLOPB 2012d).

There is also potential for smothering of the benthos (i.e., sessile invertebrates on the seafloor) resulting from interactions with WBM/SBM cuttings (described in previous section). However, effects from release of WBM/SBM cuttings are predicted to be negligible.

**Summary of Environmental Effects Assessment from Operation and Maintenance**

The environmental effects of the WREP during the operation phase in the Offshore Study Area and the mitigations to be implemented are summarized in Table 8-9. No significant adverse environmental effects on fish and fish habitat from routine WREP operation and maintenance activities are predicted. Environmental effects are generally low in magnitude, of limited geographic extent and reversible.

### 8.5.2.3 Offshore Decommissioning and Abandonment

At the end of its production life, the WHP or subsea drill centre will be decommissioned and abandoned according to C-NLOPB requirements and in accordance with *Newfoundland Offshore Petroleum Production and Conservation Regulations*, as well as any other applicable laws and industry standards at the time.

The activities involved in decommissioning and abandonment that may have environmental effects on fish and fish habitat include: removal of the WHP; plugging and abandoning of wells; operation of vessels; lighting; the removal of a safety zone; and conducting surveys (geotechnical, geophysical and environmental).

**Table 8-9 Potential Environmental Effects Assessment Summary for Fish and Fish Habitat – Operations and Maintenance**

| WREP Activity | Potential Positive (P) or Negative (N) Environmental Effect | Mitigation Measure | Evaluation Criteria for Assessing Environmental Effects [A] | | | | | | Significance Rating | Level of Confidence |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | Magnitude | Geographic Extent | Frequency | Duration | Reversibility | Ecological/Socio-cultural/Economic Significance | | |
| Presence of structure | Change in habitat quantity (P/N) | • Minimize seabed disturbance where possible<br>• Potential for reef effect | N | 1 | 6 | 5 | R | 3 | NS | H |
| Noise from drilling from a MODU and/or WHP | Change in habitat quality (N) | • Use of best practices and continual improvement programs | N | 1 | 6 | 5 | R | 3 | NS | H |
| WBM and SBM cuttings | Change in habitat quality (N) Potential mortality (of benthos) (N) | • Adhere to OWTG<br>• Use of best practices and continual improvement programs<br>• Reinjection of SBM cuttings if WHP is used | N | 3 | 6 | 5 | R | 3 | NS | H |
| Operation of vessels | Change in habitat quality (N) | • Adhere to *Canada Shipping Act, 2001* and industry best practices<br>• Follow marine traffic rules and regulations | N | 1 | 6 | 5 | R | 3 | NS | H |
| Operation of seawater systems (cooling, firewater) | Change in habitat quality (N) | • Use of best practices and continual improvement programs<br>• Adhere to OWTG | N | 1 | 6 | 5 | R | 3 | NS | H |
| Chemical use and management | Change in habitat quality (N) | • Use of best practices and continual improvement programs<br>• Proper management systems for screening and safe use of chemicals<br>• Adhere to OWTG<br>• Use of C-NLOPB's Offshore Chemical Selection Guidelines and Husky's chemical management system and chemical screening program | N | 1 | 6 | 5 | R | 3 | NS | H |
| Cementing and completing wells | Change in habitat quality (N) | • Use of best practices and continual improvement programs<br>• Adhere to OWTG | N | 1 | 1 | 2 | R | 3 | NS | H |
| Oily water treatment | Change in habitat quality (N) | • Use of best practices and continual improvement programs<br>• Adhere to OWTG | N | 1 | 6 | 5 | R | 3 | NS | H |
| Lighting | Change in habitat quality (N) | • Use of best practices and continual improvement programs to minimize disturbance | N | 1 | 6 | 5 | R | 3 | NS | H |

| WREP Activity | Potential Positive (P) or Negative (N) Environmental Effect | Mitigation Measure | Evaluation Criteria for Assessing Environmental Effects [A] | | | | | | Significance Rating | Level of Confidence |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | Magnitude | Geographic Extent | Frequency | Duration | Reversibility | Ecological/Socio-cultural/Economic Significance | | |
| Surveys (geotechnical, geophysical and environmental) | Change in habitat quality (N)<br>Potential mortality (N) | • Adherence to the *Geophysical, Geological, Environmental and Geotechnical Program Guidelines* (C-NLOPB 2012d) | L | 3 | 1 | 1 | R | 3 | NS | M |

Key:

**Magnitude:**
N = Negligible (essentially no effect)
L = Low: <10 percent of the population or habitat in the Study Area will be affected
M = Medium: 11 to 25 percent of the population or habitat in the Study Area will be affected
H = High: >25 percent of the population or habitat in the Study Area will be affected

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

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

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

**Reversibility** (population level):
R = Reversible
I = Irreversible

**Ecological/Socio-cultural/Economic Significance:**
1 = Relatively pristine area not affected by human activity
2 = Evidence of existing adverse activity
3 = High level of existing adverse activity

**Significance Rating:**
S = Significant
NS = Not Significant
P = Positive

**Level of Confidence:**
L = Low level of confidence
M = Medium level of confidence
H = High level of confidence

(A) Where there is more than one potential environmental effect, the evaluation criteria rating is assigned to the environmental effect with the greatest potential for harm

**Change in Habitat Quality**

Reduction in habitat quality may result from sedimentation, noise (vessel, seismic) and lighting. The environmental effects from removal of infrastructure are expected to be similar to those during construction and installation, but of less magnitude and geographic extent.

**Change in Habitat Quantity**

Reduction in habitat quantity may arise from decommissioning of the subsea infrastructure, since the removal of these structures will end the reef effect and refuge that this large vertical structure has provided. However, as the structures will be removed, the benthic habitat will once again become available to be colonized.

**Potential Mortality**

The presence of a safety zone during the decommissioning phase will reduce the area that can be commercially fished in the Offshore Project Area and may potentially reduce mortality of fish and shellfish. Following abandonment of the site, the safety zone may cease, and commercial fishing of fish and shellfish may resume in the Offshore Project Area.

**Summary of Environmental Effects Assessment from Decommissioning and Abandonment**

The environmental effects resulting from decommissioning and abandonment and the mitigations to be implemented are summarized in Table 8-10. Significant adverse residual environmental effects on marine fish and fish habitat from routine decommissioning and abandonment activities are not predicted. Environmental effects are generally low in magnitude, of limited geographic extent and reversible.

#### 8.5.2.4 Potential Future Activities

Potential future activities include: excavation of drill centres; dredge spoil disposal; surveys (geotechnical, geotechnical, environmental, ROV, diving); noise from drilling operations from MODU; WBM and SBM cuttings; installations of pipelines and flowlines; and chemical use and management. These activities could result in a change in habitat quality and quantity. There is potential for contamination, sedimentation and underwater noise (including drilling-associated seismic). Use of industry best practices at the time must be implemented, including adherence to the most current *Statement of Canadian Practice on Mitigation of Seismic Noise in the Marine Environment*, as referenced in the *Geophysical, Geological, Environmental and Geotechnical Program Guidelines* (C-NLOPB 2012d). The environmental effects from potential future activities are expected to be similar to those described for installation (Section 8.5.2.1) and operation and maintenance (Section 8.5.2.2).

The environmental effects resulting from potential future activities and the mitigations to be implemented are summarized in Table 8-11. Significant adverse environmental effects on marine fish and fish habitat from routine activities associated with potential future activities are not predicted. Environmental effects are generally low in magnitude, of limited geographic extent and reversible.

**Table 8-10 Potential Environmental Effects Assessment Summary for Fish and Fish Habitat – Decommissioning and Abandonment**

| WREP Activity | Potential Positive (P) or Negative (N) Environmental Effect | Mitigation Measure | Evaluation Criteria for Assessing Environmental Effects (A) | | | | | | Significance Rating | Level of Confidence |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | Magnitude | Geographic Extent | Frequency | Duration | Reversibility | Ecological/Socio-cultural/Economic Significance | | |
| Removal of WHP | Change in habitat quality (N)<br>Change in habitat quantity (N) | • Use of industry best practices | L | 1 | 6 | 2 | R | 3 | NS | M |
| Plugging and abandoning wells | Change in habitat quality (N) | • Use of industry best practices | L | 1 | 6 | 2 | R | 3 | NS | M |
| Operation of vessels | Change in habitat quality (N) | • Adhere to *Canada Shipping Act, 2001* and industry best practices<br>• Follow marine traffic rules and regulations | N | 1 | 6 | 2 | R | 3 | NS | H |
| Lighting | Change in habitat quality (N) | | N | 1 | 6 | 2 | R | 3 | NS | H |
| Safety zone | Potential increase in mortality (N) | | N | 2 | 6 | 2 | R | 3 | NS | H |
| Surveys (e.g., geophysical, geological, geotechnical, environmental, ROV, diving) | Change in habitat quality (N)<br>Potential mortality (N) | • Adherence to the *Geophysical, Geological, Environmental and Geotechnical Program Guidelines* (C-NLOPB 2012d) | L | 1 | 2 | 2 | R | 3 | NS | M |

Key:

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**Significance Rating:**
S = Significant
NS = Not Significant
P = Positive

**Level of Confidence:**
L = Low level of confidence
M = Medium level of confidence
H = High level of confidence

(A) Where there is more than one potential environmental effect, the evaluation criteria rating is assigned to the environmental effect with the greatest potential for harm

**Table 8-11 Potential Environmental Effects Assessment Summary for Fish and Fish Habitat – Potential Future Activities**

| WREP Activity | Potential Positive (P) or Negative (N) Environmental Effect | Mitigation Measure | Evaluation Criteria for Assessing Environmental Effects [A] | | | | | | Significance Rating | Level of Confidence |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | Magnitude | Geographic Extent | Frequency | Duration | Reversibility | Ecological/Socio-cultural/Economic Significance | | |
| Excavation of drill centres (including disposal of dredge spoils) | Change in habitat quality (N)<br>Change in habitat quantity (N)<br>Potential mortality (benthos) (N) | • Use of industry best practices and improvement programs<br>• Compliance with terms of Section 32 *Fisheries Act* Authorization | L | 2 | 1 | 2 | R | 3 | NS | H |
| Surveys (e.g., geophysical, geological, geotechnical, environmental, ROV, diving) | Change in habitat quality (N) | • Adherence to the *Geophysical, Geological, Environmental and Geotechnical Program Guidelines* (C-NLOPB 2012d) | L | 1 | 2 | 2 | R | 3 | NS | M |
| Noise from drilling operations from MODU at potential future subsea drill centres | Change in habitat quality (N) | • Use of industry best practices and improvement programs | L | 2-3 | 6 | 5 | R | 3 | NS | H |
| WBM and SBM cuttings | Change in habitat quality (N)<br>Change in habitat quantity (N)<br>Potential mortality (benthos) (N) | • Use of industry best practices and improvement programs<br>• Adhere to OWTG<br>• Compliance with terms of Section 32 *Fisheries Act* Authorization | L | 2 | 6 | 5 | R | 3 | NS | H |
| Installation of pipelines/ flowlines and testing from drill centres to FPSO including flowline protection | Change in habitat quality (N)<br>Change in habitat quantity (N) | • Use of industry best practices and improvement programs<br>• Minimize seabed disturbance | L | 3 | 1 | 2 | R | 3 | NS | H |
| Chemical use and management | Change in habitat quality (N) | • Use of industry best practices and improvement programs<br>• Adhere to OWTG | N | 1 | 6 | 5 | R | 3 | NS | H |

| WREP Activity | Potential Positive (P) or Negative (N) Environmental Effect | Mitigation Measure | Evaluation Criteria for Assessing Environmental Effects [A] | | | | | | Significance Rating | Level of Confidence |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | Magnitude | Geographic Extent | Frequency | Duration | Reversibility | Ecological/Socio-cultural/Economic Significance | | |

Key:

**Magnitude:**
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#### 8.5.2.5 Accidental Events

Accidental event scenarios during installation or operation phases of the WREP considered in this assessment include: subsea hydrocarbon blowout; surface hydrocarbon blowout; SBM whole mud spill; marine vessel incident (including collision) (i.e., diesel fuel spill); or other spills. An accidental event may result in a decrease in habitat quality and habitat quantity or potential mortality.

Subsea blowouts are classified as shallow or deep water, based on how the gas behaves upon exiting and contacting the water. Well blowouts generally involve crude oil (or gas condensate) and natural gas; the volume ratio varies depending on the fluid characteristics and the reservoir itself. Models for both subsea and surface blowouts were produced by SL Ross (2012), based on oil flow rates of 6,435 $m^3$ per day and 3,963 $m^3$ per day during winter and summer scenarios. Based on modelling results, the oil spill trajectory for the Offshore Project Area covers an extensive area due to the quick dispersal and the amount of hydrocarbons that could potentially be released in the event of such an accident. The spatial extent of the area that could potentially be affected by a hydrocarbon spill is therefore much larger in the offshore than the nearshore (see a discussion of modelling results in Sections 3.7 and 3.8). These represent the maximum oil flow rate estimated from the reservoir and the reduced flow expected after a 120-day release period. An oil spill is predicted to be persistent under both summer and winter conditions due to formation of water-in-oil emulsions during summer, and because the water is colder than the oil's pour point in winter. Consequently, the natural dispersion would be low, and the oil would remain at the surface for an extended period. After approximately one day of exposure at the water surface, the oil will have lost between 18 and 21 percent of its volume due to evaporation, with the maximum anticipated amount of evaporation over the life of the surface oil is estimated to be 31 to 36 percent (SL Ross 2012).

The winter zone of influence is smaller than in summer due to strong, persistent westerly winds in the winter, creating a tighter trajectory. The summer wind direction is more variable and the modelled slick moves over a wider area. Overall, a release of crude oil from the Offshore Project Area would persist and surface slicks would remain for several weeks. Just 0.04 percent of slicks were predicted to reach the shore; of the 83,220 oil slicks modeled, nine reached shore in March, 26 in October and one in November. These slicks were predicted to reach the coast 45 to 92 days after the hydrocarbon release. Details on the oil spill fate and behaviour modelling can be found in Section 3.8.

Small batch spills could occur from hose ruptures or from platform storage facilities. A vessel collision could result in a larger batch spill of diesel fuel oil. Batch spills are considered instantaneous events.

Modelling was conducted to predict the dispersion footprint and potential effects of an SBM whole mud accidental release (AMEC 2012c). Modelling was based on the synthetic drilling fluid Puredrill IA-35LV (65 percent by volume), with a total density of 1,350 $kg/m^3$. Four spill scenarios were considered: a surface tank discharge; a rise flex joint failure (at two difference fall velocities); and a BOP disconnect. These were modelled over varying fall velocities and release times as well as seasons. The maximum deposition footprint occurred in winter for the riser flex joint scenario, with the lowest fall velocity and longest release period (three hours). The majority of modelled spills had a footprint of 1,800 $m^2$ or smaller (e.g., 30 m by 60 m). The smallest footprints

(30 m b 30 m) were modelled for the BOP disconnect scenario over a relatively short release time (one hour) and at a high fall velocity. Details on the SBM modelling can be found in Section 3.5.

Spill and blowout prevention will be incorporated into the design and daily operation and maintenance of the WREP. For example, there will be frequent maintenance, testing and inspection of all equipment, best practices put in place, good communication, audits of facilities and equipment and regular employee training to minimize the likelihood of an accident or malfunction. Husky has an existing oil spill response plan for the offshore operations; this will be modified to include the proposed WREP. Further information on this is detailed in Section 16.9.

The following mitigation measures will be included in the WREP to reduce the potential for an accidental event:

- All activities will adhere to Annex I of the *International Convention for the Prevention of Pollution from Ships* (MARPOL 73/78)
- An oil spill response plan will be in place (the WREP will be encompassed within the existing Oil Spill Response Plan)
- Husky's existing Ice Management Plan will be reviewed and revised as required to include the new WREP facilities (and supporting platform specific procedures will be developed if the WHP option is selected)
- Adherence to standard navigation procedures, Transport Canada regulations and CCG requirements.

**Change in Habitat Quality**

The potential effects of hydrocarbon spills on fish habitat quality (e.g., plankton, benthos), including contamination, are discussed in Section 8.5.1.3.

**Potential Mortality**

The effects of hydrocarbon spills on fish mortality are discussed in Section 8.5.1.3.

Potential environmental effects from an SBM release include smothering of individuals and food resources for fish and shellfish, sedimentation and contamination. The rate of biodegradation of these muds is driven by temperature, hydrostatic pressure and oxygen levels. Bioaccumulation of PAHs can occur; scallops have been found to be particularly sensitive to effects from drilling waste, even at low levels, and have demonstrated weight loss in somatic and reproductive tissue, although the effects were reversed once exposure ended (Cranford et al. 2005). SBMs are non-toxic, but it is likely such effects result from physical effects such as fine particles of bentonite and barite interfering with feeding and digestion. Released SBM cuttings would likely settle near the sediment-water interface and not be buried in sediment and consequently, those marine fauna (particularly sessile invertebrates) that are on the sediment surface would be most affected. Sessile organisms are likely to be smothered in areas where cuttings are greater than 1 cm thick (Bakke et al. 1989). Recruitment could also be reduced locally due to decreased habitat quality.

**Summary of Offshore Environmental Effects Assessment**

An accidental event in the offshore is predicted to be reversible and is not expected to cause an adverse effect on Fish and Fish Habitat resulting in a decrease in abundance or alteration in distribution of the population over more than one generation or so that natural recruitment would not reestablish the populations(s) to baseline conditions within several generations. Residual environmental effects on fish and fish habitat from offshore accidental events are therefore predicted to be not significant. The environmental effects resulting from an offshore accidental event and the mitigations to be implemented are summarized in Table 8-12.

### 8.5.3 Cumulative Environmental Effects

#### 8.5.3.1 Nearshore

Cumulative environmental effects on Fish and Fish Habitat in the Nearshore Study Area could occur as a result of the WREP activities in combination with anthropogenic activities in the past, present and future including industry and military use, commercial fisheries and marine traffic. These activities can cause disturbance of marine habitat, reduce marine populations, increase noise and contribute to contamination. Placentia Bay has several busy ports and is a centre of transport for the oil and gas industry.

The head of Placentia Bay has become essential to the oil and gas industry in Newfoundland because the bay is ice-free, it has the necessary infrastructure and facilities and has an existing skilled workforce. In addition to oil and gas, Placentia Bay has been used for mining, transport and military activities. Existing facilities include a transshipment terminal for crude oil at Whiffen Head, an oil refinery in Come By Chance, a large ferry terminal in Argentia, Marystown Shipyard, and the Cow Head Fabrication Facility. The Vale Newfoundland & Labrador Limited nickel processing plant in Long Harbour is in development. The Newfoundland and Labrador Refining Corporation (NLRC) is proposing to construct an oil refinery at Southern Head. There has been a proposal (currently suspended) for a liquefied natural gas (LNG) terminal near Grassy Point by Newfoundland LNG. Decommissioned or inactive facilities include a phosphorus plant in Long Harbour, a naval base in Argentia and mining sites in St. Lawrence.

The 1990 *Public Review on Tanker Safety and Marine Spills Response Capability* (Brander-Smith 1990) suggested Placentia Bay had the greatest risk of an oil spill in Canada. Prompted by this and environmental assessments, Transport Canada initiated an assessment of accidental spills along the south coast of Newfoundland in 2005 using quantitative modelling, as well as local knowledge, to identify risk and local concerns (BAE-Newplan Group Limited 2007). Risk analyses by Transport Canada and DFO found that the most probable area for a spill is inner Placentia Bay and likely in range of up to 1,590 $m^3$ (10,000 barrels) (SL Ross 2007) predicted to occur every 27 to 33 years (SL Ross 2007). They also note the risk of spill has decreased over time due to implementation of greater preventative measures.

**Table 8-12 Potential Environmental Effects Assessment Summary for Fish and Fish Habitat – Accidental Events**

| WREP Activity | Potential Positive (P) or Negative (N) Environmental Effect | Mitigation Measure | Evaluation Criteria for Assessing Environmental Effects (A) | | | | | | Significance Rating | Level of Confidence |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | Magnitude | Geographic Extent | Frequency | Duration | Reversibility | Ecological/Socio-cultural/Economic Significance | | |
| SBM whole mud spill | Change in habitat quality (N)<br>Potential mortality (N) | • Oil Spill Response Plan<br>• Use of best practices and continual improvement programs | L | 1 | 1 | 1 | R | 3 | NS | H |
| Marine vessel incident, including collision (i.e., diesel fuel spill) | Change in habitat quality (N)<br>Potential mortality (N) | • Oil Spill Response Plan<br>• Use of best practices and continual improvement programs | L | 2 | 1 | 1 | R | 3 | NS | M |
| Subsea hydrocarbon blowout | Change in habitat quality (N)<br>Potential mortality (N) | • Oil Spill Response Plan<br>• Use of best practices and continual improvement programs | H | 4 | 1 | 3 | R | 3 | NS | M |
| Hydrocarbon surface spill | Change in habitat quality (N)<br>Potential mortality (N) | • Oil Spill Response Plan<br>• Use of best practices and continual improvement programs | H | 4 | 1 | 3 | R | 3 | NS | M |
| Other spills (e.g., fuel, waste materials) | Change in habitat quality (N)<br>Potential mortality (N) | • Oil Spill Response Plan<br>• Use of best practices and continual improvement programs | L | 2 | 1 | 1 | R | 3 | NS | H |

Key:

**Magnitude:**
N = Negligible (essentially no effect)
L = Low: <10 percent of the population or habitat in the Study Area will be affected
M = Medium: 11 to 25 percent of the population or habitat in the Study Area will be affected
H = High: >25 percent of the population or habitat in the Study Area will be affected

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

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

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

**Reversibility** (population level):
R = Reversible
I = Irreversible

**Ecological/Socio-cultural/Economic Significance:**
1 = Relatively pristine area not affected by human activity
2 = Evidence of existing adverse activity
3 = High level of existing adverse activity

**Significance Rating:**
S = Significant
NS = Not Significant
P = Positive

**Level of Confidence:**
L = Low level of confidence
M = Medium level of confidence
H = High level of confidence

(A) Where there is more than one potential environmental effect, the evaluation criteria rating is assigned to the environmental effect with the greatest potential for harm

In 2004, total annual movement in Placentia Bay was 8,286 vessels, including 1,276 oil tankers, 62 chemical tankers, 522 cargo ships, 2,046 tug boats, 1,501 ferry movements and 1,589 fishing boats and other small vessels (under 20 m) (Transport Canada 2007). Marine traffic data collected by Transport Canada for the ports of Come by Chance, Whiffen Head, Marystown and Long Harbour from May 2011 to April 2012 (with November 2011 and March 2012 data missing) reported 1,756 commercial vessels entering ports in Placentia Bay (C. McDonald, Transport Canada, pers. comm.). However, Transport Canada does not track commercial shipping traffic into ports of Argentia, Arnold's Cove, Burin, Southern Harbour or North Harbour, and that value does not include ferry or fishing vessels. Marine Atlantic operates a car and passenger ferry from Argentia Harbour to North Sydney, Nova Scotia, from mid-June to end of September annually. For the 2012 season, there are 60 crossings scheduled to travel to or from Argentia. There is also recreational marine transportation in Placentia Bay, but data on recreational use of the Bay (e.g., by recreational fishers, boaters) are not available.

Cod is the most important species harvested in NAFO Unit Area 3PSc (Placentia Bay) (Section 9.3.2.2), accounting for just over half of the catch by weight between 2005 and 2010, followed by snow crab (16.3 percent) and herring (approximately 10 percent). The 10 top species, together, comprise more than 97 percent of the total quantity of the harvest in these years. The fisheries in Placentia Bay are conducted year-round, although in recent years, the overall catch has been much less evenly distributed throughout the year compared to a decade ago. Since the 3Psc ground fishery reopened in the mid-1990s, the peak harvesting months in terms of quantity of harvest have been June and July and this is still very much the case in 2012. This pattern is influenced by the cod fishing activities, which generally occur throughout all months except April. However, May and June are the two highest months by value, owing to the large harvest of high-value snow crab in May. For Atlantic cod, June and July accounted for more than 55 percent of the total cod catch during 2005 to 2010, but there is also a fairly strong fishery in the fall and early winter period, while the snow crab fisheries are concentrated in the May to July period. The herring fishery has a spring and late fall/winter component, with most taken in December. Lobster, following the open season for this species (typically mid- to late April to late June) in this area (Lobster Fishing Area 10), is strongly focused in those months. Capelin are harvested in June and July, although this species fishery usually takes place in a very short period (six to eight days) during the season.

WREP activities in the nearshore will include operation of support craft associated with construction and installation activities, including but not limited to heavy lift vessels, construction vessels, supply vessels, helicopters, tow vessels and barges. However, in comparison to existing vessel traffic in Placentia Bay, WREP vessels will represent a negligible incremental increase in shipping traffic. The cumulative environmental effects of the WREP on fish and fish habitat in the nearshore are predicted to be not significant.

#### 8.5.3.2 Offshore

In the Offshore Study Area, cumulative environmental effects on fish and fish habitat could occur as a result of the WREP in combination with past, present and future oil and gas activities, including the existing White Rose field (including North Amethyst), Terra Nova development, Hibernia oil development, Hibernia Southern Extension project, planned Hebron oil development, exploration seismic activity and exploration drilling

activities, which can contribute to physical disturbance, contamination, chronic pollution, smothering effects and increased noise. Commercial fisheries can adversely affect fish and fish habitat through physical disturbance (i.e., trawling), degradation of habitat, removal of biomass (both target and non-target species) and noise effects. Marine traffic contributes noise effects as well as chronic oil pollution. Wiese and Ryan (2003) report that due to the density of traffic off Newfoundland (i.e., between Europe and North America), the amount of persistent oil in the marine environment is very high along Newfoundland coastlines.

As of June 2012, there are a total of 284 wells on the North Grand Banks (C-NLOPB website), and proposed future activities in the Offshore Study Area include a seismic program in Jeanne d'Arc Basin by Western Geco Canada (2012 to 2015), a seismic program in Flemish Pass by Husky (2012 to 2020), the WREP activities described in this document and the Hebron project. The proposed Hebron project is 46 km southwest from White Rose. The project will be use a standalone gravity base structure (GBS). It will be designed to store 190,000 $m^3$ (1.2 million barrels) of crude oil, with an estimated production rate of 23,900 $m^3$/day oil. The oil will be offloaded to shuttle tankers via an offshore loading system similar to that used at Hibernia.

Existing oil and gas activities in the offshore include those occurring in the White Rose field, Hibernia oil field and Terra Nova oil field, as detailed in Table 5.4 (Chapter 5), and summarized here. The Hibernia oil field is approximately 50 km northwest of the *SeaRose FPSO*. Hibernia includes a GBS with storage capacity for 1.3 million barrels of oil and has been in production since November 1997. Activities in the Hibernia oil field include drilling and production, three support and stand-by vessels, and three shuttle tankers that transport the crude oil to Whiffen Head (Placentia Bay) or direct to market. The Hibernia South Extension Project is located approximately 6 km from Hibernia and may include up to six drill centres (each with up to 11 wells) that will be connected to the existing Hibernia GBS.

The Terra Nova oil field is located approximately 50 km southwest of the *SeaRose FPSO*, and has been in production since January 2002. Terra Nova uses an FPSO facility capable of storing up to 960,000 barrels of oil. The Terra Nova development includes four drill centres, and a total of 34 wellbores and sidetracks have been drilled to date: 14 development wells in the Graben area; 11 development wells in the East Flank; and one extended reach producer and extended reach water injection well in the Far East Central area. Two shuttle tankers and two to four support vessels are associated with the Terra Nova development.

The WREP will be located in the White Rose field. Existing operations use the *SeaRose FPSO*, with four existing drill centres (Northern, Central, Southern and North Amethyst) and one drill centre under excavation/installation (South White Rose extension) and subsea flowlines tied-back to the *SeaRose FPSO*. There are a total of 30 existing wells at the White Rose field. There are three shuttle tankers and four to six supply vessels that provide support services in the ice-free season, and an additional five supply vessels may be in service during the ice season. Husky is proposing to develop up to two additional drill centres within the White Rose field.

There is a potential cumulative environmental effect from the WBM discharge when considered together with other drilling projects. While it is acknowledged that each production or exploration well is contributing to a cumulative environmental effect on

marine fish habitat, each of these projects is affecting a localized area and the environmental effects are reversible. All routine discharges from WREP activities will be in accordance with the OWTG (NEB et al. 2010) and related monitoring requirements.

Routine activities associated with marine transportation contribute to underwater noise and may affect Fish and Fish Habitat. However, the contribution of a small number of vessels in association with the WREP is not expected to considerably increase the amount of ambient noise.

Commercial fishing on the Grand Banks and Flemish Cap is considerable, though the WREP Offshore Project Area does not overlap with any major fishing areas. Important commercial fisheries in NAFO Division 3L are primarily snow crab and shrimp at this time. Although commercial fisheries can have an environmental effect on Fish and Fish Habitat through resource extraction, disturbance, degradation of habitat, pollution and noise, the current level of commercial exploitation within the Offshore Project Area is very limited and DFO manages commercial fisheries to keep populations at sustainable levels.

WREP activities will represent a negligible incremental increase to the overall cumulative environmental effects to Fish and Fish Habitat in the Offshore, as the effect on the seafloor will be localized, of short duration and unlikely to overlap in space with other activities. The cumulative environmental effects of the WREP on Fish and Fish Habitat are predicted to be not significant.

### 8.5.4 Determination of Significance

The determination of significance is based on the definition provided in Chapter 5 and the criteria described in Section 8.2. It considers the magnitude, geographic extent, duration, frequency, reversibility and ecological context of each environmental effect within the Nearshore and Offshore Study Areas and their interactions. Significance is determined at the population level within the Nearshore and Offshore Study Areas.

The significance of potential residual environmental effects, including cumulative environmental effects, resulting from the interaction between WREP-related activities and fish and fish habitat, after taking into account any proposed mitigation, is summarized in Table 8-13.

The potential residual adverse environmental effects of the WREP on Fish and Fish Habitat are not considered of sufficient geographic extent, magnitude, duration, frequency and/or irreversibility to result in a decline in abundance or change in distribution of a population(s) over more than one generation within the Nearshore and/or Offshore Study Areas. Any potential residual adverse environmental effects of the WREP on Fish and Fish Habitat will be mitigated. The potential residual adverse environmental effects of the WREP on Fish and Fish Habitat are therefore predicted to be not significant.

**Table 8-13 Significance Ratings for Potential Residual Environmental Effects of White Rose Extension Project Activities on Fish and Fish Habitat**

| Phase | Residual Adverse Environmental Effect Rating (A) | Level of Confidence | Probability of Occurrence (Likelihood) |
|---|---|---|---|
| Construction/Installation | NS | H | N/A (B) |
| Operation and Maintenance | NS | H | N/A |
| Decommissioning and Abandonment | NS | H | N/A |
| Accidental Events | NS | M | N/A |
| Cumulative Environmental Effects | NS | H | N/A |

KEY

| Residual Environmental Effects Rating: | Level of Confidence in the Effect Rating: | Probability of Occurrence of Significant Environmental Effect: |
|---|---|---|
| S = Significant Adverse Environmental Effect | L = Low level of Confidence | L = Low Probability of Occurrence |
| NS = Not Significant Adverse Environmental Effect | M = Medium Level of Confidence | M = Medium Probability of Occurrence |
| P = Positive Environmental Effect | H = High level of Confidence | H = High Probability of Occurrence |

N/A – Not Applicable

(A) As determined in consideration of established residual environmental effects rating criteria

(B) Effect is not predicted to be significant, therefore the probability of occurrence rating is not required under CEAA

### 8.5.5 Follow-up and Monitoring

Husky's existing EEM program will be re-designed to incorporate the WREP once it is installed in the Offshore Project Area. This program will consider marine fish and fish habitat that may be affected by WREP activities. The parameters of the existing EEM program includes sediment chemistry, sediment toxicity, benthic invertebrate communities, water chemistry, fish and shellfish body burden and taint and fish health.

A fish habitat compensation agreement (Authorization No. 07-01-002) has been in place with DFO since 2007 to compensate for the excavation of up to five subsea drill centre sites, of which only two have been excavated to date (the NADC and SWRX). The construction of a subsea drill centre for the West White Rose pool was one of the potential subsea drill centres assessed and compensated for in 2007. Husky will discuss the requirements of an amendment to that authorization with DFO, resulting from the WREP.

As per requirements under its existing fish habitat compensation approval (Authorization No. 07-01-002), Husky will continue to conduct the fish habitat compensation monitoring program in North Harbour. The requirements for further fish habitat compensation and monitoring will be discussed with DFO in light of changes to the *Fisheries Act*.

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# 9.0 Fisheries

Fisheries were selected as a VEC because of their economic and historical importance in both the Nearshore and Offshore Study Areas. Offshore, these are commercial wild fisheries harvested largely by Canadian registered enterprises inside Canada's Exclusive Economic Zone and by both Canadian and non-Canadian vessels outside the Exclusive Economic Zone.

Within Placentia Bay, in the Nearshore area, the fisheries are primarily commercial wild harvesting but also include a more limited amount of commercial aquaculture and a small amount of recreational fisheries. There are no known aboriginal fisheries in these areas that are not part of the commercial harvesting.

Fishing activities considered include all those conducted in order to generate fishing income, including deploying, setting and/or accessing gear on fishing grounds, retrieving/hauling the gear to harvest the fish and getting the catch back to port where they can be sold.

## 9.1 Environmental Assessment Boundaries

This section describes the spatial and temporal boundaries used for the assessment of potential effects on fisheries.

### 9.1.1 Spatial

The spatial boundaries described below have been defined based on potential WREP interactions, modelling results and a consideration of VEC-specific boundaries, in accordance with the CEA Agency Operational Statement (2003b). In accordance with the Scoping Document, the following spatial boundaries have been used in this environmental assessment. The nearshore boundaries (see Figure 9-1) apply to the WHP development option only; the offshore boundaries (see Figure 9-2) will apply for either development option.

#### 9.1.1.1 Nearshore

The Nearshore Project Area is an area encompassing the on-land and marine area within Port of Argentia Harbour and the two potential deep-water sites, where topsides-CGS mating will occur. This area includes all WREP traffic routes between the alternative deep-water mating sites, except for vessels into and out of Placentia Bay, which will follow the existing Vessel Traffic Separation Scheme (VTSS) routes in the bay (see Figure 9-1).

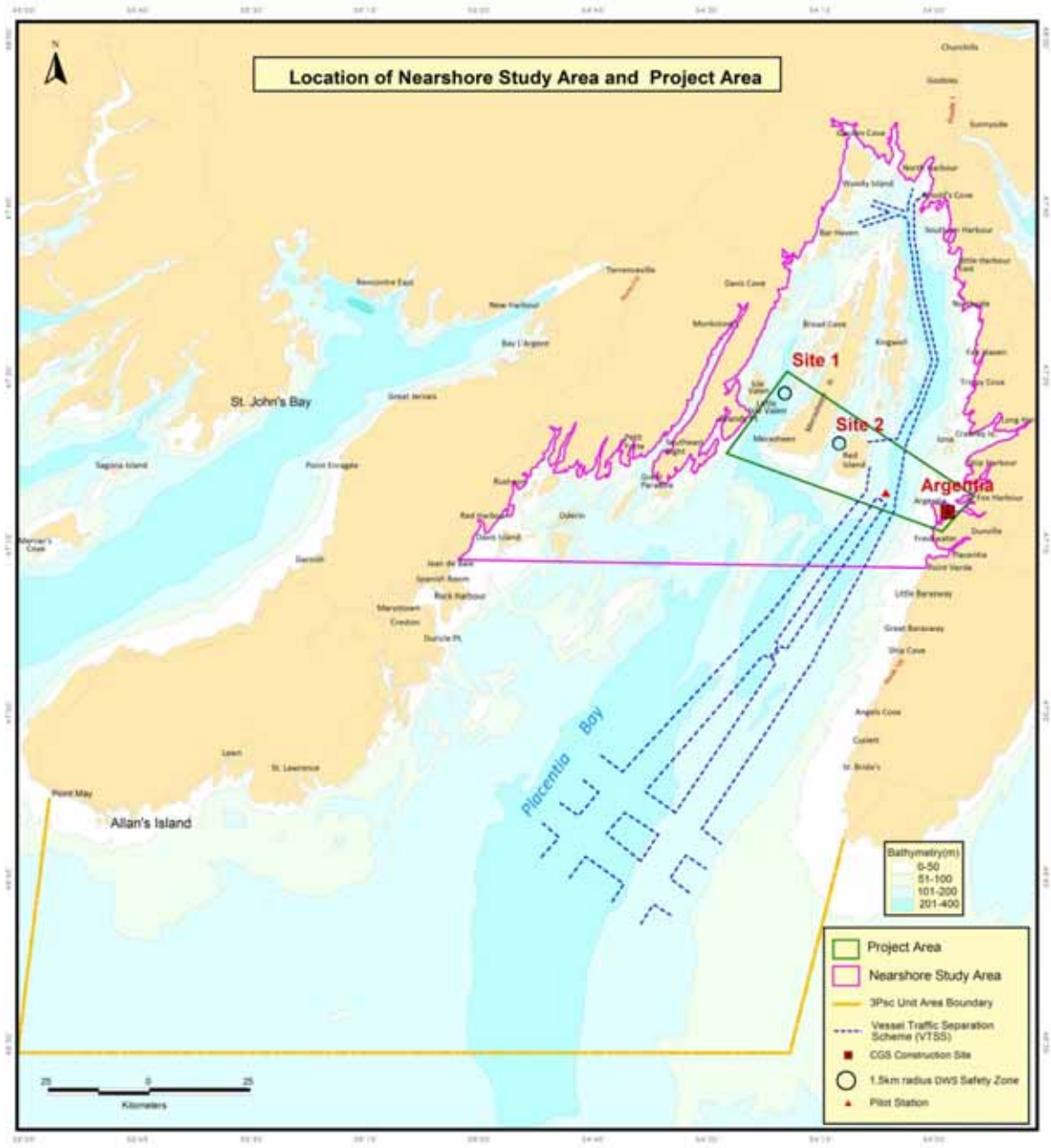



**Figure 9-1 Unit Area 3Psc, Nearshore Study Area, Project Area, Potential Deep-water Site Safety Zones and Placentia Bay Vessel Traffic Separation Scheme**

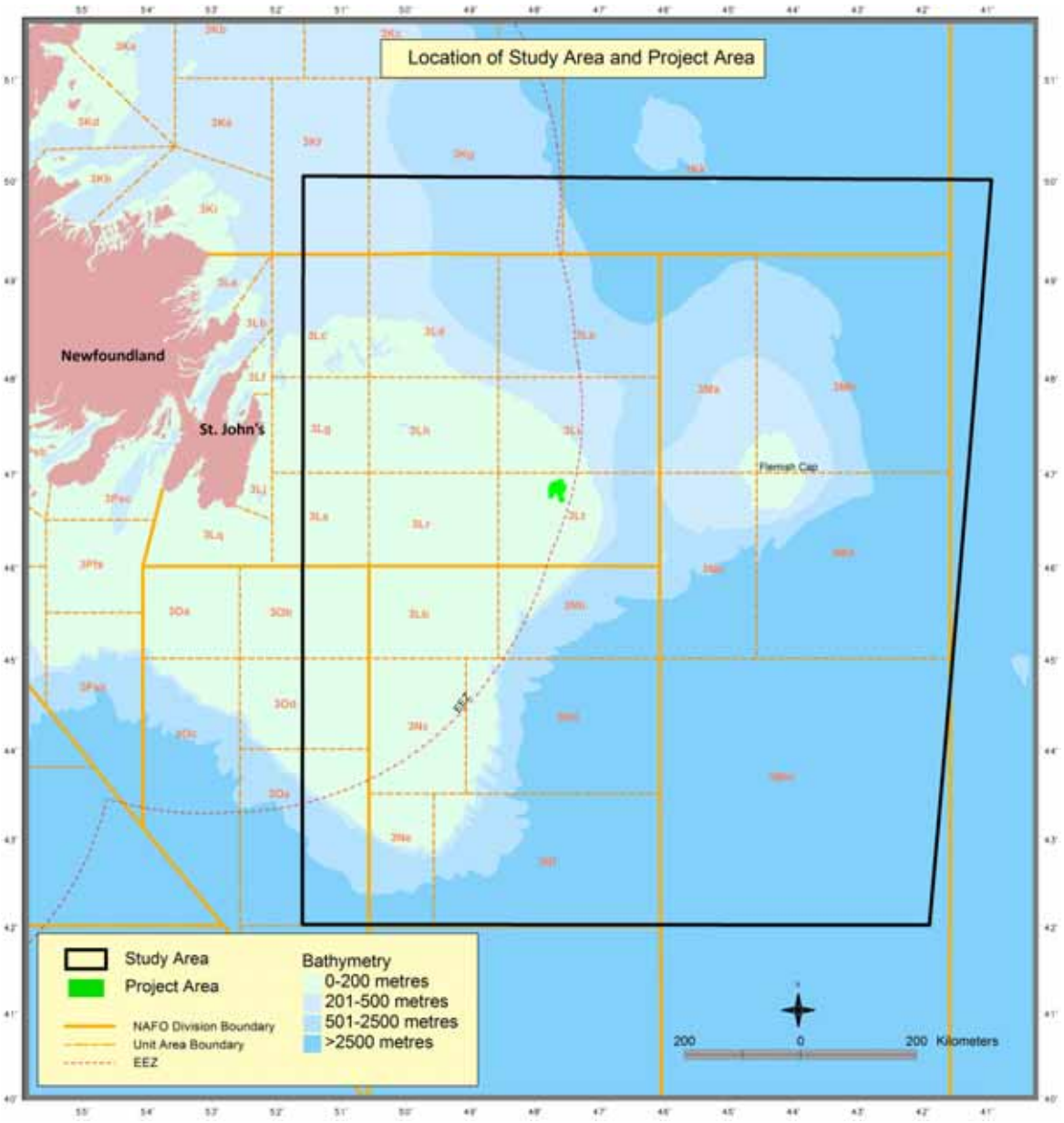



**Figure 9-2 Offshore Study Area, Project Area and Fishing Zones**

The nearshore Affected Area are those areas where fishing-related activities could be affected, depending on which of the two potential deep-water mating sites within the Nearshore Project Area is selected. Around the selected deep-water mating site, a safety zone will be established in compliance with regulations and in consultation with stakeholders, and within which most other potential effects will be contained. Affected areas outside the safety zone will be WREP vessel traffic routes to and from Argentia, and to and from the deep-water mating site (including the route taken by the ship transporting the topsides module for mating with the CGS), and the completed WHP tow-out route through Placentia Bay. The Affected Area in case of an accident, such as a fuel spill from a WREP vessel, will depend on many factors such as the amount of the

spill, prevailing sea and wind conditions, the duration of the spill and the success of emergency response measures.

The Nearshore Study Area (see Figure 9-1) has been defined by modelling WREP-environment interactions, such as accidental events, noise and sedimentation from dredging. This is the area within which significance will be determined for nearshore activities and it represents a compilation of the various nearshore Affected Areas for all WREP works, activities and accidental events.

#### 9.1.1.2 Offshore

The Offshore Project Area is the marine area within which all offshore WREP works and activities are to occur (as defined in Chapter 2). The Offshore Project Area is defined by the existing White Rose field (see Figure 9-2).

The offshore Affected Area is, with the exception of vessel traffic to and from ports (including the route that will be used during the tow-out of the WHP from Placentia Bay), the area within which all planned activities during the installation, operations and maintenance and the decommissioning phases will be contained (within the existing White Rose safety zone, established in accordance with Transport Canada requirements, and fully within the Offshore Project Area. As with current operations, vessel traffic to and from the White Rose field will operate within established shipping corridors between St. John's and the Offshore Project Area. The existing safety zone in the White Rose field is not expected to change as a result of the WREP. The Affected Area in case of an accident, such as a spill from drilling, production or vessel, will depend on many factors such as the amount of the spill, prevailing sea and wind conditions, the duration of the spill and the success of emergency response measures.

The Offshore Study Area (see Figure 9-2) has been defined by modelling WREP environment interactions, such as accidental events and emissions and discharges, and considers all phases of the WREP. This is the area within which significance will be determined for offshore activities and it represents a compilation of the various offshore Affected Areas for all WREP works, activities and accidental events.

### 9.1.2 Temporal

The temporal boundaries for the assessment are defined in Chapter 5 and outlined in Table 9-1.

**Table 9-1 Temporal Boundaries of Nearshore and Offshore Study Areas**

| Study Area | Temporal Boundary |
|---|---|
| **Nearshore** | • In the case of the WHP development option, site preparation, graving dock construction, construction of CGS, dredging, topsides mating and tow-out will occur over an estimated 30 to 38 months from 2013 to 2016. Some activity will occur at all times of year until completion.<br>• In the case of the subsea drill centre development option, no nearshore activities will occur |
| **Offshore** | • In the case of the WHP development option, site preparation, installation of the WHP and initial production/maintenance will occur from 2016 to 2017. The WHP will be decommissioned and abandoned in accordance with standard practices at the end of its production life, which is anticipated to be 25 years<br>• The subsea drill centre option is scheduled to begin construction in 2014, with first oil expected in 2015. Under this option, the wells will be plugged and abandoned at the end of its production life (anticipated to be 20 years), and the subsea infrastructure removed or abandoned in accordance with relevant regulations |

### 9.1.3 Administrative Boundaries

Administrative boundaries for the fisheries are boundaries associated with resource management. For the nearshore area, this is fisheries Unit Area (UA) 3Psc (Placentia Bay), which contains both the Nearshore Study Area and Project Area (see Figure 9-1). The Offshore Study Area includes most of Northwest Atlantic Fisheries Organization (NAFO) Divisions 3L, 3M and 3N (3LMN), and much smaller portions of Divisions 3O and 3K. The Offshore Project Area is located within UA 3Lt. (see Figure 9-2). The Newfoundland and Labrador Department of Fisheries and Aquaculture (NLDFA) manages aquaculture, emerging fisheries and developing fishery projects within the territorial seas (22 km (12 nm)).

## 9.2 Definition of Significance

For the fisheries, a significant adverse residual environmental effect is one that has a measurable and sustained adverse effect on commercial fishing incomes, or on opportunities for recreational fishing activity.

## 9.3 Existing Environment

### 9.3.1 Information Sources

The descriptions of both the Nearshore and Offshore Study and Project Area environments in this chapter are based in part on data derived from DFO time series catch and effort datasets for the period 1990 to 2010, the latest available year for reliable data. However, much of the description is based on data for more recent years (2005 to 2010) since the fisheries have changed substantially since the 1990s (DFO 2012c). These data represent all catch reported as landed within Atlantic Canada (Newfoundland and Labrador, Scotia-Fundy, Gulf and Quebec Regions). While all the data indicate the fisheries management UA in which the harvest occurred, a portion of the catch is

specifically geo-referenced by latitude and longitude, which allows plotting of past harvesting locations[1] to indicate fishing activities in relation to WREP activities and structures. These fishing locations are shown on the maps in this chapter as dark blue points. The points are not "weighted" by quantity of harvest, but show where fishing effort was recorded.

In the offshore areas, almost all of the catch is consistently geo-referenced. Between 2005 and 2010, an average of 98.5 percent of the harvest by quantity was geo-referenced in UA 3Lt, where the Offshore Project Area is located. This allows a reliable picture of gear deployment and/or fishing effort can be presented. In the Nearshore Study Area (i.e., UA 3Psc), a much smaller proportion of the total data is geo-referenced (an average of 27.2 percent of the harvest by quantity, ranging from approximately 13 percent in 2005 to 47 percent in 2010). In this area, some species catches are more consistently geo-referenced than others. For example, UA 3Psc snow crab catches were 94 percent geo-referenced in 2010, while just 15 percent of groundfish and 0 percent of the lobster were geo-referenced.

In the commercial fisheries tables and graphs based on the DFO datasets, the weight of the harvest (in tonnes) and the value of the harvest (in Canadian dollars) are provided. However, for indicating activity and absolute or relative abundance, quantities are the more useful measure and are directly comparable from month to month and year to year. Values (for the same quantity of harvest) may vary annually with species, negotiated prices, changes in exchange rates and fluctuating market conditions. The values used in this section are taken directly from the DFO datasets and are not corrected to current dollars.

#### 9.3.1.1 Nearshore Sources

Since the geo-referenced data are less comprehensive for the Nearshore Project Area, the descriptions of existing conditions also use 3Psc (Nearshore Study Area) UA-level data as well to provide a more comprehensive analysis of potential effects. The UA 3Psc dataset captures species harvested from 3PSc wherever they were landed or processed. Thus, catches by fishers who are not based in Placentia Bay are included, while catches made by Placentia Bay-based vessels are excluded if they were harvested beyond the 3Psc area. For example, some of the larger (greater than 35') vessels based in the area take a portion of their annual catch on fishing grounds farther offshore, such as St. Pierre Bank, whereas catches by fishers based in other areas of the province (e.g., in Fortune Bay), are included in the analysis since they are taken within 3Psc.

As noted above, the DFO geo-referenced catch statistics do not provide a complete picture of the location and distribution of established and current species harvesting activities in 3Psc, or within the Nearshore Project Area. As such, given the requirement for more "site-specific" information on fisheries operations in and near those sites, the DFO catch and effort data has been supplemented with information obtained from fisher representatives attending consultation meetings and also through telephone interviews

[1] The coordinates given are those recorded in the vessel's fishing log, and is reported in the database by degree and minute of latitude and longitude; thus the position is accurate within approximately 925 m (0.5 nm) of the reported coordinates. It should be noted that 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.

with knowledgeable local fishers. DFO managers familiar with the Placentia Bay fisheries environment have also contributed their insights. Information from these sources has been used to provide a more detailed description of current harvesting activities, gear locations and vessel operations at a very localized, site-specific level. Data on aquaculture were provided by the NLDFA.

A summary of issues and concerns raised by fish harvesters and Fish, Food and Allied Workers (FFAW) representatives at meetings in the Nearshore Study Area on 14 and 15 June, 2012, is provided in Section 6.2.1.2. A list of all persons consulted for this report is provided in Appendix A.

#### 9.3.1.2 Offshore Sources

While the DFO datasets capture all reported Canadian and Canada-landed catches, catches by foreign enterprises landed outside these areas are not included. For foreign fisheries, primarily outside the Exclusive Economic Zone boundary, the NAFO STATLANT 21B dataset for 2000 to 2010 are used (NAFO 2012). These datasets capture NAFO-managed harvests by Canadian fishers and non-Canadian NAFO states at the fisheries management Division level within the NAFO Convention Area. As described above (Section 9.1.3), the Offshore Study Area includes most of NAFO Divisions 3LMN and some of Divisions 3O and 3K. The NAFO STATLANT data are presented in tonnes.

Other sources consulted for the offshore description include DFO species management plans, quota reports, other research reports and studies, and consultations with scientists, managers and fishing interests. Additional information was obtained during consultations with offshore fishers, which is described in Section 6.2.2.

### 9.3.2 Nearshore Environment

This section provides a general overview and description of commercial fisheries activities in Placentia Bay and in the Nearshore Project Area. For the purpose of this baseline analysis, the area examined is all of Placentia Bay, which is encompassed by UA 3Psc. This administrative area is shown in Figure 9-1 and subsequent maps.

Section 9.3.2.1 provides a general discussion of Placentia Bay's recent commercial wild fisheries, including a description of key species harvested, catch patterns and locations, gear types and seasonality and the distribution of enterprises, vessel and species licences by homeport and species harvesting locations. Current (2011-2012) harvesting activities within the three Nearshore Project Area sites are described in more detail in Section 9.3.2.2. Aquaculture operations and sites are discussed in Section 9.3.2.8.

#### 9.3.2.1 Historical Overview of Regional Fisheries (Placentia Bay)

Beginning in 1992, an Atlantic cod harvesting moratorium was declared and directed fisheries for that species was no longer permitted in most areas. The collapse of this mainstay fishery led to drastic changes in most of Atlantic Canada, as effort shifted to other species, especially crustaceans such as snow crab and northern shrimp. NAFO Divisions 3Ps and 3Pn have been exceptions during the moratorium, and are now the only remaining Grand Banks areas with a directed (though reduced) Atlantic cod fishery.

However, harvesting activities in 3Ps (including Placentia Bay) were affected by the moratoria. For example, within UA 3Psc for the period 1984 to 1990, 74 percent of the catch by quantity was cod while snow crab made up just 3 percent; during 1994-1995, immediately after the cod moratorium was imposed, cod made up only 6 percent of the harvest while snow crab catches increased to 24 percent. In terms of value, cod accounted for nearly 60 percent of the value of the 3Psc harvest (1984 to 1992), but only a negligible amount in 1994-1995. A limited cod fishery was reinstated in 3PSc in 1997 under a strict management regime, and during 2000 to 2002, cod again accounted for nearly 60 percent of the harvest by quantity, though in more recent years quotas have been reduced once more.

Between the 1986 and the 1995 harvest, the total biomass taken from Placentia Bay declined from more than 17,000 tonnes to under 2,000 tonnes, a drop of nearly 90 percent. However, the landed value of the 3PSc fishery did not experience a similar decline, owing primarily to high-priced species such as lobster, snow crab and lumpfish roe. In that year, the value of the fishery was only 8 percent lower than in 1986 in current dollars (approximately $9,740,000 vs. $10,634,000). Value continued to rise after 1995 until, by 2002 the harvest from 3PSc was worth more than $18 million, nearly 180 percent of the value of the harvest in 1986. Even with weaker prices in some recent years, snow crab is still a very valuable species in this area, as further discussed below. During 2005 to 2010, the annual average value of the catch in 3Psc was $10.4 million.

Since the mid-1990s, the fisheries, fisheries management and licencing regimes in Placentia Bay have continued to evolve. Most importantly, a fish harvesting rationalization strategy was implemented in the province that reduced the number of participants in the harvesting sector, and a professionalization process was introduced that prescribed specific levels of experience and training required to be a professional fish harvester. Along with this system, DFO introduced the "core" harvesting enterprise designation, with restrictions on harvesting by those who are not part of such an enterprise.

#### 9.3.2.2 Current Placentia Bay Fisheries

The composition of the harvest from 3Psc during the period 2005 to 2010, by weight and value, is provided in Table 9-2.

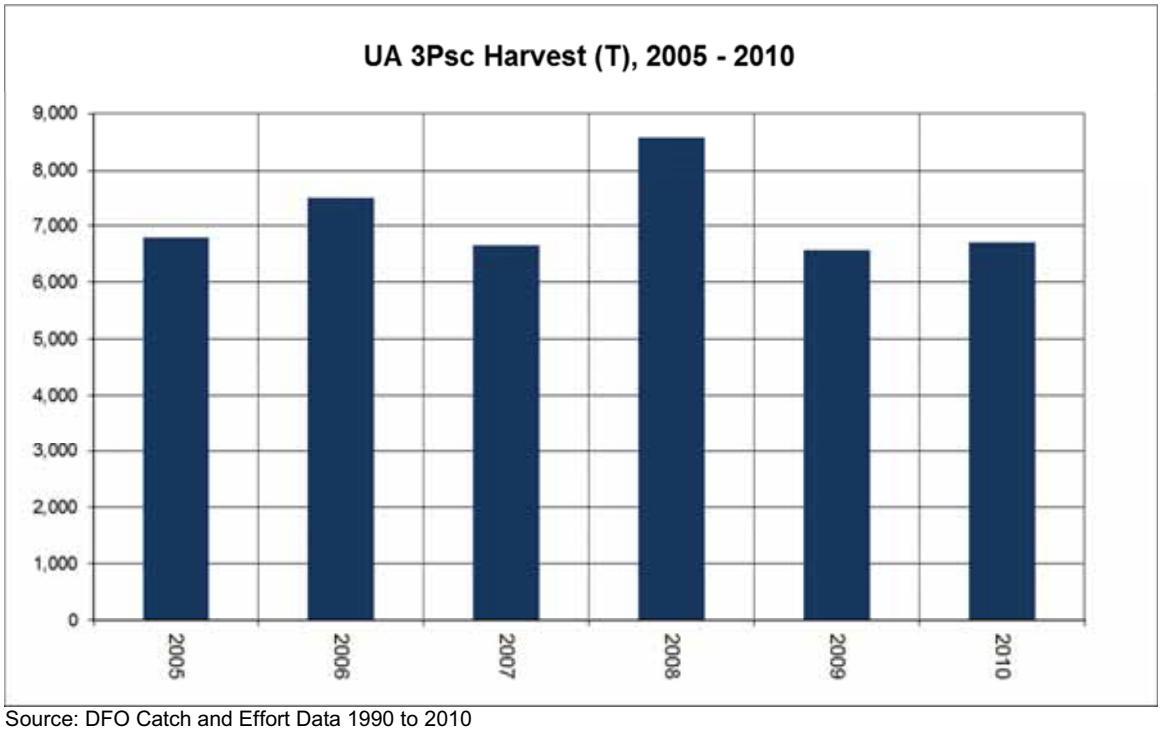
As these data show, cod is by far the most important species harvested in the area, accounting for just over half of the catch by weight, followed by snow crab (16.3 percent) and herring (approximately 10 percent). Although snow crab comprised only 16 percent of the overall quantity of harvest, given its high product value it accounted for over 35 percent of the landed value during 2005 to 2010. The 10 top species, together, comprise more than 97 percent of the total quantity of the harvest in these years. In terms of value, cod and snow crab together made up nearly 80 percent of the average annual value.

**Table 9-2 Unit Area 3Psc by Species, 2005 to 2010 Annual Average Harvest, Quantity and Value**

| Species | Tonnes | % of Total by T | S | % of Total by $ |
|---|---|---|---|---|
| Cod | 3,603 | 50.5% | 4,589,606 | 44.2% |
| Snow Crab | 1,165 | 16.3% | 3,668,858 | 35.3% |
| Herring | 711 | 10.0% | 143,877 | 1.4% |
| Sea Cucumber | 366 | 5.1% | 224,839 | 2.2% |
| Whelks | 342 | 4.8% | 347,563 | 3.3% |
| Capelin | 190 | 2.7% | 49,327 | 0.5% |
| Lumpfish (roe) | 162 | 2.3% | 469,050 | 4.5% |
| Mackerel | 147 | 2.1% | 45,498 | 0.4% |
| American Plaice | 141 | 2.0% | 94,133 | 0.9% |
| Winter Flounder | 98 | 1.4% | 45,051 | 0.4% |
| Lobster | 55 | 0.8% | 536,520 | 5.2% |
| Skate | 47 | 0.7% | 13,771 | 0.1% |
| Sea Scallops | 45 | 0.6% | 80,360 | 0.8% |
| All Other Species | 17 | 0.2% | 22,765 | 0.2% |
| Sea Urchins | 14 | 0.2% | 19,188 | 0.2% |
| Icelandic Scallops | 13 | 0.2% | 19,050 | 0.2% |
| Redfish | 9 | 0.1% | 5,076 | 0.0% |
| Pollock | 5 | 0.1% | 2,489 | 0.0% |
| Monkfish | 4 | 0.1% | 4,444 | 0.0% |
| Total | 7,132 | 100.0% | 10,381,464 | 100.0% |
| Source: DFO Catch and Effort Data 2005 to 2010 | | | | |

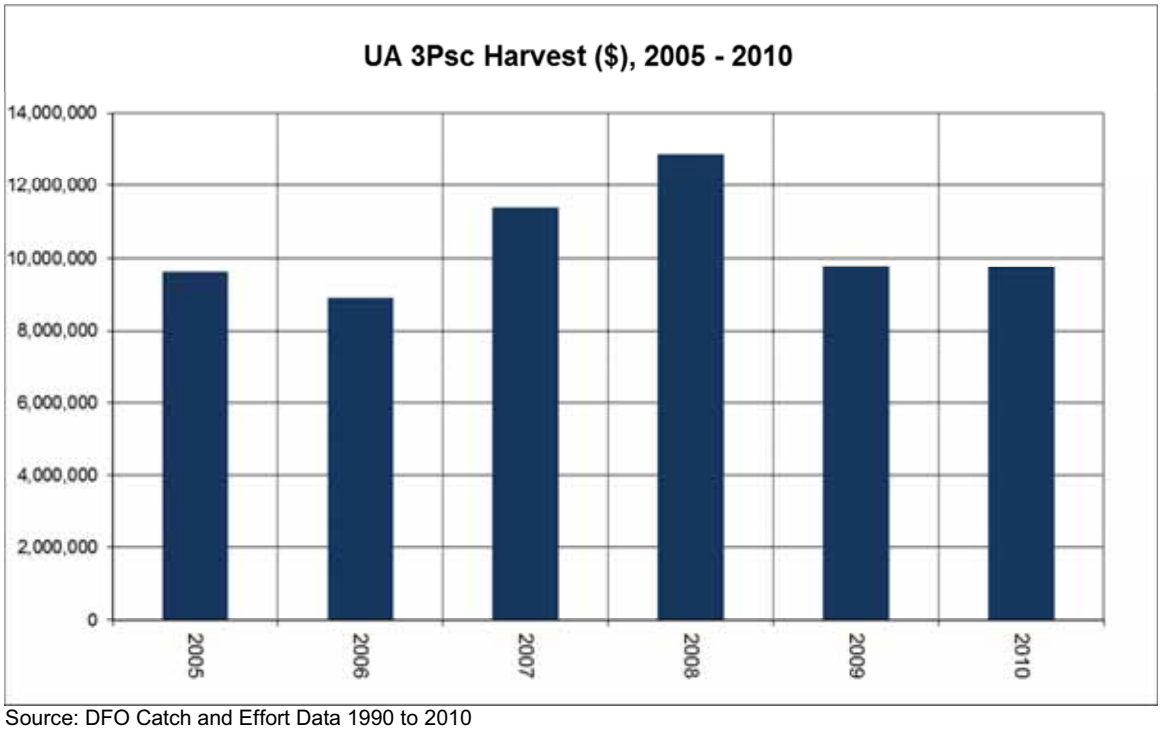
Although the herring fishery is important (especially as bait), it does not have the same economic value as the other key species fisheries. While lobster accounts for only a small percentage by weight of the overall 2005 to 2010 catch (less than 1 percent), given its consistently high value, this species remains very important to many area fishers (just over 5 percent of the total catch value).

The quantity and value of the 3Psc fisheries by year from 2005 to 2010 are plotted in Figures 9-3 and 9-4. As they indicate, the area's annual catch was relatively consistent during the six year period, with the peak occurring in 2008 with a total catch of almost 8,600 tonnes and nearly $12,900,000 in value.




Source: DFO Catch and Effort Data 1990 to 2010

**Figure 9-3 Quantity of Harvest by Year, Unit Area 3Psc, 2005 to 2010**

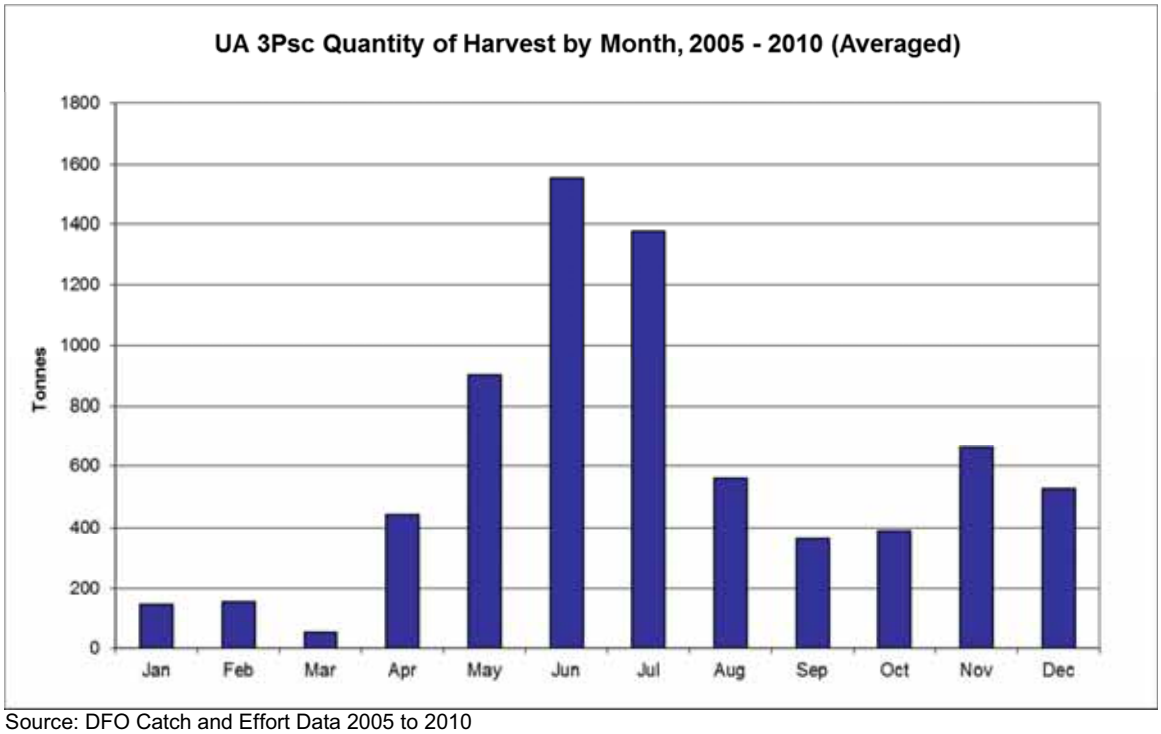



Source: DFO Catch and Effort Data 1990 to 2010

**Figure 9-4 Value of Harvest by Year, Unit Area 3Psc, 2005 to 2010**

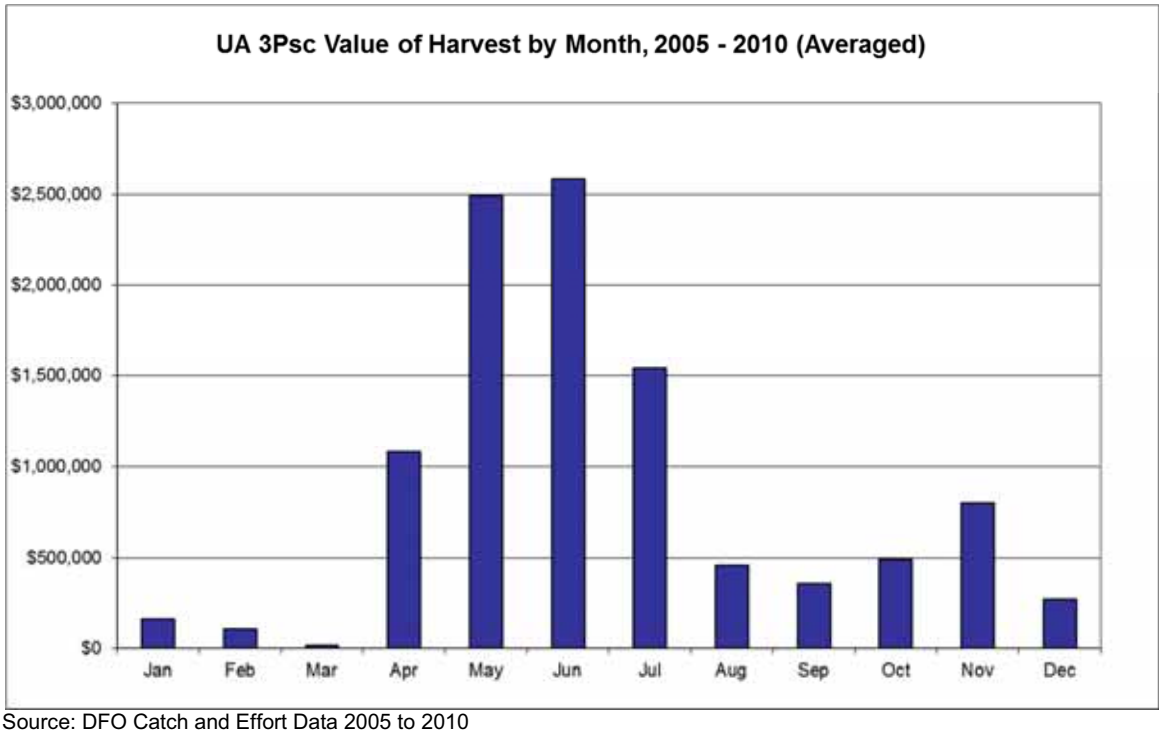
### 9.3.2.3 Timing of Harvest

The fisheries in Placentia Bay are conducted year-round (see Figures 9-5 and 9-6), although in recent years the overall catch has been much less evenly distributed throughout the year compared to a decade ago. Since the 3Psc ground fishery reopened in the mid-1990s, the peak harvesting months in terms of quantity of harvest have been June and July and this is still very much the case in 2012. This pattern is influenced by the cod fishing activities, which generally occur throughout all months except April. However, May and June are the two highest months by value, owing to the large harvest of high-value snow crab in May.




Source: DFO Catch and Effort Data 2005 to 2010

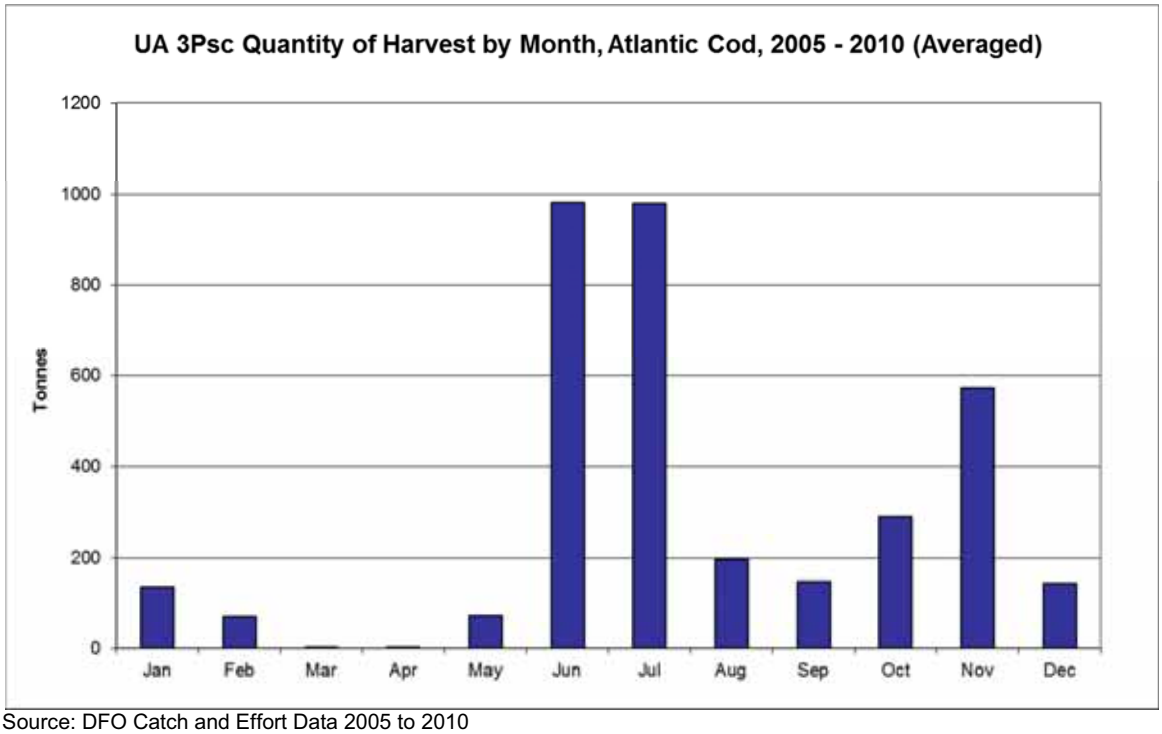
**Figure 9-5 Unit Area 3Psc Quantity of Harvest by Month, All Species, 2005 to 2010 Average**




Source: DFO Catch and Effort Data 2005 to 2010

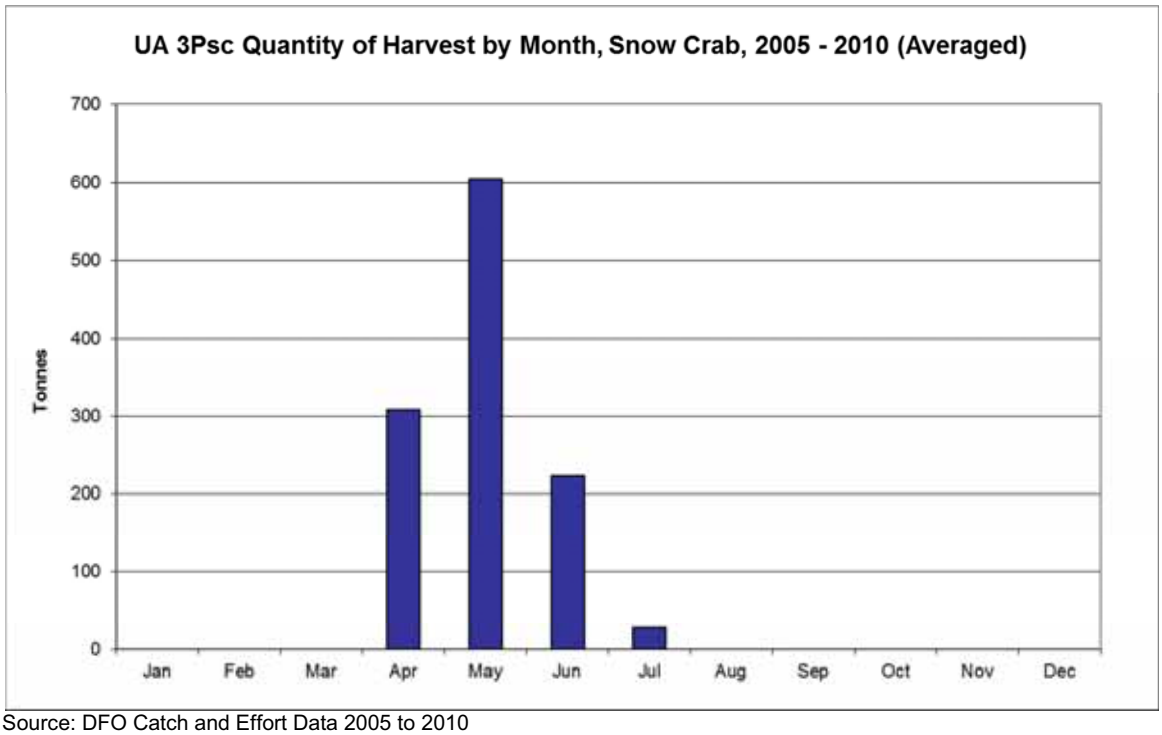
**Figure 9-6 Unit Area 3Psc Value of Harvest by Month, All Species, 2005 to 2010 Average**

Average quantity of landings for the more important commercial species in 3Psc are shown in Figures 9-7 to 9-11. For Atlantic cod, June and July accounted for more than 55 percent of the total cod catch during 2005 to 2010, but there is also a fairly strong fishery in the fall and early winter period, while the snow crab fisheries are concentrated in the May to July period. The herring fishery has a spring and late fall/winter component, with most taken in December. Lobster, following the open season for this species (typically mid- to late April to late June) in this area (Lobster Fishing Area 10), is strongly focused in those months. Capelin are harvested in June and July, although this species fishery usually takes place in a very short period (six to eight days) during the season.



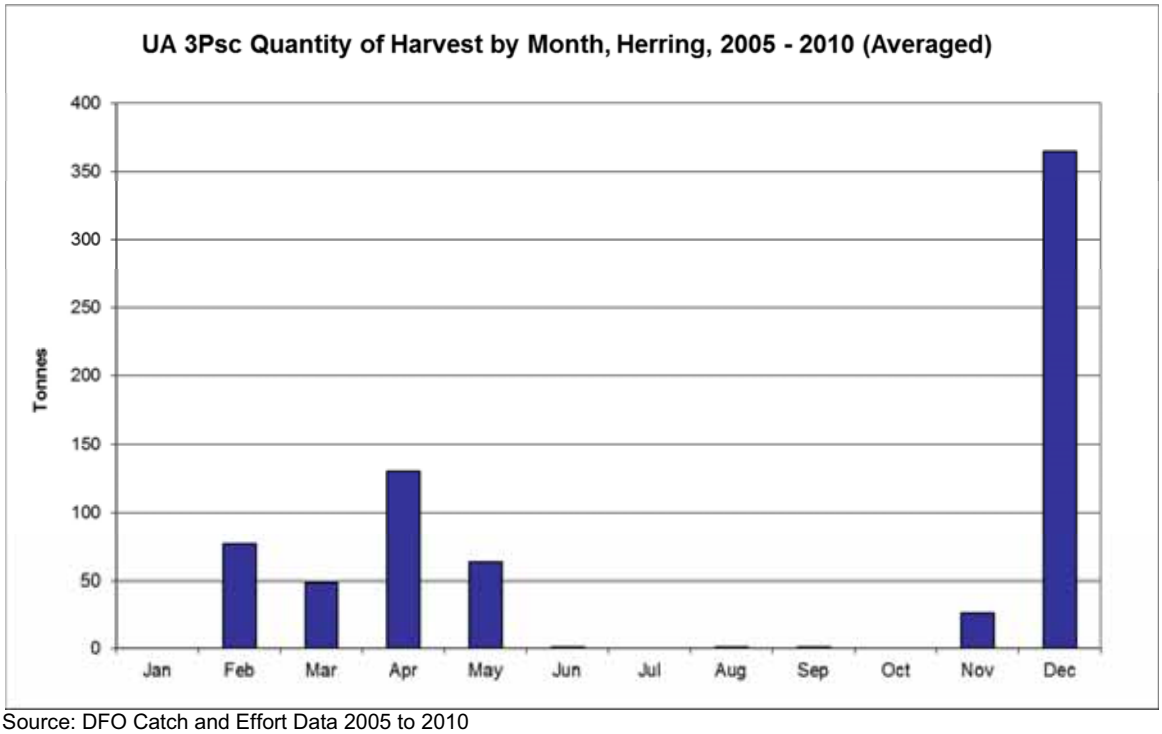

Source: DFO Catch and Effort Data 2005 to 2010

**Figure 9-7 Unit Area 3Psc Quantity of Harvest by Month, Atlantic Cod, 2005 to 2010 Average**



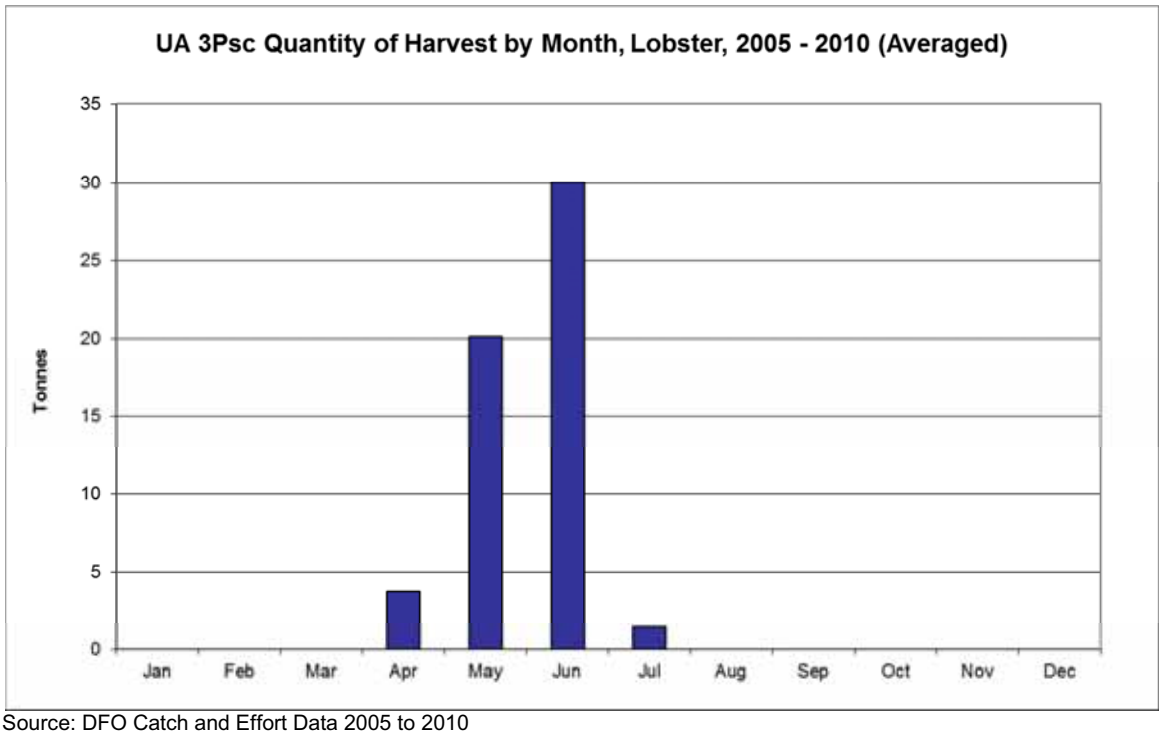

Source: DFO Catch and Effort Data 2005 to 2010

**Figure 9-8 Unit Area 3Psc Quantity of Harvest by Month, Snow Crab, 2005 to 2010 Average**



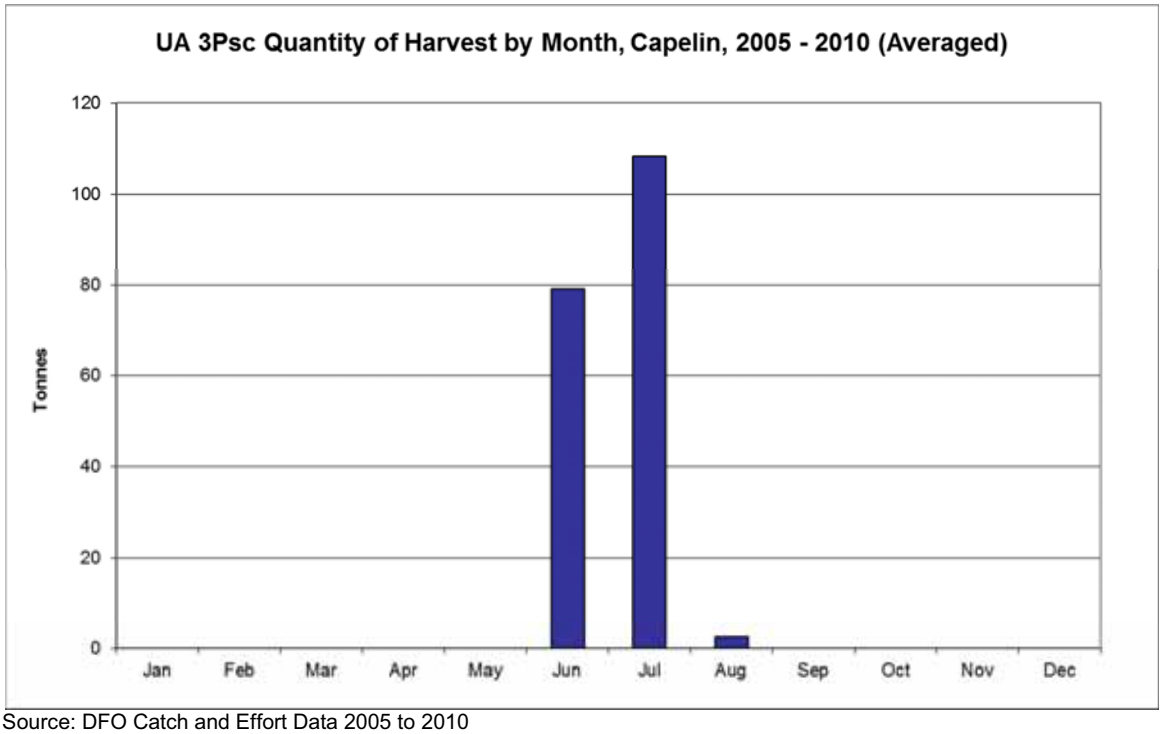

Source: DFO Catch and Effort Data 2005 to 2010

**Figure 9-9 Unit Area 3Psc Quantity of Harvest by Month, Herring, 2005 to 2010 Average**




Source: DFO Catch and Effort Data 2005 to 2010

**Figure 9-10 Unit Area 3Psc Quantity of Harvest by Month, Lobster, 2005 to 2010 Average**



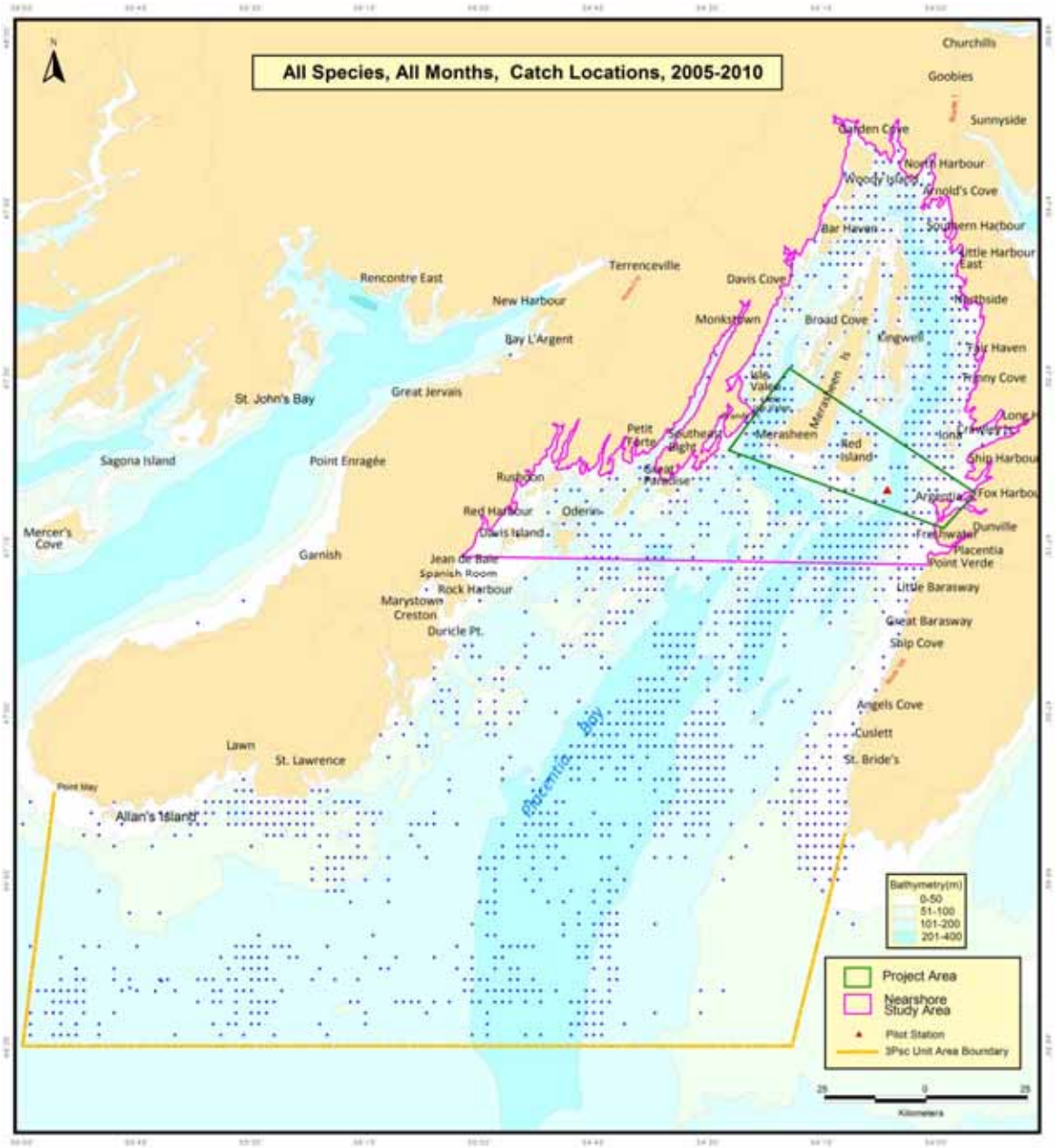

Source: DFO Catch and Effort Data 2005 to 2010

**Figure 9-11 Unit Area 3Psc Quantity of Harvest by Month, Capelin, 2005 to 2010 Average**

### 9.3.2.4 Harvesting Locations

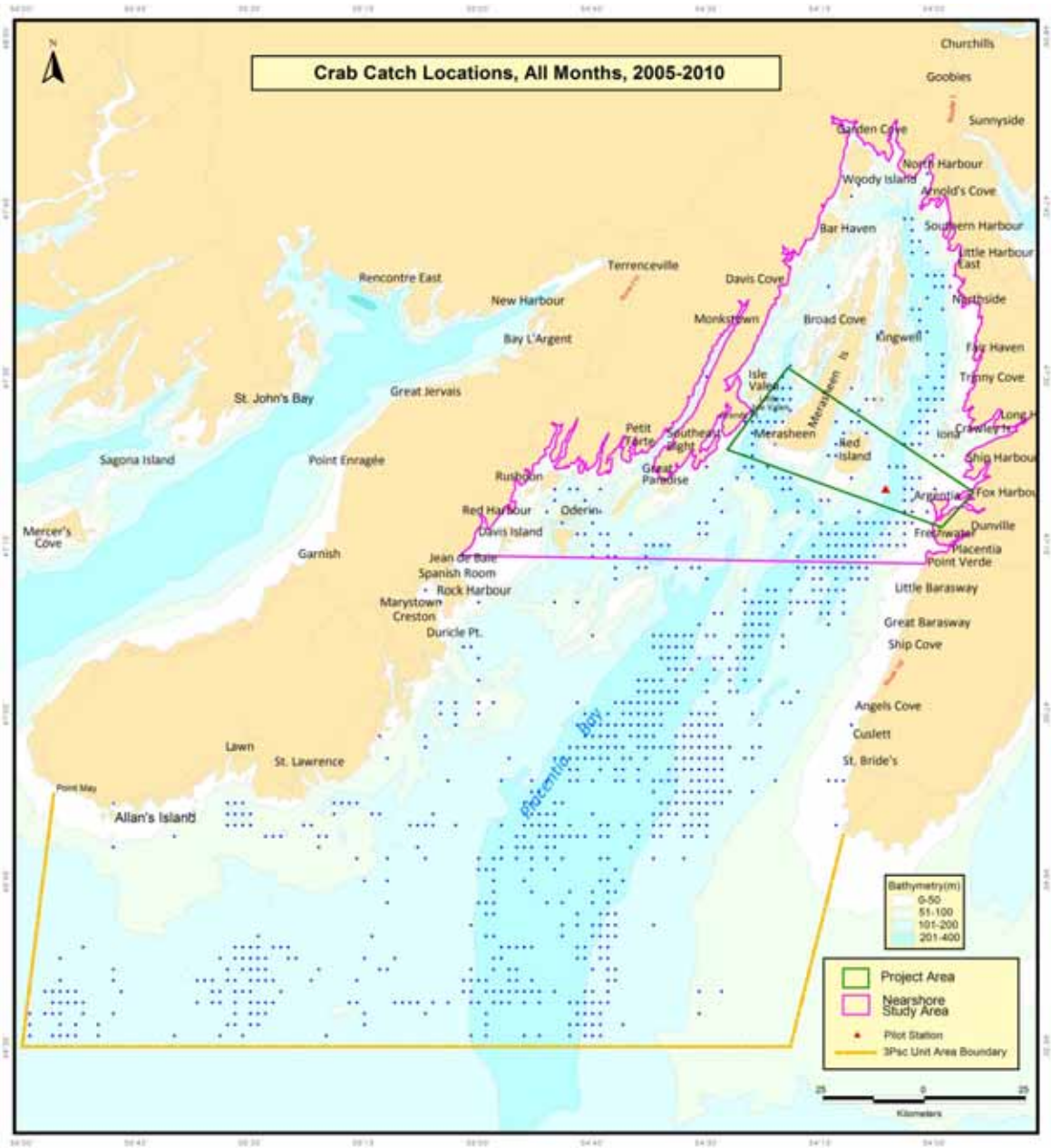
The locations of all the geo-referenced catch data recorded for 3Psc, aggregated for all months and all geo-referenced species from 2005 to 2010 are shown in Figure 9-12 (see discussion in Section 9.3.1 about data limitations). Thus, the data shown on this map represent only a sub-set of the species catches harvested in 3Psc during 2005 to 2010. As such, the map does not indicate lobster fishing sites, for example, since DFO does not require fishers to record in their logbooks the locations where they harvest this particular species. According to fishers consulted for this report, most Placentia Bay fishers are now required to record their cod catch locations in their logbooks; however, most of these records are not included in the DFO catch and effort data for 2005 to 2010. However, the dataset set does include cod catches by larger vessels.

Harvesting locations of snow crab, herring and capelin, aggregated for all months, 2005 to 2010, are illustrated in Figures 9-13 to 9-15. Recorded herring harvest locations are shown in Figure 9-14; the majority of the area's herring catch data are not geo-referenced, except in cases where it is caught by vessels greater than 34'11". Thus, the map in Figure 9-14 does not show a complete picture of the distribution and location of herring catches in Placentia Bay, especially those taken with fixed gear. Nevertheless, it is well-known that herring are taken - mainly for bait - at numerous locations throughout 3Psc.



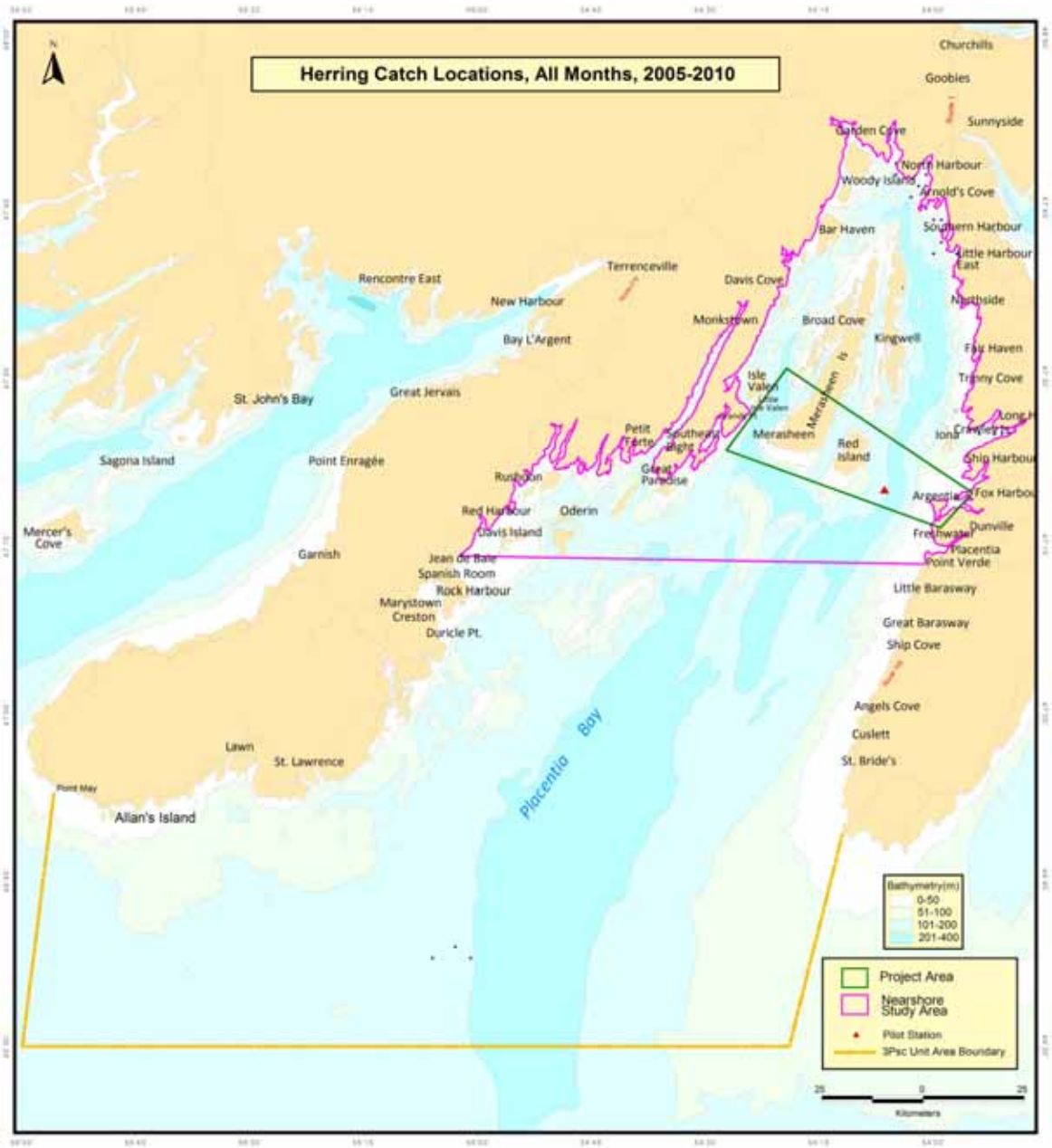

Source: DFO Geo-referenced Catch and Effort Data 2005 to 2010

**Figure 9-12 Harvesting Locations, All Geo-referenced Species Data, All Months 2005 to 2010**



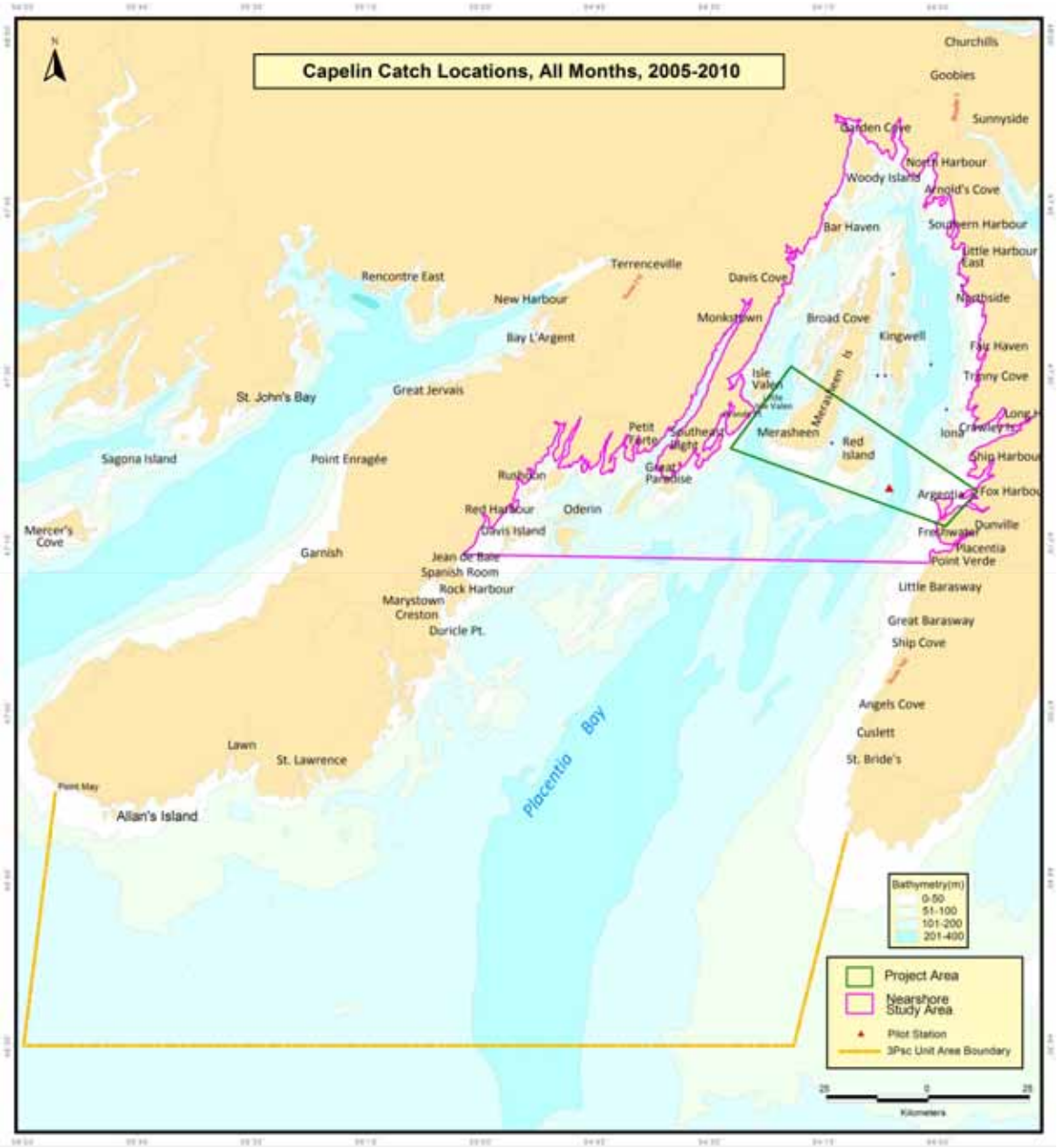

Source: DFO Geo-referenced Catch and Effort Data 2005 to 2010

**Figure 9-13 Snow Crab Harvesting Locations, 2005 to 2010, Aggregated**




Source: DFO Geo-referenced Catch and Effort Data 2005 to 2010

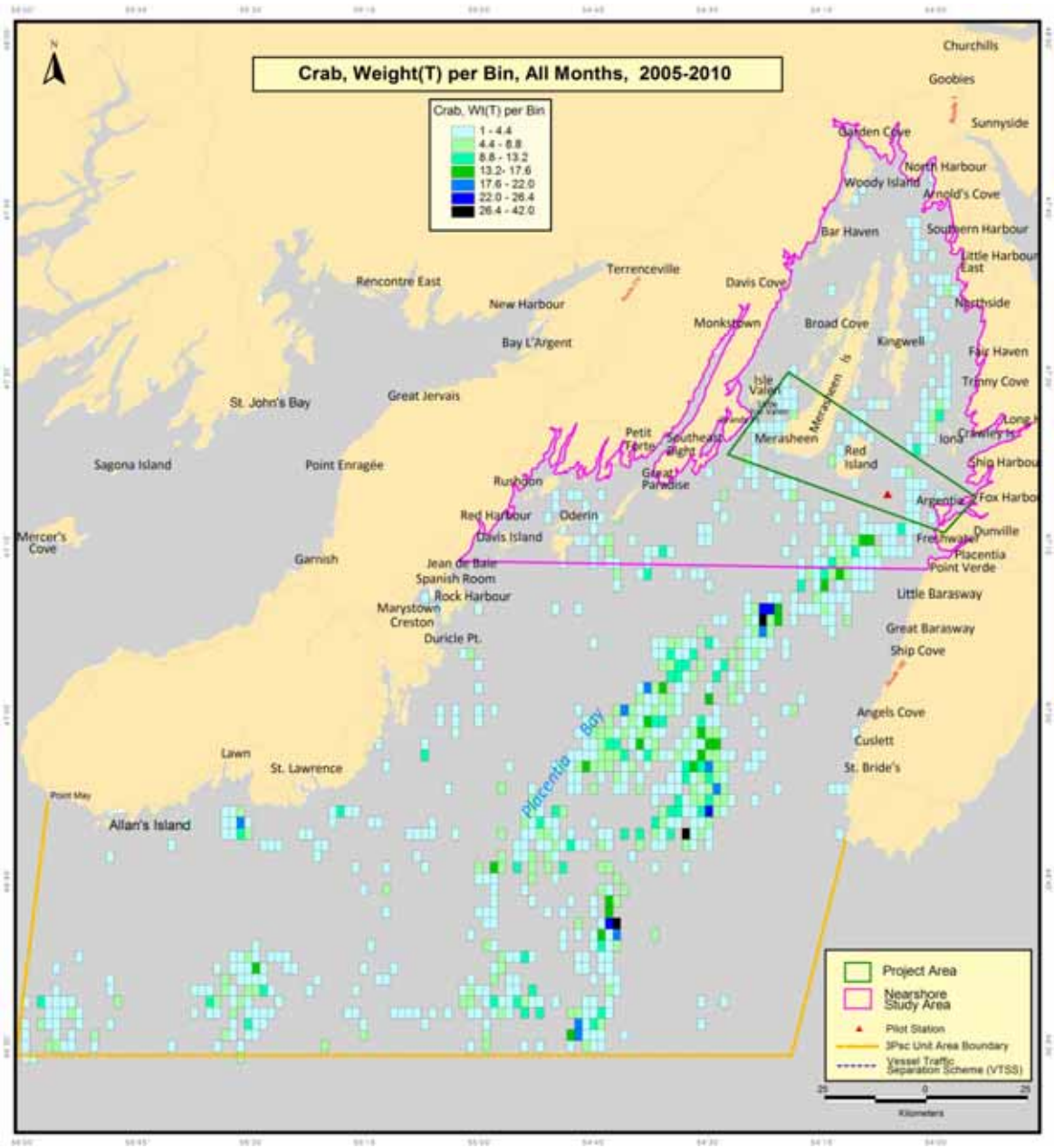
**Figure 9-14 Herring Harvesting Locations, 2005 to 2010, Aggregated**




Source: DFO Geo-referenced Catch and Effort Data 2005 to 2010

**Figure 9-15 Capelin Harvesting Locations, 2005 to 2010, Aggregated**

A view of the relative importance (by weight), of the various locations where snow crab are usually harvested is illustrated in Figure 9-16, as measured by the aggregated weight of the catches within a small geographic area; a “bin” represents catches, in tonnes, made over time within an area of sea-bed measuring 1.25 by 1.85 km (note that the quantities indicated are six-year totals, not average yearly catches).




Source: DFO Geo-referenced Catch and Effort Data 2005 to 2010

**Figure 9-16 Snow Crab Harvesting Location Bin Analysis by 2005 to 2010 Aggregated Weights**

### 9.3.2.5 Fishing Gear

Placentia Bay fisheries employ both mobile gear (typically towed by a vessel) and fixed gear (most often set out and left by the fisher, typically anchored or weighted in place). Fixed gear fisheries (e.g., gillnets, or lobster and crab pots) tend to be more “site specific” than mobile fisheries, with fewer alternative grounds available. Also, fixed gear may be left in place for several days while the fishing boat returns to port. Mobile fishing gear (e.g., otter trawls or scallop dredges) are always accompanied by the fishing vessel.

In many cases the fishing gear used in Placentia Bay is specific to the species harvested. Pots (*aka* traps) are used for snow crab and lobster, scallop drags for scallops, and diving for sea urchins. Cod is harvested using several gear types but in Placentia Bay, the majority of the cod catch is harvested with gillnets. The average quantity and value of the total harvest by each gear and gear type (fixed versus mobile) for the 2005 to 2010 period is listed in Table 9-3.

**Table 9-3 3Psc Harvest by Gear and Gear Type, 2005 to 2010 Annual Average, Quantity and Value**

| Gear | Type | Tonnes | % of Total by T | $ | % of Total by $ |
|---|---|---|---|---|---|
| Gillnet (set of fixed) | Fixed | 3,587 | 50.3% | 4,542,081 | 43.8% |
| Pots | Fixed | 1,562 | 21.9% | 4,553,183 | 43.9% |
| Purse Seine | Mobile | 540 | 7.6% | 108,870 | 1.0% |
| Sea Cucumber Drag | Fixed | 315 | 4.4% | 197,037 | 1.9% |
| Longline | Fixed | 302 | 4.2% | 365,035 | 3.5% |
| Hand Line (baited) | Fixed | 285 | 4.0% | 341,790 | 3.3% |
| Trap Net | Fixed | 282 | 4.0% | 82,404 | 0.8% |
| Dredge (Boat) | Mobile | 108 | 1.5% | 127,213 | 1.2% |
| Beach and Bar Seine | Fixed | 79 | 1.1% | 16,721 | 0.2% |
| Tuck Seine | Fixed | 46 | 0.6% | 11,641 | 0.1% |
| Diving | Mobile | 14 | 0.2% | 19,188 | 0.2% |
| Bottom Otter Trawl (stern) | Mobile | 10 | 0.1% | 9,523 | 0.1% |
| Source: DFO Catch and Effort Data 2005 to 2010 | | | | | |

Overall, during 2005 to 2010, over 90 percent of the all-species harvested was taken with fixed gear. The following describe the principal gears used in the area.

## Gillnets

Fixed or set gillnets are constructed of monofilament netting, and are typically set as multiples, or “fleets”. There are 50 nets in a fleet; each net is 300' long, for a typical length of 15,000' per fleet. Fishers may fish 8 to 10 fleets at once. The nets are anchored to the seabed to keep the gear stationary, and have buoys on each end which float on the surface. The net itself is kept open or full through the use of weights attached to the bottom of the net. A highflyer buoy usually marks one end of the set gillnet, though not always. Gillnets are the main fishing gear used mainly for cod but also for lumpfish, plaice and white hake.

## Pots

***Crab Pots.*** These are fairly large traps made of polyethylene netting or webbing over iron rod frames. They may be conical or rectangular in shape. Snow crab pots are baited and set on the seabed, singly or in strings, buoyed at the surface, typically in deep water. Crab gear generally has a highflyer (radar reflector) at one end at the surface and a large buoy at the other (for strings). Some fishers use highfliers at both ends. Depending on weather, they may be left unattended for several days at a time. The amount of gear fishers are permitted to use varies by licence category, and by the area in which a licence holder may be fishing.

***Lobster Pots (Traps).*** Inshore lobster fishers, such as those in Placentia Bay, use baited lobster traps (or pots), which are smaller than crab pots. The design may vary but they generally are made of a curved wooden lath frame covered by cotton or nylon twine netting and are weighted so that they sink. Some traps are rectangular with metal frames. They are set on the bottom, either individually or in groups in a line or string, marked with buoys. Lobster pots are set in much shallower water than crab gear, and in areas close to shore. In Lobster Fishing Area 10 (Placentia Bay), 200 traps are permitted per licence.

**Purse Seines**

The main species harvested by this type of gear in the area is herring. This mobile gear uses nets to encircle a school of fish. The gear has floats to hold up the upper part of the nets and weights at the bottom to keep it vertical in the water. A cable that passes through rings on the bottom of the net allows it to be pulled together to trap the fish. A small boat takes one end of the net around the school, encircling it. It is then winched in by the larger (main) boat.

### 9.3.2.6 Enterprises, Licences and Boats

The number of Core and non-Core enterprises by community and vessel length for Placentia Bay (Fishing Area 10) in 2003 is shown in Table 9-4. The number of species licences held by 3Psc fishing enterprises is shown in Table 9-5.

A "core" fishing enterprise is a commercial fishing enterprise holding key species licences, under the system established by DFO in 1996. New core enterprises are not normally created, although existing enterprises may be transferred to a new eligible harvester. DFO requires that the transfer go to a Level II professional fish harvester as certified by the Professional Fish Harvesters Certification Board (PFHCB) of Newfoundland and Labrador. A non-core enterprise is one holding other (perhaps a single) species licences. “Non-Key” licence holders are enterprises that do not hold a “key” licence (e.g., crab or cod), but are nevertheless duly registered/certified fish harvesters.

**Table 9-4 Distribution of Core, Non-Core and Non-Key Enterprises by Homeport, Placentia Bay (3Psc), 2012**

| Enterprise Type | Home Port Name | No. Of Enterprises |
|---|---|---|
| Core | Arnold's Cove | 15 |
| Core | Baine Harbour | 8 |
| Core | Bar Haven (Vacated) | 2 |
| Core | Beau Bois | 1 |
| Core | Boat Hr. (Inc. Brookside) | 5 |
| Core | Burin | 18 |
| Core | Come By Chance | 3 |
| Core | Davis Cove (Vacated) | 5 |
| Core | Dunville | 4 |
| Core | Fair Haven | 12 |
| Core | Fox Cove (Near Burin) | 1 |
| Core | Fox Harbour | 9 |
| Core | Freshwater, P. Bay | 1 |

| Enterprise Type | Home Port Name | No. Of Enterprises |
|---|---|---|
| Core | Garden Cove | 2 |
| Core | Great Paradise (Vacated) | 1 |
| Core | Haystack (Vacated) | 1 |
| Core | Isle Au Valen (Vacated) | 2 |
| Core | Jean De Baie | 1 |
| Core | Jerseyside | 4 |
| Core | Lamaline | 17 |
| Core | Lawn | 17 |
| Core | Little Bay, P.B. | 1 |
| Core | Little Harbour East P.B. | 13 |
| Core | Little Paradise (Vacated) | 2 |
| Core | Little St. Lawrence | 1 |
| Core | Long Harbour | 2 |
| Core | Lord's Cove | 8 |
| Core | Marystown & Mooring Cove | 1 |
| Core | Merasheen (Vacated) | 5 |
| Core | Monkstown | 5 |
| Core | Mt. Arlington Heights | 1 |
| Core | North Harbour, P.B. | 12 |
| Core | Oderin (Vacated) | 2 |
| Core | Parkers Cove | 7 |
| Core | Patrick's Cove | 1 |
| Core | Petite Forte | 21 |
| Core | Placentia (Incl Southeast) | 16 |
| Core | Point Au Gal | 4 |
| Core | Point May | 5 |
| Core | Port Ann (Vacated) | 1 |
| Core | Port Au Bras | 1 |
| Core | Prowseton & Sand Hr. (Vacated) | 3 |
| Core | Red Harbour | 10 |
| Core | Red Island (Vacated) | 8 |
| Core | Rock Harbour | 1 |
| Core | Rushoon | 1 |
| Core | Ship Harbour | 5 |
| Core | South East Bight | 30 |
| Core | Southern Harbour | 40 |
| Core | St. Bride's | 41 |
| Core | St. Lawrence | 6 |
| Non-Core | Boat Hr (Inc. Brookside) | 1 |
| Non-Core | Burin | 2 |
| Non-Core | Fair Haven | 1 |
| Non-Core | Fox Harbour | 1 |
| Non-Core | Freshwater, P. Bay | 2 |
| Non-Core | Garden Cove | 1 |
| Non-Core | Jerseyside | 1 |
| Non-Core | Lamaline | 1 |
| Non-Core | Lawn | 2 |

| Enterprise Type | Home Port Name | No. Of Enterprises |
|---|---|---|
| Non-Core | Little Harbour East P.B. | 3 |
| Non-Core | Little St. Lawrence | 2 |
| Non-Core | Lord's Cove | 1 |
| Non-Core | Merasheen (Vacated) | 1 |
| Non-Core | Mt. Arlington Heights | 1 |
| Non-Core | Parkers Cove | 1 |
| Non-Core | Placentia (Incl Southeast) | 1 |
| Non-Core | Ship Harbour | 1 |
| Non-Core | South East Bight | 1 |
| Non-Core | Southern Harbour | 3 |
| Non-Core | St. Lawrence | 3 |
| Non-Core | Swift Current | 1 |
| Non-Key | Argentia | 1 |
| Non-Key | Arnold's Cove | 15 |
| Non-Key | Baine Harbour | 1 |
| Non-Key | Boat Hr (Inc. Brookside) | 4 |
| Non-Key | Burin | 36 |
| Non-Key | Burin Bay Arm | 6 |
| Non-Key | Come By Chance | 4 |
| Non-Key | Dunville | 3 |
| Non-Key | Fair Haven | 2 |
| Non-Key | Freshwater, P. Bay | 2 |
| Non-Key | Jean De Baie | 2 |
| Non-Key | Jerseyside | 3 |
| Non-Key | Lamaline | 1 |
| Non-Key | Lawn | 1 |
| Non-Key | Lewin's Cove | 2 |
| Non-Key | Little Bay, P.B. | 7 |
| Non-Key | Little Harbour East P.B. | 5 |
| Non-Key | Long Harbour | 1 |
| Non-Key | Marystown & Mooring Cove | 55 |
| Non-Key | Mt. Arlington Heights | 3 |
| Non-Key | Old Cove-Woody Island (Vacated) | 1 |
| Non-Key | Petite Forte | 2 |
| Non-Key | Placentia (Incl Southeast) | 3 |
| Non-Key | Port Au Bras | 3 |
| Non-Key | Prowseton & Sand Hr. (Vacated) | 1 |
| Non-Key | Red Harbour | 2 |
| Non-Key | Rock Harbour | 3 |
| Non-Key | Rushoon | 9 |
| Non-Key | Ship Harbour | 2 |
| Non-Key | Southern Harbour | 4 |
| Non-Key | Spanish Room | 4 |
| Non-Key | St. Bride's | 1 |
| Non-Key | St. Lawrence | 7 |
| Source: DFO Licensing Branch, St. John’s, NL | | |

**Table 9-5 Number of Licences by Enterprise Type, Placentia Bay (3Psc), 2012**

| Enterprise Type | Species Licence | Number of Licences / Licence Shares |
|---|---|---|
| Core | Bait - Commercial | 279 |
| Core | Capelin FG - Commercial | 87 |
| Core | Capelin MG - Commercial | 2 |
| Core | Cod - Commercial - Combined IQ | 88 |
| Core | Eels - Commercial | 4 |
| Core | Groundfish FG - Commercial | 383 |
| Core | Groundfish MG - Commercial | 3 |
| Core | Herring FG - Commercial | 110 |
| Core | Herring MG - Commercial | 10 |
| Core | Herring MG - Experimental | 4 |
| Core | Lobster - Commercial | 299 |
| Core | Mackerel FG - Commercial | 130 |
| Core | Mackerel MG - Commercial | 7 |
| Core | Salmon (Atlantic) - Commercial | 5 |
| Core | Scallop - Commercial | 199 |
| Core | Scallop - Recreational | 10 |
| Core | Sea Urchins - Commercial | 5 |
| Core | Seal - Personal Use | 2 |
| Core | Seal - Professional - Commercial | 21 |
| Core | Shark - Recreational | 1 |
| Core | Snow Crab - Inshore - Commercial | 324 |
| Core | Snow Crab - Inshore - Commercial - Combined IQ | 77 |
| Core | Snow Crab - Small Supplementary - Commercial | 53 |
| Core | Snow Crab - Small Supplementary - Commercial - Combined IQ | 11 |
| Core | Squid - Commercial | 202 |
| Core | Tuna, Bluefin - Commercial | 7 |
| Core | Whelk - Commercial | 214 |
| Non-Core | Bait - Commercial | 15 |
| Non-Core | Groundfish FG - Commercial | 24 |
| Non-Core | Herring FG - Commercial | 3 |
| Non-Core | Lobster - Commercial | 15 |
| Non-Core | Mackerel FG - Commercial | 1 |
| Non-Core | Scallop - Commercial | 2 |
| Non-Core | Scallop - Recreational | 3 |
| Non-Core | Seal - Assistant - Commercial | 1 |
| Non-Core | Seal - Personal Use | 1 |
| Non-Core | Squid - Commercial | 7 |
| Non-Core | Whelk - Commercial | 1 |
| Non-Key | Bait - Commercial | 1 |
| Non-Key | Eels - Commercial | 2 |
| Non-Key | Scallop - Recreational | 152 |
| Non-Key | Seal - Assistant - Commercial | 5 |
| Non-Key | Seal - Personal Use | 33 |
| Non-Key | Seal - Professional - Commercial | 14 |

| Enterprise Type | Species Licence | Number of Licences / Licence Shares |
|---|---|---|
| Non-Key | Shark - Recreational | 6 |
| Non-Key | Squid - Commercial | 1 |
| Non-Key | Whelk - Commercial | 1 |
| Source: DFO Licensing Branch, St. John's, NL | | |

The boats used by most enterprises are small, less than 35-feet in length. The quantity harvested annually from 3PSc by each length class during the 2005 to 2010 period is shown in Table 9-6. The current number of vessels by length class for each Placentia Bay homeport is shown in Table 9-7.

**Table 9-6 Unit Area 3Psc Harvest by Vessel Length Class, 2005 to 2010, Quantity and Value**

| Year | Vessel Class | Weight (T) | Value ($) |
|---|---|---|---|
| 2005 | unspecified | 49 | 42,374 |
| 2005 | 1-34.9 ft | 4,945 | 7,592,630 |
| 2005 | 35-44.9 ft | 1,556 | 1,837,377 |
| 2005 | 45-64.9 ft | 239 | 153,280 |
| 2005 | 125 ft or more | 0 | 6 |
| | | | |
| 2006 | 1-34.9 ft | 5,214 | 7,113,522 |
| 2006 | 35-44.9 ft | 1,556 | 1,580,340 |
| 2006 | 45-64.9 ft | 698 | 201,416 |
| 2006 | 65-99.9 ft | 27 | 15,320 |
| | | | |
| 2007 | 1-34.9 ft | 5,187 | 9,511,622 |
| 2007 | 35-44.9 ft | 1,382 | 1,805,202 |
| 2007 | 45-64.9 ft | 82 | 59,931 |
| | | | |
| 2008 | 1-34.9 ft | 5,341 | 9,764,368 |
| 2008 | 35-44.9 ft | 1,844 | 2,575,270 |
| 2008 | 45-64.9 ft | 1,386 | 526,494 |
| | | | |
| 2009 | 1-34.9 ft | 4,208 | 7,366,307 |
| 2009 | 35-44.9 ft | 1,538 | 2,051,037 |
| 2009 | 45-64.9 ft | 821 | 346,614 |
| 2009 | 65-99.9 ft | 5 | 2,115 |
| | | | |
| 2010 | 1-34.9 ft | 3,889 | 7,099,411 |
| 2010 | 35-44.9 ft | 1,958 | 2,336,809 |
| 2010 | 45-64.9 ft | 869 | 307,051 |
| Source: DFO Catch and Effort Data 2005 to 2010 | | | |

**Table 9-7 Number of Vessels by Length Class by Homeport of Enterprise, Placentia Bay (3Psc), 2012**

| Enterprise Type | Home Port Name | < 25' | 25-39' | 40-44' | 45-54' | 55-64' | >64' | Total |
|---|---|---|---|---|---|---|---|---|
| Core | Arnold's Cove | 11 | 15 | 1 | | | | 27 |
| Core | Baine Harbour | 6 | 7 | 2 | | | | 15 |
| Core | Bar Haven (Vacated) | 2 | 2 | | | | | 4 |
| Core | Beau Bois | | 1 | | | | | 1 |
| Core | Boat Hr (Inc. Brookside) | 4 | 4 | | | | | 8 |
| Core | Burin | 14 | 12 | 4 | | 1 | | 31 |
| Core | Come By Chance | 4 | 1 | | | | | 5 |
| Core | Davis Cove (Vacated) | 5 | 4 | 1 | | | | 10 |
| Core | Dunville | 3 | 4 | | | | | 7 |
| Core | Fair Haven | 13 | 10 | | | | | 23 |
| Core | Fox Cove (Near Burin) | 1 | 1 | | | | | 2 |
| Core | Fox Harbour | 7 | 7 | 2 | | | | 16 |
| Core | Freshwater, P. Bay | 1 | | | | | | 1 |
| Core | Garden Cove | 2 | 2 | | | | | 4 |
| Core | Great Paradise (Vacated) | 1 | 1 | | | | | 2 |
| Core | Haystack (Vacated) | 1 | 1 | | | | | 2 |
| Core | Isle Au Valen (Vacated) | 2 | 2 | | | | | 4 |
| Core | Jean De Baie | 2 | | | | | | 2 |
| Core | Jerseyside | 3 | 3 | | 1 | | | 7 |
| Core | Lamaline | 10 | 15 | | | | | 25 |
| Core | Lawn | 8 | 10 | 7 | | | | 25 |
| Core | Little Bay, P.B. | 1 | | 1 | | | | 2 |
| Core | Little Harbour East P.B. | 8 | 11 | 1 | 3 | 1 | | 24 |
| Core | Little Paradise (Vacated) | 2 | 2 | | | | | 4 |
| Core | Little St. Lawrence | | 1 | | | | | 1 |
| Core | Long Harbour | 3 | 2 | | | | | 5 |
| Core | Lord's Cove | 4 | 7 | | 1 | | | 12 |
| Core | Marystown & Mooring Cove | | | | | 1 | | 1 |
| Core | Merasheen (Vacated) | 6 | 4 | | | | | 10 |
| Core | Monkstown | 5 | 5 | | | | | 10 |
| Core | Mt. Arlington Heights | 1 | 1 | | | | | 2 |
| Core | North Harbour, P.B. | 14 | 6 | | | | | 20 |
| Core | Oderin (Vacated) | | 2 | | | | | 2 |
| Core | Parkers Cove | 5 | 7 | | | | | 12 |
| Core | Patrick's Cove | 1 | | | | | | 1 |
| Core | Petite Forte | 14 | 19 | 3 | | | | 36 |
| Core | Placentia (Incl Southeast) | 13 | 10 | 6 | 1 | | | 30 |
| Core | Point Au Gal | 3 | 4 | | | | | 7 |
| Core | Point May | 4 | 5 | | | | | 9 |
| Core | Port Ann (Vacated) | 1 | 1 | | | | | 2 |
| Core | Port Au Bras | 1 | 1 | | | | | 2 |
| Core | Prowseton & Sand Hr. (Vacated) | 3 | 2 | 1 | | | | 6 |
| Core | Red Harbour | 9 | 10 | | | | | 19 |

| Enterprise Type | Home Port Name | < 25' | 25-39' | 40-44' | 45-54' | 55-64' | >64' | Total |
|---|---|---|---|---|---|---|---|---|
| Core | Red Island (Vacated) | 6 | 9 | | | | | 15 |
| Core | Rock Harbour | 1 | 1 | | | | | 2 |
| Core | Rushoon | | 1 | | | | | 1 |
| Core | Ship Harbour | 4 | 4 | 1 | | | | 9 |
| Core | South East Bight | 26 | 28 | | | | | 54 |
| Core | Southern Harbour | 34 | 27 | 5 | 6 | 2 | | 74 |
| Core | St. Bride's | 8 | 30 | 7 | 3 | | | 48 |
| Core | St. Lawrence | 3 | 4 | 2 | | | | 9 |
| Non-Core | Boat Hr. (Inc. Brookside) | 1 | | | | | | 1 |
| Non-Core | Burin | 2 | | | | | | 2 |
| Non-Core | Fair Haven | 1 | | | | | | 1 |
| Non-Core | Fox Harbour | 1 | | | | | | 1 |
| Non-Core | Freshwater, P. Bay | 1 | 2 | | | | | 3 |
| Non-Core | Garden Cove | 1 | | | | | | 1 |
| Non-Core | Jerseyside | 2 | | | | | | 2 |
| Non-Core | Lamaline | | 1 | | | | | 1 |
| Non-Core | Lawn | | 2 | | | | | 2 |
| Non-Core | Little Harbour East P.B. | 2 | 2 | | | | | 4 |
| Non-Core | Little St. Lawrence | 2 | | | | | | 2 |
| Non-Core | Lord's Cove | 1 | | | | | | 1 |
| Non-Core | Mt. Arlington Heights | 1 | | | | | | 1 |
| Non-Core | Parkers Cove | 1 | 1 | | | | | 2 |
| Non-Core | Placentia (Incl Southeast) | | 1 | | | | | 1 |
| Non-Core | Ship Harbour | 1 | 1 | | | | | 2 |
| Non-Core | Southern Harbour | 2 | 1 | | | | | 3 |
| Non-Core | St. Lawrence | 3 | | | | | | 3 |
| Non-Core | Swift Current | 1 | | | | | | 1 |
| Non-Key | Arnold's Cove | | | | | | 2 | 2 |
| Non-Key | Lamaline | 1 | | | | | | 1 |
| Non-Key | Mt. Arlington Heights | 1 | | | | | | 1 |
| Non-Key | Placentia (Incl Southeast) | 1 | | | | | | 1 |
| Source: DFO Licensing Branch, St. John’s, NL | | | | | | | | |

### 9.3.2.7 Fisheries in the Project Area and Work Sites

This section provides more detailed information about the fisheries and fish harvesting activities within the Nearshore Project Area, including the CGS construction site at Argentia and the two possible sites for the mating location. These are deep-water mating site 1 in the Western Channel and, alternatively, deep-water mating site 2 in the Eastern Channel. Description of harvesting activities near these three areas is based primarily on consultations with area fishers, FFAW personnel and agency managers, supplemented with analysis of the geo-referenced portion of the DFO catch data. The location of these sites, with an estimated 1.5 km radius safety zone that will be established around the selected deep-water mating site is shown in Figure 9-17. The map also shows communities and other features in the general vicinity that are referenced in the following fisheries descriptions.

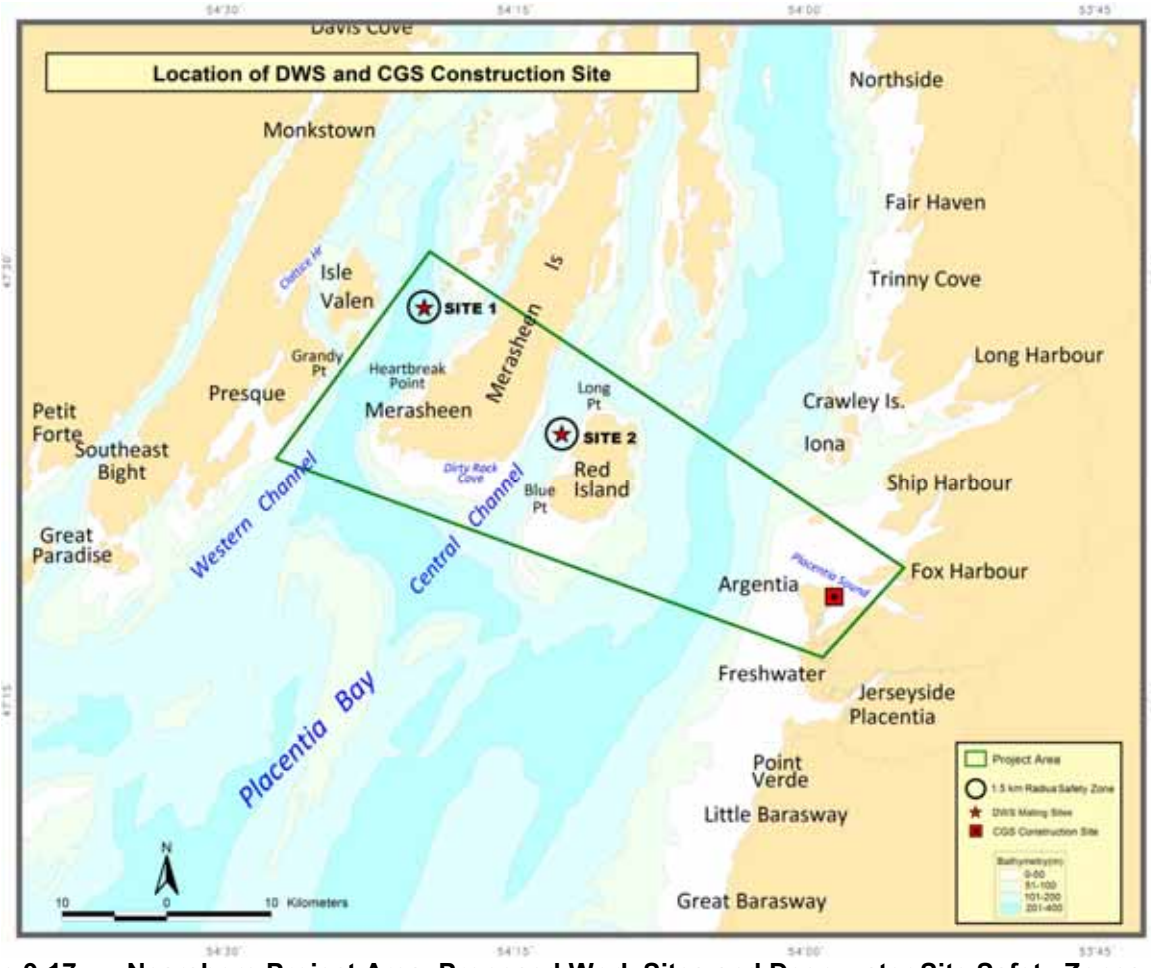



**Figure 9-17 Nearshore Project Area, Proposed Work Sites and Deep-water Site Safety Zones Argentia Concrete Gravity Structure Construction Site**

Fishers attending the Placentia meeting reported that very little fishing activity takes place in Argentia Harbour generally, and no harvesting activities take place in the immediate vicinity of the CGS construction site. However, they noted that lobster pots are set at various locations along the shoreline adjacent to the site, continuing along the shoreline towards Placentia Sound and extending into the south shore of the sound. Lobster is also harvested on suitable grounds on the north shore of the sound, continuing to the west to Fox Harbour.

Fishers reported that herring spawn near the shore along the east side of the Argentia Peninsula above the jetty, although DFO managers stated they were not aware of this, at least in recent years. Fishers also reported that capelin sometimes spawn on the beach in the cove between the tip of the Peninsula and The Pond, and that capelin traps have sometimes been set close to the shore in this area. They noted that lobster pots have been set just to the north of this capelin trap area, and that flounder have also been harvested on grounds just beyond that lobster area.

DFO Placentia fisheries records show that cod have been harvested (with gillnets) within the area where the proposed Dredge Corridor 2 is located (see Figure 2-13), and that

some lobster fishing also usually occurs in the vicinity of this corridor. Additionally, they indicated that scallops are harvested in the area between Fox Island and the mouth of Placentia Sound, (M. Hurley, pers. comm., May 2012).

DFO managers also stated that cod are taken at various locations relatively close to land along the north side of Placentia Sound, and on grounds to the west along this shoreline up to Fox Harbour and continuing along the north shore extending west to Isaac Point. These grounds are said to be very good cod hand lining areas, and are used by both commercial harvesters and recreational fishers.

Geo-referenced catch data for 2005 to 2010 were examined for a marine area 2.5 km in radius from the CGS construction site (see Figure 9-17). This analysis indicated that a range of species have been harvested within this area in every year since 2005. Other non-geo-referenced species are also likely harvested there. The data included sea scallops, snow crab, cod, mackerel, lumpfish and whelk. According to these data, an average of 8 t per year was harvested, with an estimated (by DFO) value of approximately $8,300 annually. The predominant species catch was mackerel. These diverse catches were taken by a variety of gears, including purse seine, pots, longline, baited handline and gillnets. As fishers attending the Placentia meeting noted, the DFO data do not account for other species, such as lobster, herring, flounder, lumpfish, etc., which are not part of the geo-referenced dataset because they are taken in smaller vessels that are not required to record the coordinates of their catch locations.

The DFO data indicate that these geo-referenced harvesting activities took place throughout most months of the fishing season, with activities in July and September accounting for most of the catch. These geo-referenced data also show that enterprises from such communities as Placentia, Jerseyside, Argentia, Main Brook, Fox Harbour and Southern Harbour harvested various species in the general vicinity of the Argentia site.

**Deep-water Site Alternative 1 – Western Channel**

Fishers attending meetings in Placentia and Petit Forte in June 2012 provided information about current harvesting activities in the immediate vicinity of the proposed deep-water mating site 1 location within the Western Channel. Additional information on established and current harvesting activities in this area was obtained via telephone interviews with fishers based in Monkstown and Davis Cove.

Two Davis Cove fishers provided detailed information about their fishing activities in the immediate vicinity of the proposed mating site, as well as on current locations of other crab and cod harvesting operations in the Western Channel area south of Isle Valen (F. Tobin and W. Collins, pers. comm., June 2012).

One Davis Cove enterprise operator reports that he harvests most of his 150-pot crab quota directly within the proposed deep-water mating site 1 safety zone area. He usually sets out five fleets of gear in strings of 25 to 30 pots per fleet. The gear is set east-to-west in depths between 145 to 165 m (80 to 90 fathoms). The pots are set approximately 36 m apart and thus a string of gear is approximately 1 km in length. During the season, he usually moves his pots from one area to another depending on catch rates; a fleet of gear may be moved to another seabed area approximately 1 km away. He reports that two other enterprises also fish crab in the same general area of the Channel, on grounds

between Isle Valen and Merasheen Island, and that other local crab vessels fish their gear farther down the Channel on grounds south of Grandy Point. Several Arnold's Cove vessels, operating from their summer homeport of Tack's Beach, fish their crab on grounds located north of Isle Valen.

This Davis Cove fisher's cod (gillnet) grounds are located on the west side of Isle Valen in shallower water off the shoreline between Davis Cove and Clattice Harbour, not within Site 1. He reports that several vessels operating from the summer community of Merasheen fish their cod on grounds (in 165 to 185 m water depths) off the shore in the area between Merasheen and Breakheart Point. He noted that gillnets that are set in deeper water of the Channel are often moved to shallower water for the weekend break to avoid having them becoming entangled with crab. At times, and at some locations, cod nets may be set in deeper portions of the Channel (e.g., in water depths greater than 365 m).

During the interviews, fishers referred to the existence of the very deep hole in the middle of the Channel located just a few kilometres south, or southeast, of Site 1. This hole is known locally as the "Dumping Ground" (sometimes Devil's Cove Hole), and is said to be over 365 m deep. Apparently, this is the location where the US Navy dumped many tonnes of waste material when the base at Argentia was being closed. One Davis Cove fisher noted that he has, on occasion, fished crab in this hole and found it to be a very abundant crab-fishing spot.

A second Davis Cove fisher reported that he harvests his crab on grounds south of Little Isle Valen in the nearshore area adjacent to the shore from Grandy Point south to Long Point (a shoreline area known locally as the "Preseque Shore"). His gear is also set in strings of approximately 25 pots, usually in a northeast-southwest orientation. He reports that as of June 2012, approximately 20 crab vessels were fishing in the Channel area south of Grandy Point; these included three or four Davis Cove fishers, two Monkstown vessels, several enterprises based in homeports on the east side of Placentia Bay (e.g., from Arnold's Cove and Placentia) and a number of crab fishers from Southeast Bight and Petit Forte.

This fisher also mentioned fishing in the "Dumping Ground" and reported that this hole is situated close to Devil's Cove Island, in 275 to 475 m water. He says that this area has a very muddy bottom ("black mud"). The fisher harvests cod on grounds north of Grandy Point closer to Isle Valen in water depths ranging from 18 to 96 m and as deep as 185 m, although it was noted that some vessels routinely set their cod gear in deeper water, between 235 to 275 m. He noted that his gillnets "run off the land" (i.e., in a southerly direction), and also re-iterated the fact that fishers generally prefer not to set their nets in deep water because they may become entangled with crab.

Fishers from Southeast Bight and Petit Forte attending the 15 June consultation meeting reported on their harvesting activities in the Western Channel area. Some of these fishers hold "inner" licences, and others hold "outer" licences. The latter group must harvest their crab quota in areas 22 km (greater than 12 nm) from shore. Those holding "inner" licences fish in the outer portion of Western Channel and generally set their gear below the area used by Davis Cove harvesters (i.e., on crab grounds south of Long Point and the entrance to Presque Harbour). A total of 11 Petit Forte/Southeast Bight crab enterprises hold "inner" licences. Fishers from these two communities report that they fish their cod from May to July, and sometimes into August (as well as later in the

Fall), using gillnets set in approximately 185 m water in the same general areas where they fish crab.

DFO personnel and various other fishers provided additional comments and details on species harvesting activities and seasons in the Western Channel area. These are summarized here.

Crab fishing usually takes place from early April to early July. All of the crab vessels fishing in the Isle Valen portion of the Western Channel have an annual quota (in 2012) of approximately 4.8 t (10,500 lb) and are permitted to fish 150 pots (at 25 to 30 pots per string of gear, most vessels would be setting five or six fleets of crab gear).

Most of the cod harvest occurs in June and July, with August being a “lull” period, during which very little cod (or crab) fishing takes place. Fixed gear licence holders are permitted to fish a total of 20 nets and - depending on bottom conditions - harvesters will generally have three nets per fleet, setting six fleets of three nets and one fleet of two nets. Gillnets may be set directly on the seafloor, or suspended a few metres above the seabed. The gear is weighted down and affixed by a rope to buoys at one (or either) end of the fleet; one end of the fleet may also be attached to a “highflyer”. Gillnets are generally set in a fleet of three nets (two in shallower water); a three-net fleet is approximately 275 m in length. Each fisher has a 7.7 t (17,000 lb) individual quota, although some enterprises have acquired an additional quota from another licence holder.

Views on weather/shelter conditions in the potential Western Channel deep-water mating site vary. One locally-based fisher stated that the Site 1 area is in a relatively protected part of the Channel, and does not often experience heavy seas; however, another operator commented that Site 1 can be “a rough spot” at times.

Although the deep-water mating site safety zone is estimated to be 1.5 km in radius, the geo-referenced 2005 to 2010 catch data were examined within a 2.5 km radius data analysis zone from the potential deep-water mating site to capture the available data both in and near the site. Examination of the DFO geo-referenced data falling within that data analysis radius indicated that this area was fished exclusively by a 34’11” Davis Cove vessel or vessels in April and May 2009 and during May and June 2010. These snow crab catches came from pots set mostly in water depths between 230 and 320 m. According to the DFO data, an average of 5.1 t was taken per year in that two year period.

**Deep-water Site Alternative 2 – Central Channel**

Fish harvesting operations at deep-water mating site 2 (see Figure 9-17) in the Central Channel on the west side of Red Island were discussed at consultations with fishers in Arnolds Cove, Placentia and Petite Forte in 2012. One Placentia-based enterprise indicated that he has harvested cod within this area, and others noted that cod traps have been set at several locations on the west shoreline of the Island between Blue Point and Long Point (and just beyond that point). Fishermen attending the Arnold’s Cove meeting also reported that one local enterprise has fished cod on the east side of Red Island on grounds near Red Island Harbour and south from this location.

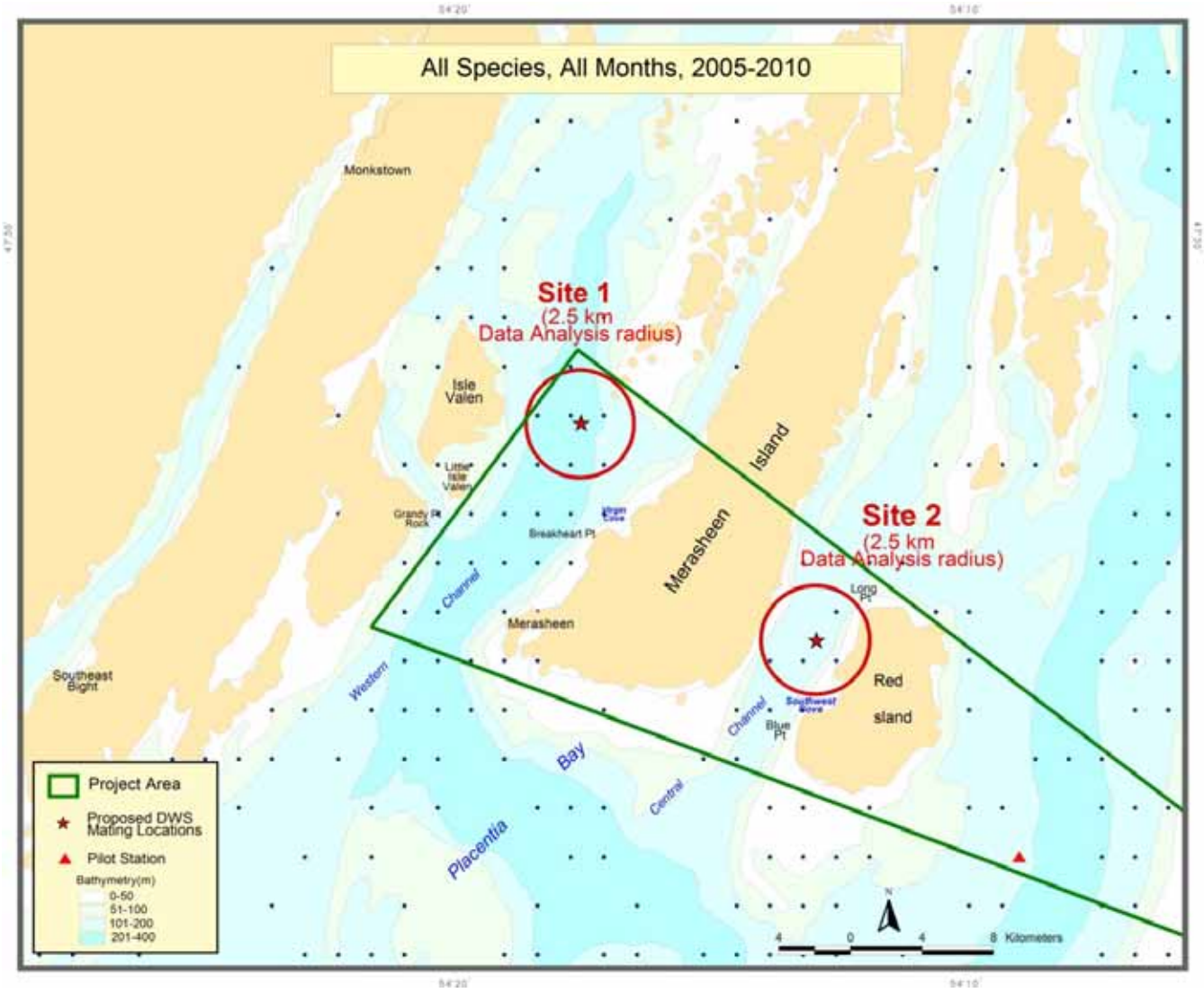
According to DFO's Placentia office personnel, there has been very little fishing activity in the middle, deeper part of the Central Channel in recent years, and they suggested that, compared to the Central Channel site, Site 2 (Western Channel) might be a more suitable location for the deep-water mating site from a fisheries harvesting/gear location perspective. But DFO also noted that the Central Channel area west of Red Island is well protected from the weather and that this passageway is not used very much by larger ships. However, fishers attending the Arnold's Cove and Placentia consultation meetings indicated that many fishers with homeports on the east side of Placentia Bay prefer to travel through this Channel en route to, or returning from, their fishing grounds on the west side of the Bay, or when travelling to their fishing grounds in the southern part of Placentia Bay, and beyond. Red Island is also a popular cabin area, frequented by fishers.

The available geo-referenced catch data for the Central Channel 2.5 km radius data analysis zone indicate that, during 2009 and 2010, snow crab were harvested in the deeper water of the Channel lying within the deep-water mating site 2 analysis zone, and that 45 t of capelin were taken with tuck seine in June/July of 2006. According to the DFO data, this species was harvested in 45 m water by 45 to 54 foot vessels based in Southern Harbour. The data also indicate that an average (of all geo-referenced species) of 8.3 t per year was harvested within the general vicinity of the proposed deep-water mating site, but outside of the 2.5 km radius analysis zone. In 2009-2010, a total of 2 t of crab were harvested in deep-water mating site 2 area during the April to June period. The geo-referenced statistics indicate that enterprises from Garden Cove, Southern Harbour and Arnold's Cove fished in the Site 2 area during 2006, 2009 and 2010. Fishers from other Placentia Bay communities may also have fished in this deep-water mating site 2 area, even though their catch records are not indicated in the DFO geo-referenced catch statistics.

According to the DFO geo-referenced catch data, most of the crab pots were set in water depths ranging from 140 to 180 m, although some catches were taken in water depths between 230 to 270 m.

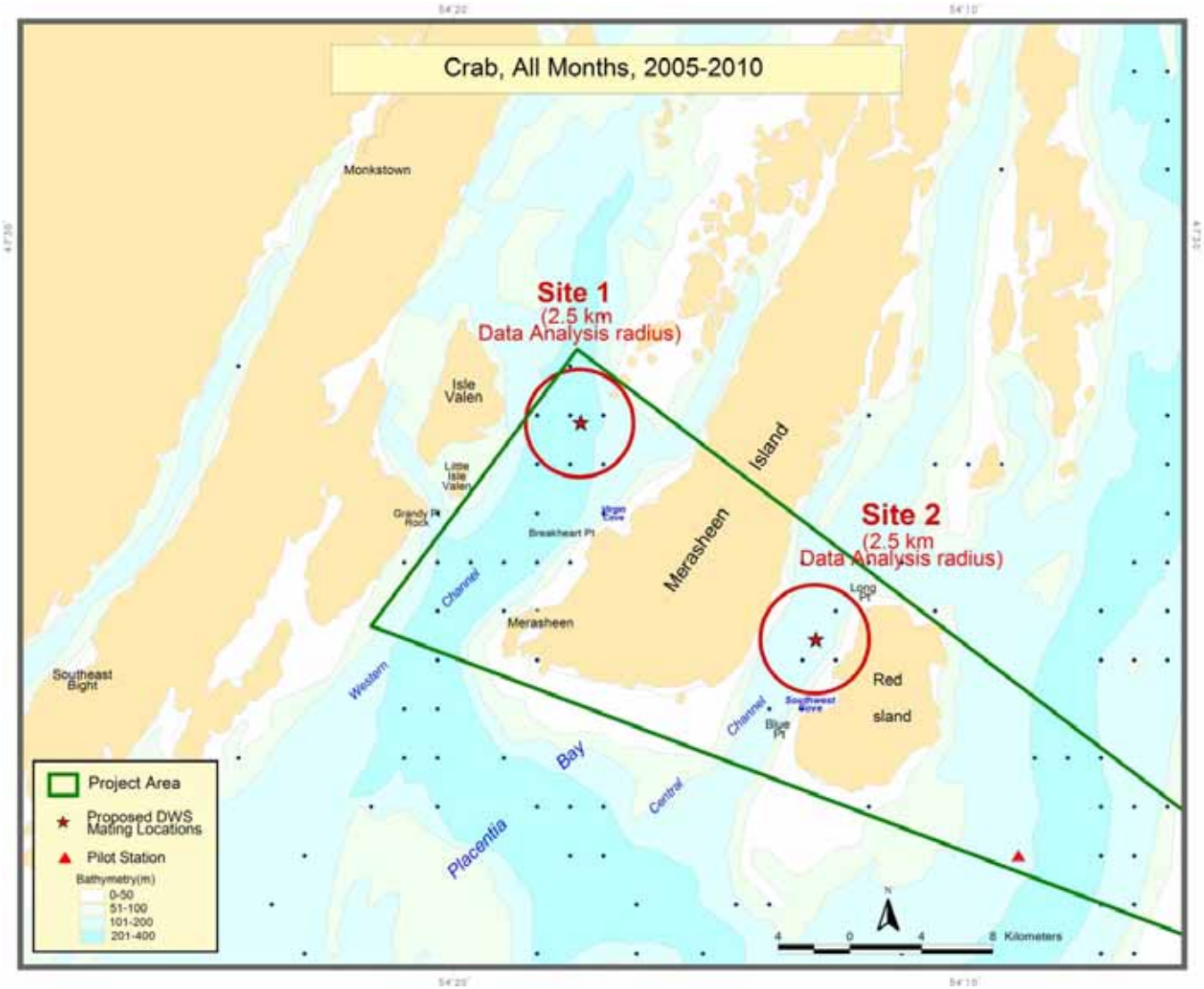
Analysis of the DFO catch data within the Central Channel, but outside of the 2.5 radius deep-water mating site analysis zone, show that in addition to crab, cod and other groundfish species were harvested in the deeper (greater than 100 m) water of the Channel, as well as in the shallower water (less than 100 m) of this waterway. There are several such cod gillnetting areas located off the southeast tip of Merasheen Island, approximately 3 to 4 km south of Dirty Rock Cove.

The incidence of geo-referenced catch data (for all geo-referenced species catches and for snow crab) within the vicinity of each site is shown in Figures 9-18 and 9-19. The relative importance of crab fishing areas (using the bin analysis discussed above) is illustrated in Figure 9-20 (note that, as in the previous bin analysis, the quantities indicated are six-year totals, not average yearly catches).



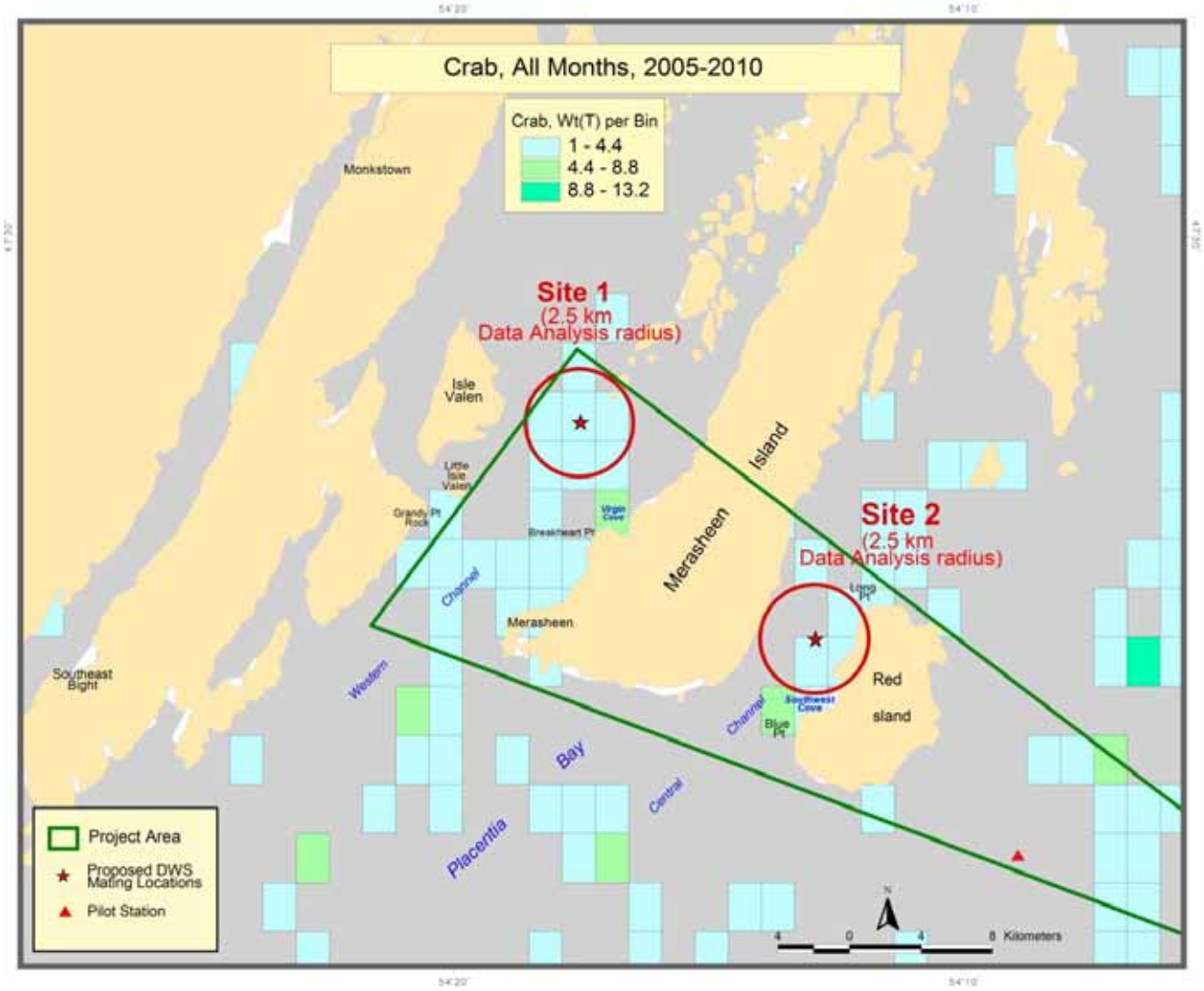

Source: DFO Geo-referenced Catch and Effort Data 2005 to 2010

**Figure 9-18 Harvesting Locations, All Geo-referenced Species Data, Deep-water Sites 1 and 2, 2005 to 2010**




Source: DFO Geo-referenced Catch and Effort Data 2005 to 2010

**Figure 9-19 Harvesting Locations, Geo-referenced Snow Crab Data, Deep-water Sites 1 and 2, 2005 to 2010**




Source: DFO Geo-referenced Catch and Effort Data 2005 to 2010

**Figure 9-20 Deep-water Sites 1 and 2 Geo-referenced Snow Crab Harvesting Location Bin Analysis by 2005 to 2010 Aggregated Weights**

#### 9.3.2.8 Placentia Bay Aquaculture Activities

The majority of the aquaculture development and investment activities in southern Newfoundland are presently concentrated in the Bay d'Espoir and Fortune Bay areas. The province's aquaculture Strategic Plan notes "The Newfoundland salmonid industry is located in Bay d'Espoir, the only area of the province that is suitable for the growing of steelhead trout and salmon" (Burke Consulting 2000). However, NLDFA aquaculture managers believe that Placentia Bay has many of the desirable characteristics of Bay d'Espoir, and are confident that Placentia Bay has substantial growth opportunities, including possibilities for the development of salmon and rainbow trout farming, as well as further expansion of existing cod and mussel operations.

Aquaculture sites are located in inshore areas, usually in sheltered coves or along protected shorelines. Sites are typically chosen for the quality of the marine environment, and must consider a wide array of factors such as water temperatures, tides, bathymetry, benthic conditions, prevailing winds and currents, salinity, littoral factors and influences, proximity to other human activities such as commercial fishing, use of existing marine areas by pleasure craft, nearby shipping, other marine-oriented industries, community sewage outfalls and access to services such as roads and electrical service. A potential site must also undergo a regulatory review and assessment of the physical setting and oceanographic conditions of the marine area proposed for the licence.

The development of aquaculture resources in Placentia Bay has been underway since the mid-1990s. A cod hatchery was also established in Placentia Bay in the early 1990s, but this was subsequently destroyed by fire. In 1997, there were about seven active aquaculture operations and several applications to investigate and/or develop additional sites, and two sea urchin sites were later approved, but by 2003 these were no longer active.

During 2000-2003, there was a relatively substantial level of interest in the area's aquaculture sector and NLDFA received many applications for the development of new mussel and cod farming sites particularly on the Burin Peninsula side of the Bay and around Merasheen Island.

By 2003, there were 15 approved aquaculture operations, comprising six blue mussel sites and nine cod grow-out facilities. At this point, most of these aquaculture sites were still at a "developmental" stage (i.e., they had product in the water but no substantial amount of commercial sales). In 2004, NLDFA reported that only four operators were selling their product on a commercial basis. Nevertheless, based on discussions with NLDFA experts and 2004 production and sales data obtained from selected aquaculture enterprises, the annual value of aquaculture production (after primary processing) in Placentia Bay was estimated at $500,000 (Canning and Pitt 2004).

In 2006, a detailed analysis of aquaculture operations in Placentia Bay was undertaken as part of a larger comprehensive study of oil spill risk assessment within the South Coast-Eastern Avalon region prepared for Transport Canada (Canning and Pitt 2006). This study, based on data obtained from detailed consultations with industry participants as well as NLDFA experts, calculated the 2006-2007 mussel production levels in Placentia Bay at 1,588 t (3,500,000 lb), with a primary product value (before processing) of $1.4 million. These data were based on current production levels at the five

commercially-active mussel farming sites in Placentia Bay at the time this research was undertaken.

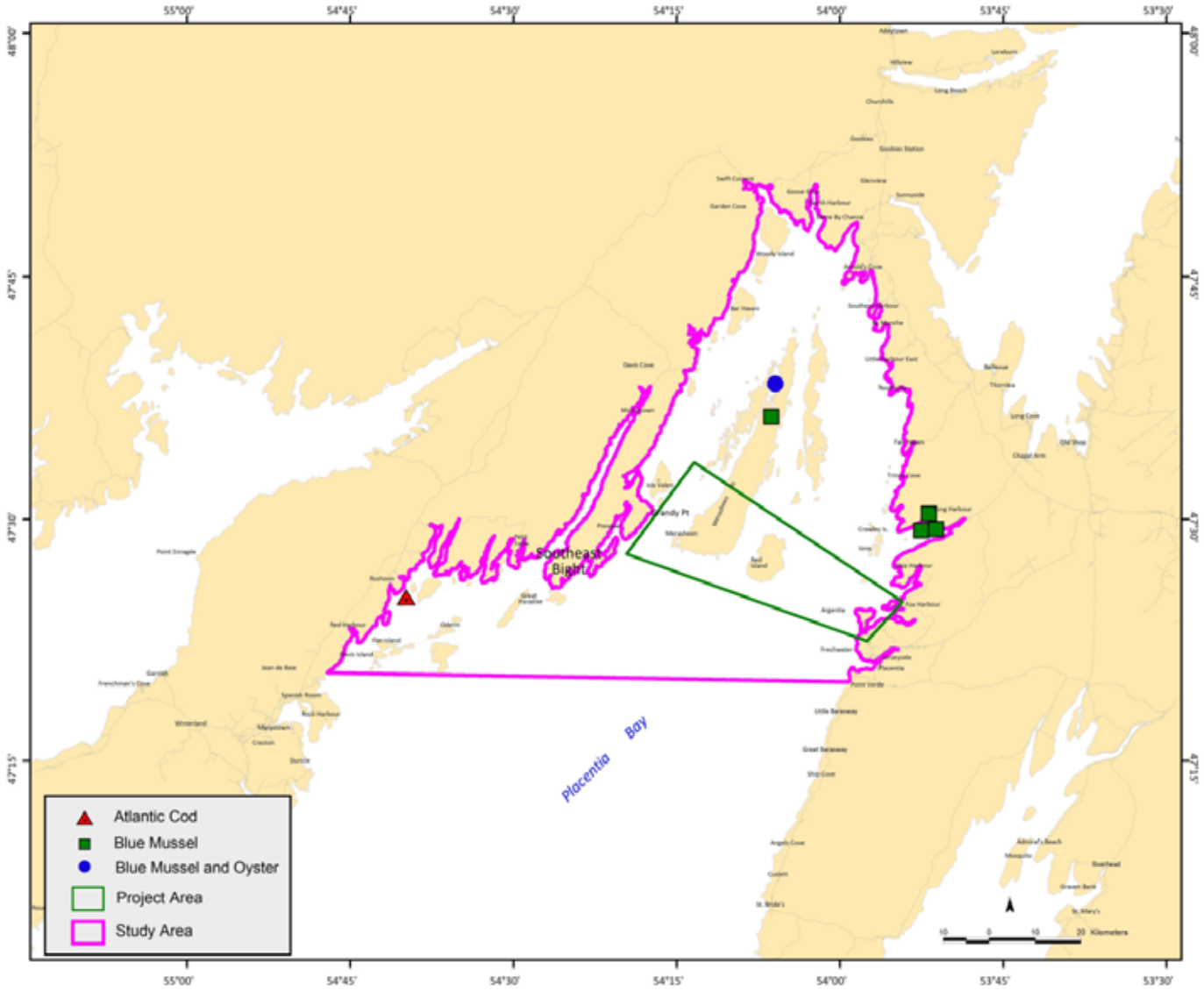
In addition to the sites that are presently licenced and in production, during the past two decades or so aquaculture activities have been investigated, approved and developed at various other locations within Placentia Bay. While none of these older aquaculture sites are currently active or under application, some of these farming locations may be re-activated at some point in the future (Canning and Pitt 2009).

Previously active (or licensed) aquaculture sites within the study area are shown in Figure 9-21, and may give some indication of the potential for a more widespread development of the area's aquaculture sector in the future.

Previous aquaculture sites (number if more than one) for the species indicated were located at the following locations:

- Blue Mussels: Bar Haven (three), Gulch Head and Cross Island
- Atlantic Cod: Fox Cove, Jigging Cove (near Monkstown), Spanish Room Point, Petite Forte Harbour (two), Muddy Hole (Sound Island), Chambers Island (three) and Isle Valen (three)
- Atlantic Salmon: Northeast Nonsuch Arm and Boat Harbour
- Sea Urchins: Cooper Island
- Applications Pending (in year 2007) to NLDFA for Placentia Bay Mussel Sites: Jean de Gaunt, Dog Harbour, Rose au Rue, Barren Island, Presque Harbour, Port Royal Arm.

As of June 2012, there were six commercial aquaculture operations in the Placentia Bay area (Table 9-8), none of which are located within the Project Area. See Figure 9-21 for their locations within Placenta Bay.




Source: NLDFA 2003/2004

**Figure 9-21 Location of Commercial Aquaculture Operations in Placentia Bay (2012)**

**Table 9-8 Placentia Bay Aquaculture Sites (2012): Enterprise Name, Location and Species**

| Lic # | Species | Licencee | Location | Size (Ha) | Lat | Long |
|---|---|---|---|---|---|---|
| 53 | Blue Mussels | Baie Sea Farms Limited | St. Croix Bay | 36 | 47.4455 | -53.8641 |
| 54 | Blue Mussels | Baie Sea Farms Limited | Crawley Island | 3.5 | 47.4250 | -53.8723 |
| 490 | Blue Mussels | Baie Sea Farms Limited | Crawley Island, Long Harbour, PB | 3.3 | 47.4250 | -53.8592 |
| 474 | Blue Mussels and Oyster | Merasheen Mussel Farms Inc. | Merasheen Island, P. Bay | 112 | 47.6165 | -54.1642 |
| 561 | Blue Mussels | Merasheen Mussel Farms Inc. | Big South West Cove, Merasheen Island | 71.7 | 47.5733 | -54.1727 |
| 666 | Atlantic Cod | Norman, Bernard | Jerseyman Island, Placentia Bay | 8 | 47.3348 | -54.8875 |
| Source: T. Budgell, NLDFA, pers. comm., 2012 | | | | | | |

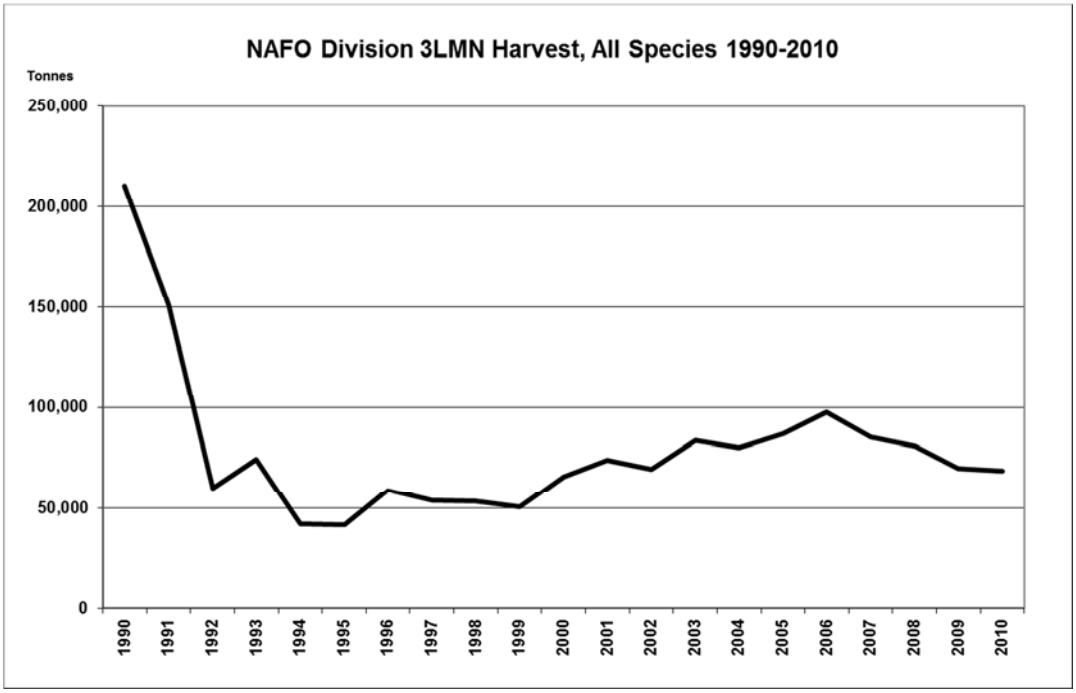
### 9.3.3 Offshore

The existing conditions of the commercial fisheries within the Offshore Study Project Areas are described in this section, with a primary focus on domestic Canadian fisheries. This overview also characterizes international fisheries in the general area as well. The Offshore Study and Project Areas are shown in relation to Canada's 200 nm Exclusive Economic Zone, NAFO fisheries management divisions, and data/management UAs in Figure 9-2.

#### 9.3.3.1 Historical Overview of Regional Fisheries (Eastern Grand Banks)

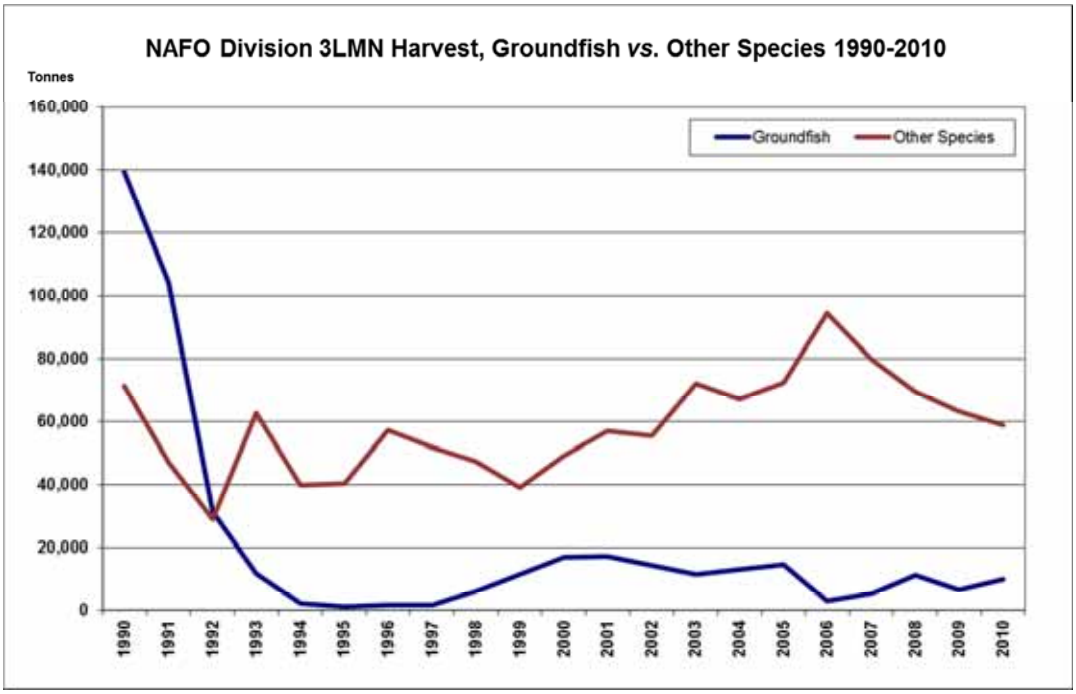
For many decades before 1992, most of the harvesting in the offshore areas of the eastern Grand Bank was groundfish (i.e., demersal species), taken by large stern otter trawlers harvesting Atlantic cod, redfish, American plaice and several other species. In 1992, with the acknowledgement of the collapse of several of these stocks, a harvesting moratorium was declared and directed fisheries for cod virtually ended in the area. In 2003, COSEWIC listed the Atlantic cod (Newfoundland and Labrador population) as an endangered species. Northern shrimp and snow crab are now the principal catches by most harvesters in the Offshore Study Area, as they are in many other areas offshore Newfoundland and Labrador, though some groundfish harvesting continues throughout the area. Other economically important fisheries in the Offshore Study Area are for deep sea clams (propeller clams, Stimpson's surf and Greenland cockles), beginning in 1989. In Newfoundland and Labrador waters, this fishery is localized primarily near eastern and southeastern edges of the Bank.

The quantity of overall fish catches between 1990 and 2010 from within NAFO Divisions 3LMN (which include the great majority of the Offshore Study Area) are presented in Figure 9-22. Groundfish are compared with the harvest of other species for the same period in Figure 9-23. Within UA 3Lt, (which contains the Project Area), historical landings have been similar, except that the impact of the closures on groundfish harvesting has been even more pronounced, and 3Lt has consistently recorded harvests of less than 2 percent of its pre-1992 levels. In 2010, there was no groundfish catch recorded there. However, it should be noted that even before the moratorium (e.g., 1984 to 1990), UA 3Lt usually accounted for just over 2 percent of the NAFO 3L groundfish harvest.




Source: DFO Catch and Effort Data 1990 to 2010

**Figure 9-22 Northwest Atlantic Fisheries Organization Divisions 3LMN Harvest, All Species, 1990 to 2010**




Source: DFO Catch and Effort Data 1990 to 2010

**Figure 9-23 Northwest Atlantic Fisheries Organization Divisions 3LMN Groundfish versus Other Species Harvests, 1986 to 2008**

### 9.3.3.2 Current Domestic Fisheries

The Offshore Study Area fisheries have been relatively stable since about 2000, as the preceding graphs show. Although fishers hope that the groundfish fisheries (especially cod) will return to previous levels throughout the Grand Banks, it is still not known when or if this might occur. The average Canadian-landed harvest for 2005 to 2010 by quantity and value reported within the Offshore Study Area is shown in Table 9-9. The principal fisheries are northern shrimp and snow crab, which together accounted for 76.6 percent of the harvest by quantity and 86.2 percent by value in those years. The remaining fisheries are groundfish (mainly yellowtail flounder and turbot (Greenland halibut)) and a variety of deep water bivalves (clams, scallops), along with smaller quantities of large pelagic species (swordfish, tunas).

**Table 9-9 Offshore Study Area Harvest by Species, 2005 to 2010 Annual Average, Quantity and Value**

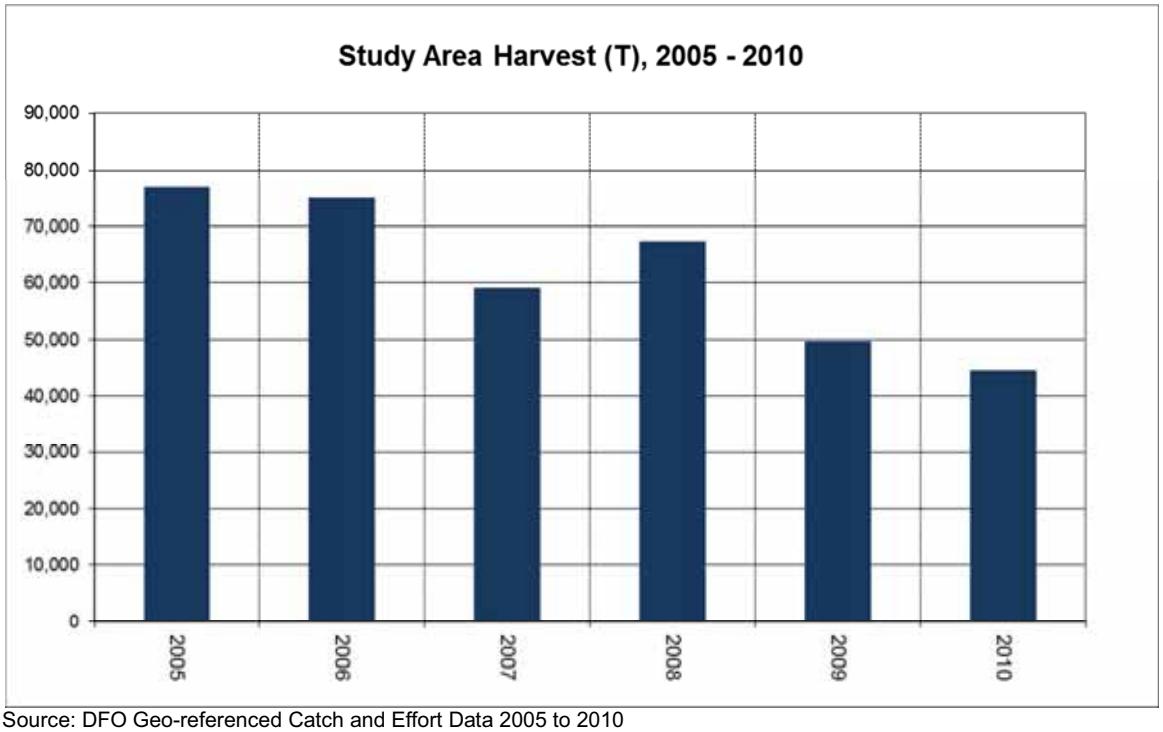
| Species | Tonnes | % of Total by T | $ | % of Total by $ |
|---|---|---|---|---|
| Northern Shrimp | 27,235 | 43.9% | 32,653,382 | 29.7% |
| Snow Crab | 20,335 | 32.7% | 62,048,270 | 56.5% |
| Groundfish | 9,373 | 15.1% | 8,776,586 | 8.0% |
| Deep Sea Clams | 4,974 | 8.0% | 5,776,673 | 5.3% |
| Icelandic Scallops | 78 | 0.1% | 110,772 | 0.1% |
| Large Pelagics | 60 | 0.1% | 477,379 | 0.4% |
| All Other Species | 52 | 0.1% | 18,378 | 0.0% |
| Total | 62,107 | | 109,861,440 | |
| Source: DFO Geo-referenced Catch and Effort Data 2005 to 2010 | | | | |

Within the Offshore Project Area, the harvest has been exclusively for snow crab since 2005 (Table 9-10).

**Table 9-10 Offshore Project Area by Species, 2005 to 2010 Annual Average, Quantity and Value**

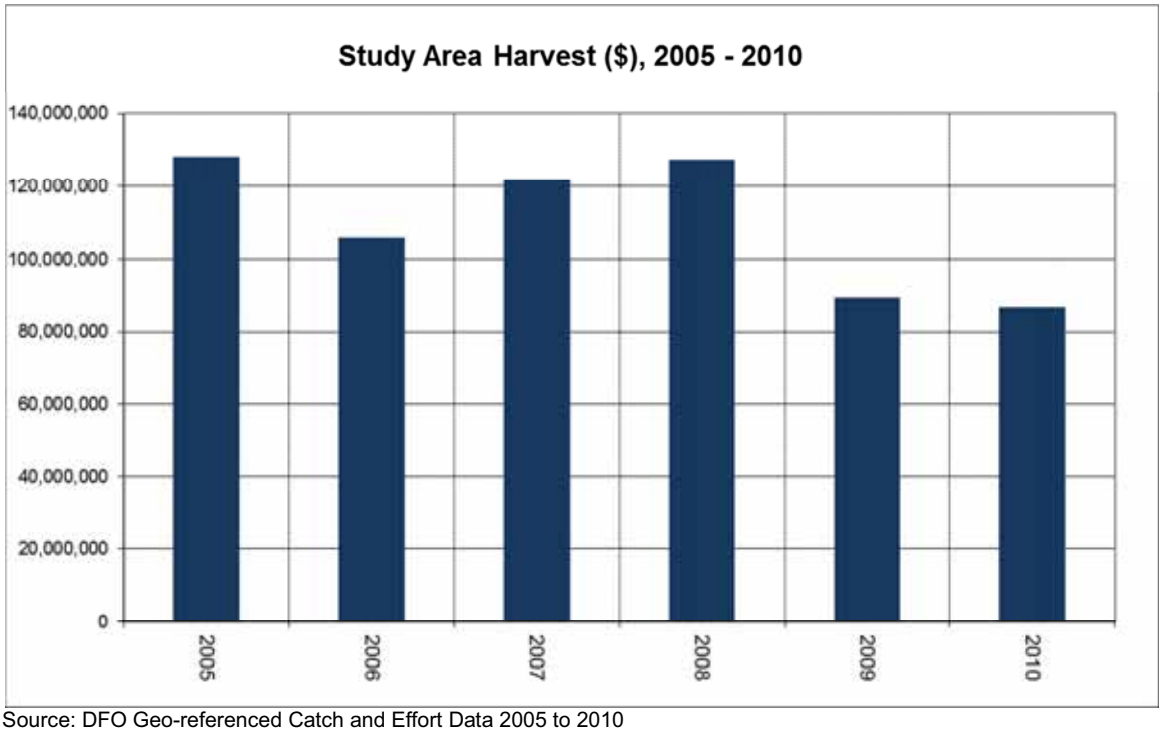
| Species | Tonnes | % of Total by T | $ | % of Total by $ |
|---|---|---|---|---|
| Snow Crab | 6 | 100% | 21,482 | 100% |
| Total | 6 | | 21,482 | |
| Source: DFO Geo-referenced Catch and Effort Data 2005 to 2010 | | | | |

The recent (2005 to 2010) annual levels of harvesting by quantity and value within the Offshore Study and Project Areas are plotted in Figures 9-24 to 9-27.



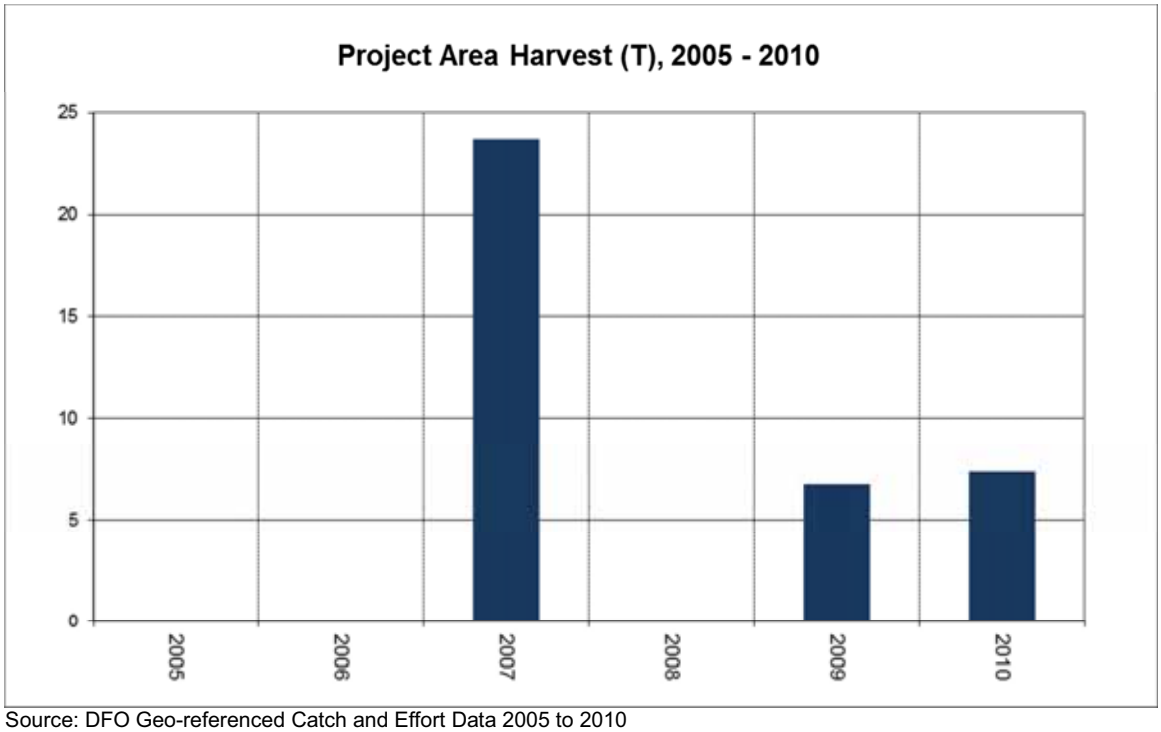

Source: DFO Geo-referenced Catch and Effort Data 2005 to 2010

**Figure 9-24 Study Area Quantity of Harvest by Year, All Species, 2005 to 2010**



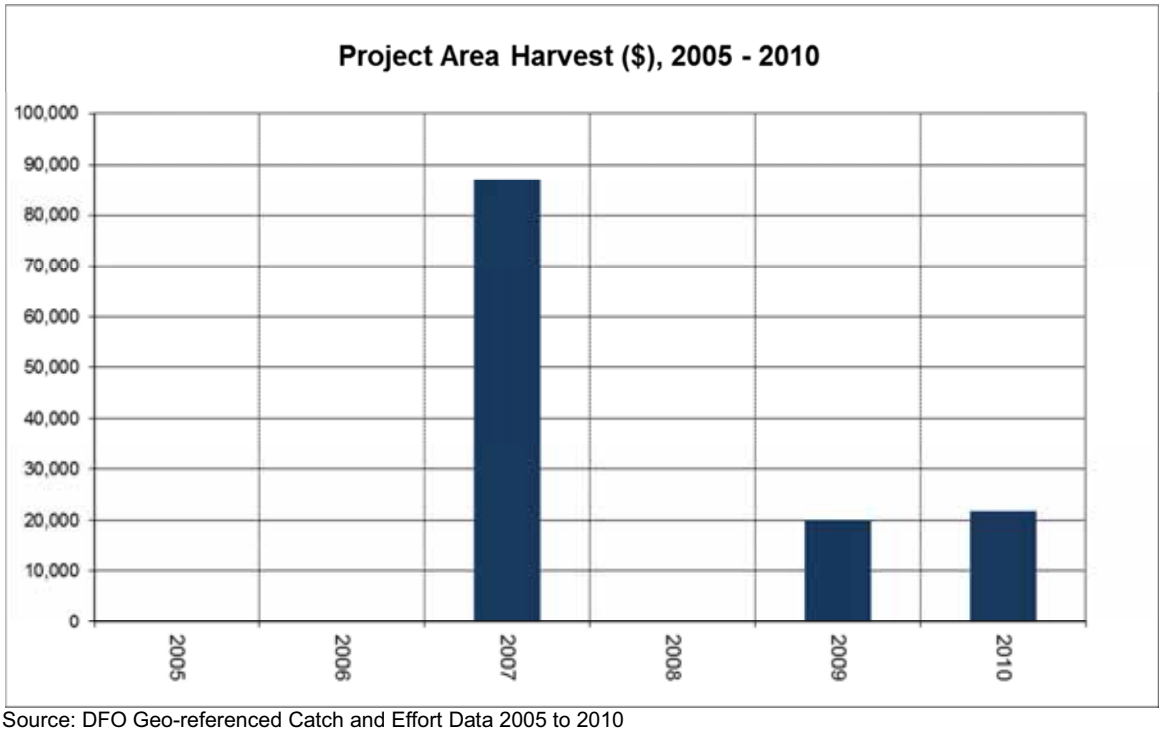

Source: DFO Geo-referenced Catch and Effort Data 2005 to 2010

**Figure 9-25 Study Area Value of Harvest by Year, All Species, 2005 to 2010**




Source: DFO Geo-referenced Catch and Effort Data 2005 to 2010

**Figure 9-26 Project Area Quantity of Harvest by Year, All Species (Snow Crab), 2005 to 2010**




Source: DFO Geo-referenced Catch and Effort Data 2005 to 2010

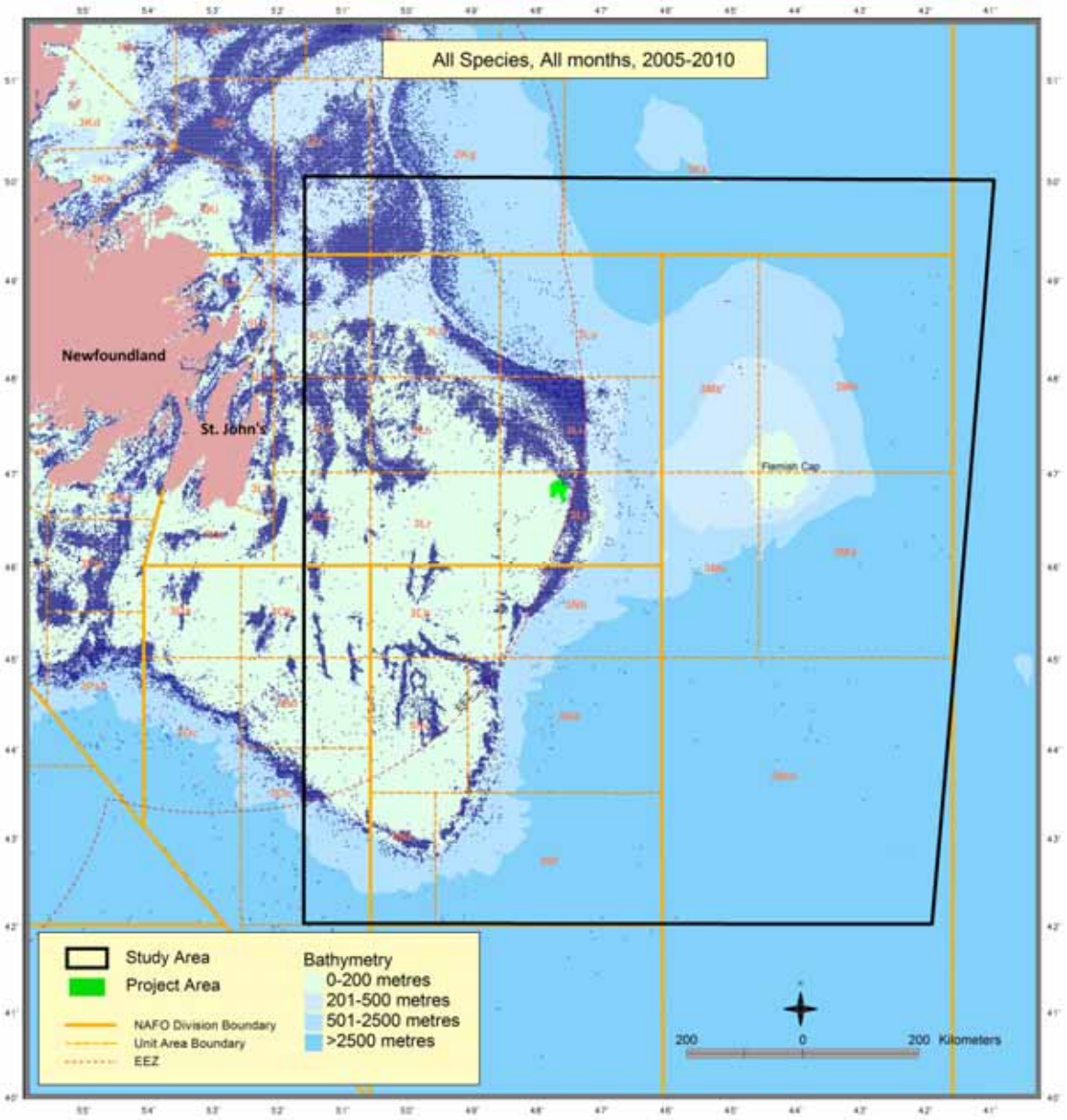
**Figure 9-27 Project Area Value of Harvest by Year, All Species (Snow Crab), 2005 to 2010**

Harvesting within the Offshore Project Area has been irregular, with no catch recorded there in three of the five years shown, and only relatively small quantities during 2009 and 2010 (Figures 9-26 and 9-27).

#### 9.3.3.3 Location and Timing of Harvest

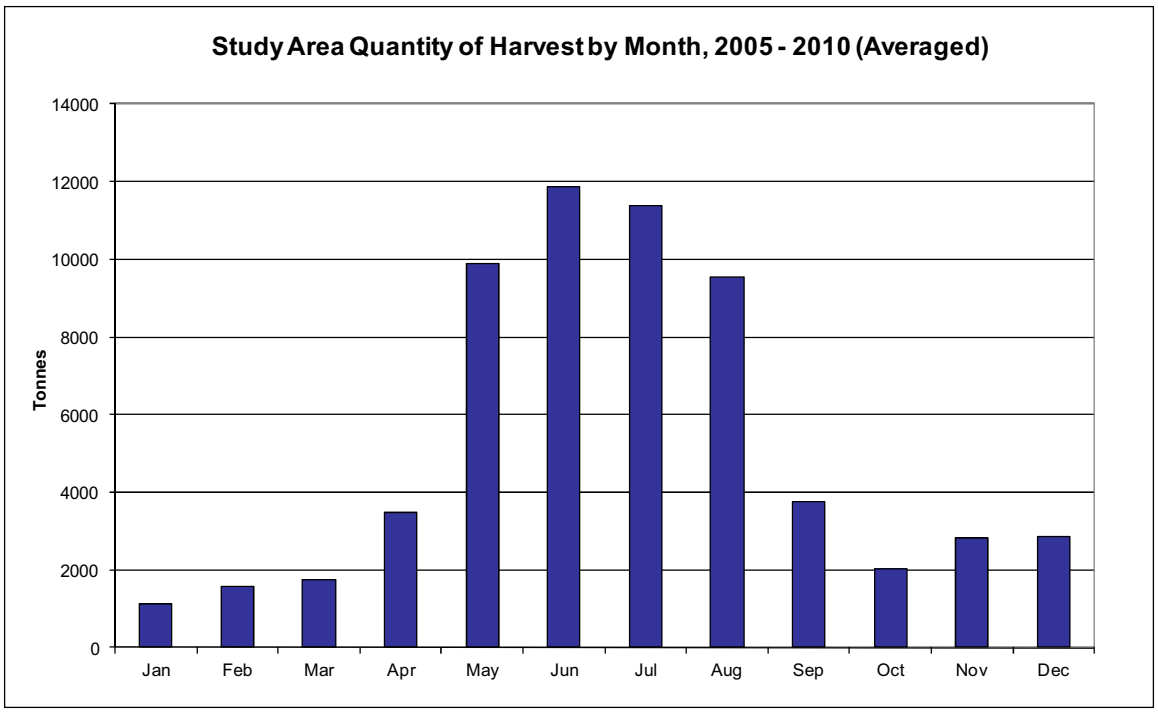
The geo-referenced harvesting locations in relation to the Offshore Study and Project Areas from 2005 to 2010, aggregated for all species during all months, are shown in Figure 9-28. Because the plots aggregate 72 full months of activity, they exaggerate the level of harvesting that would be encountered at any given time, but they define very clearly the important harvesting areas within the region. As illustrated in Figure 9-28, much of the fish harvesting within the Offshore Study Area is concentrated on or near the shelf edge and slope, much of this at depths between 200 and 500 m. Analysis of the locations from year to year also indicates a very high level of consistency from year to year since the late 1990s.

As indicated in Figures 9-29 and 9-30, harvesting effort and income are typically highest May to August and lowest during the fall and winter. The variability results as different species become the focus of the commercial fishing effort, based on resource availability, fisheries management plans and enterprise harvesting strategies. Typically, in the spring and summer, the catch is mainly snow crab and northern shrimp, although some shrimp harvesting occurs year round. Groundfish and clams may also be harvested in every month, although more of the clams are harvested in the early winter and early spring.



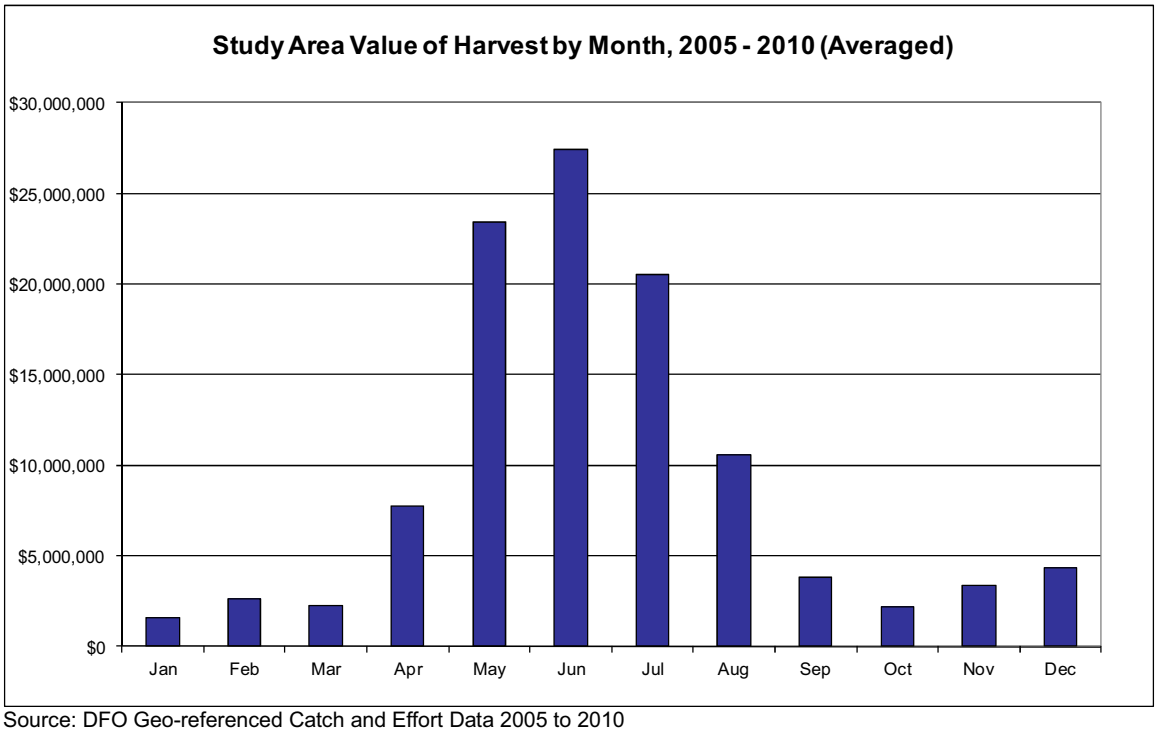

Source: DFO Geo-referenced Catch and Effort Data 2005 to 2010

**Figure 9-28 Domestic Harvesting Locations, All Species, All Months 2005 to 2010**




Source: DFO Geo-referenced Catch and Effort Data 2005 to 2010

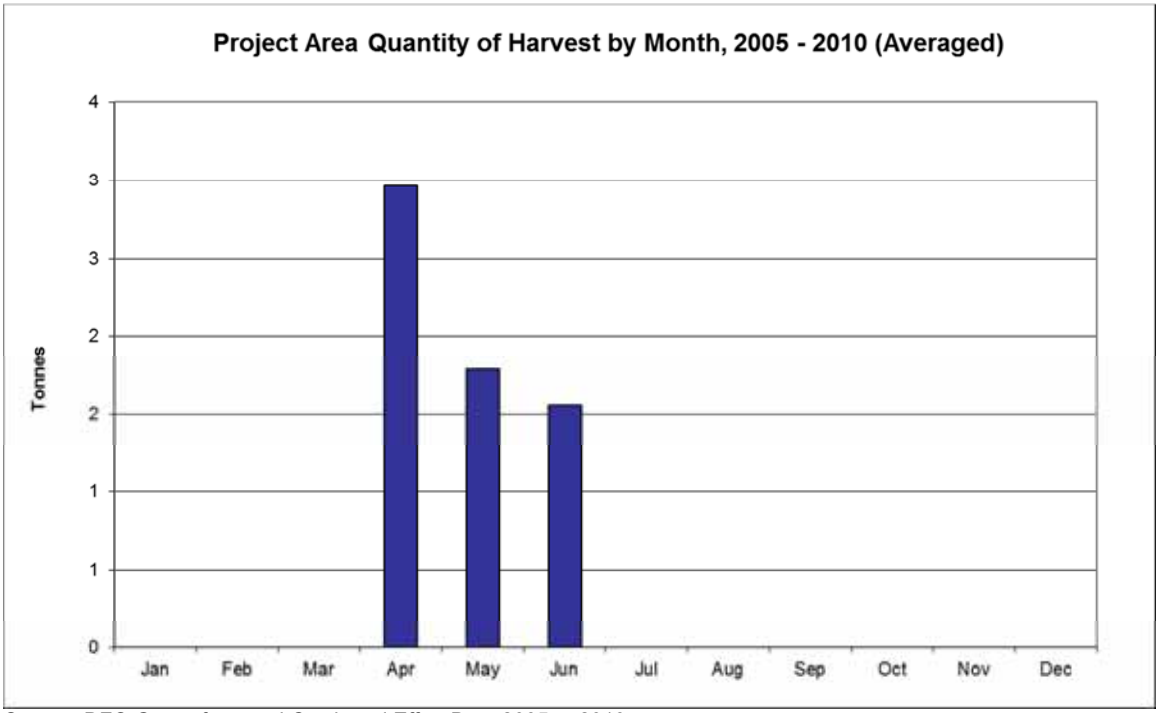
**Figure 9-29 Study Area Quantity of Harvest by Month, All Species, 2005 to 2010 Average**




Source: DFO Geo-referenced Catch and Effort Data 2005 to 2010

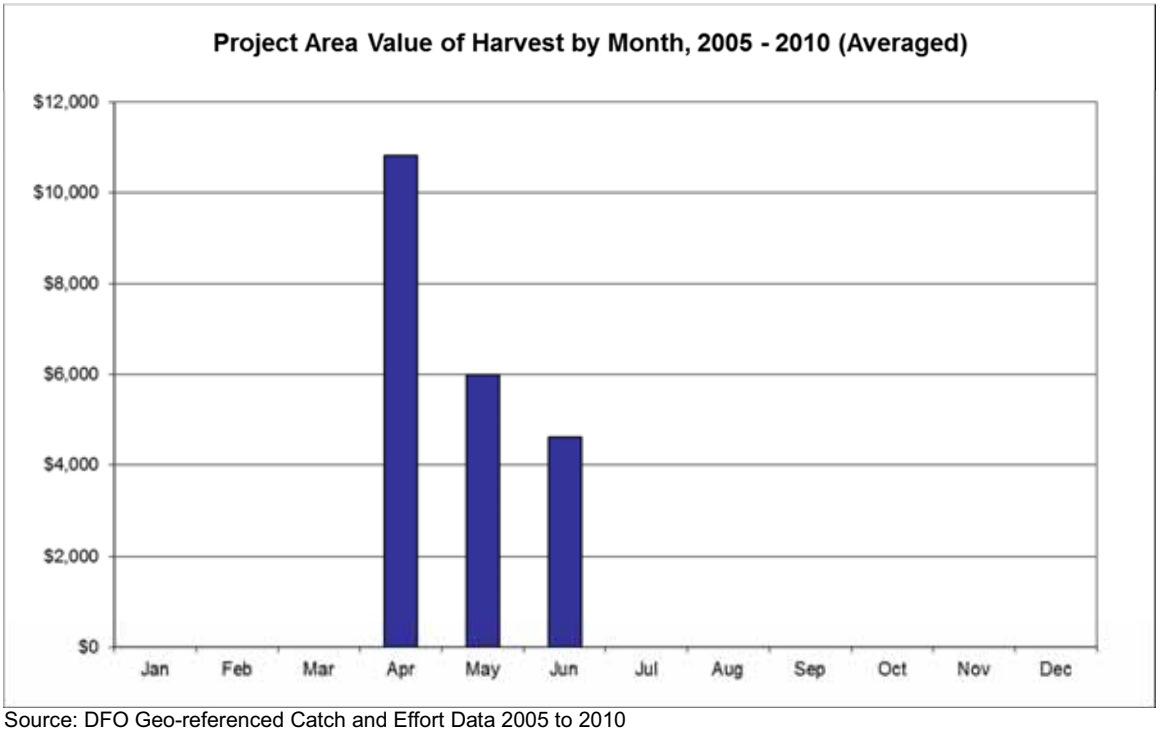
**Figure 9-30 Study Area Value of Harvest by Month, All Species, 2005 to 2010 Average**

Within the Offshore Project Area, there was no recorded harvest before April and none after June during the 2005 to 2010 period (Figures 9-31 and 9-32). As noted above, the only harvest recorded there was snow crab.




Source: DFO Geo-referenced Catch and Effort Data 2005 to 2010

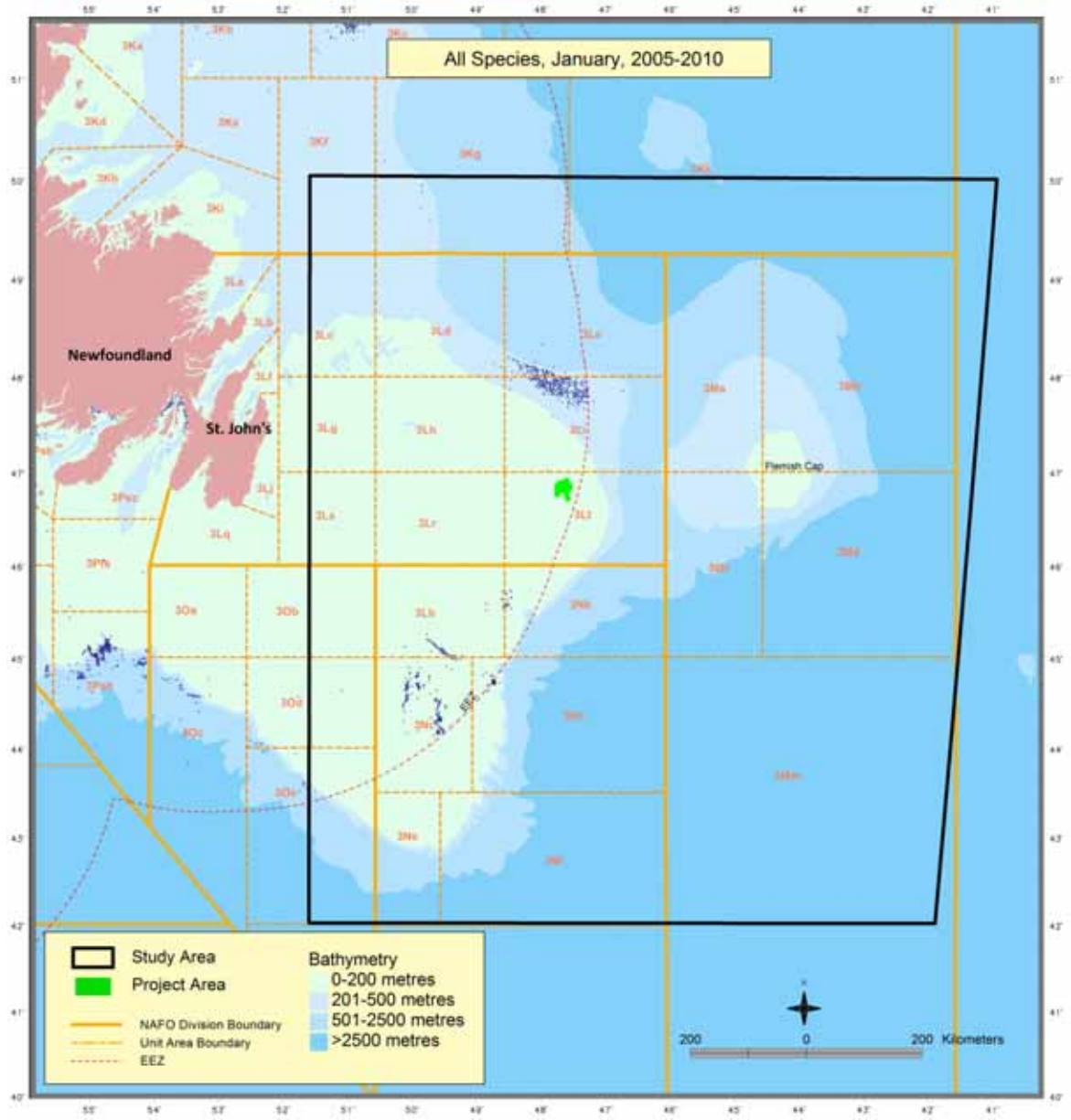
**Figure 9-31 Project Area Quantity of Harvest by Month, All Species, 2005 to 2010 Average**




Source: DFO Geo-referenced Catch and Effort Data 2005 to 2010

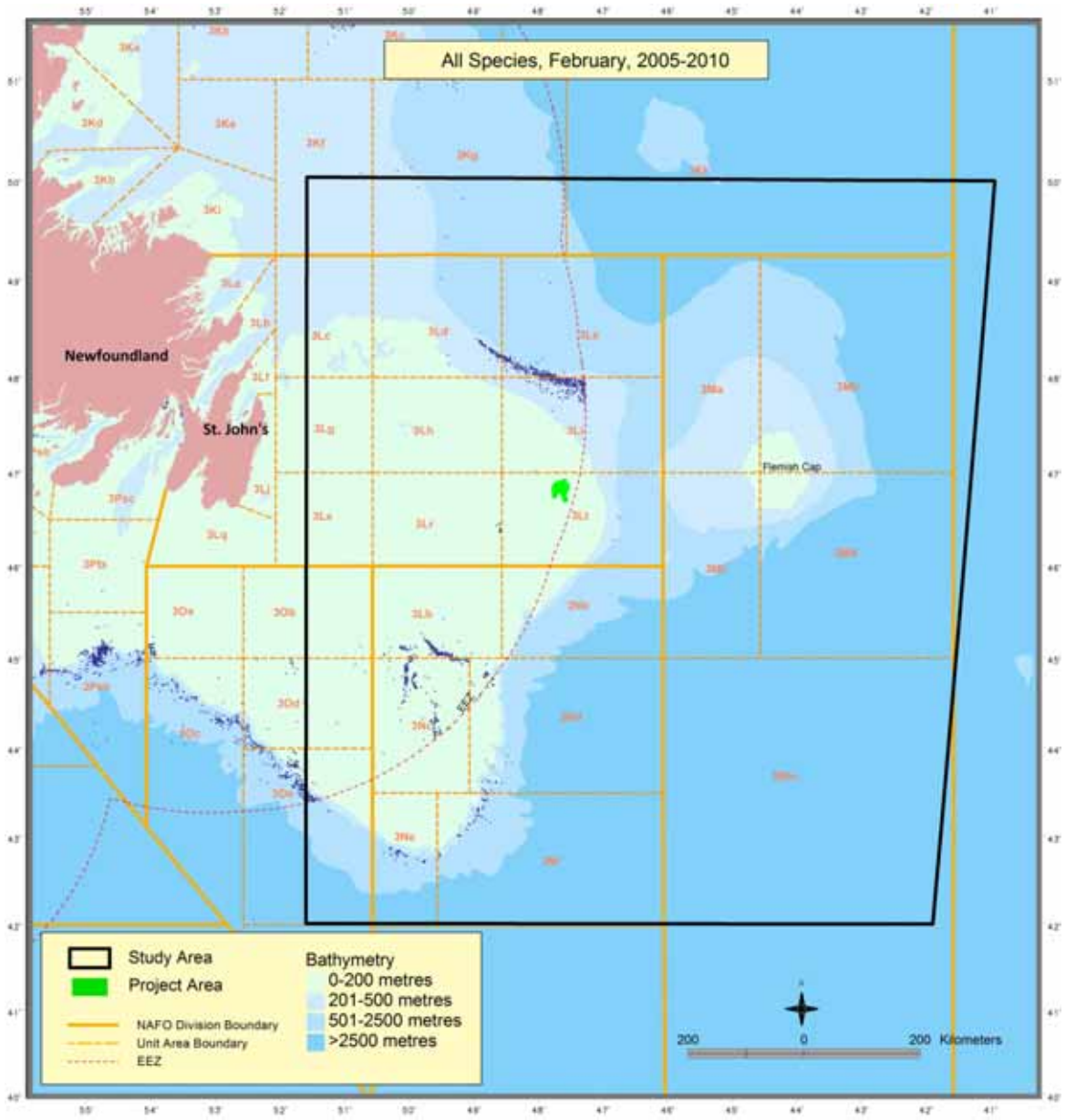
**Figure 9-32 Project Area Value of Harvest by Month, All Species, 2005 to 2010 Average**

The locations of domestic harvesting by month for all species (data aggregated for 2005 to 2010) in relation to the Offshore Study and Project Areas are shown in Figures 9-33 to 9-44.



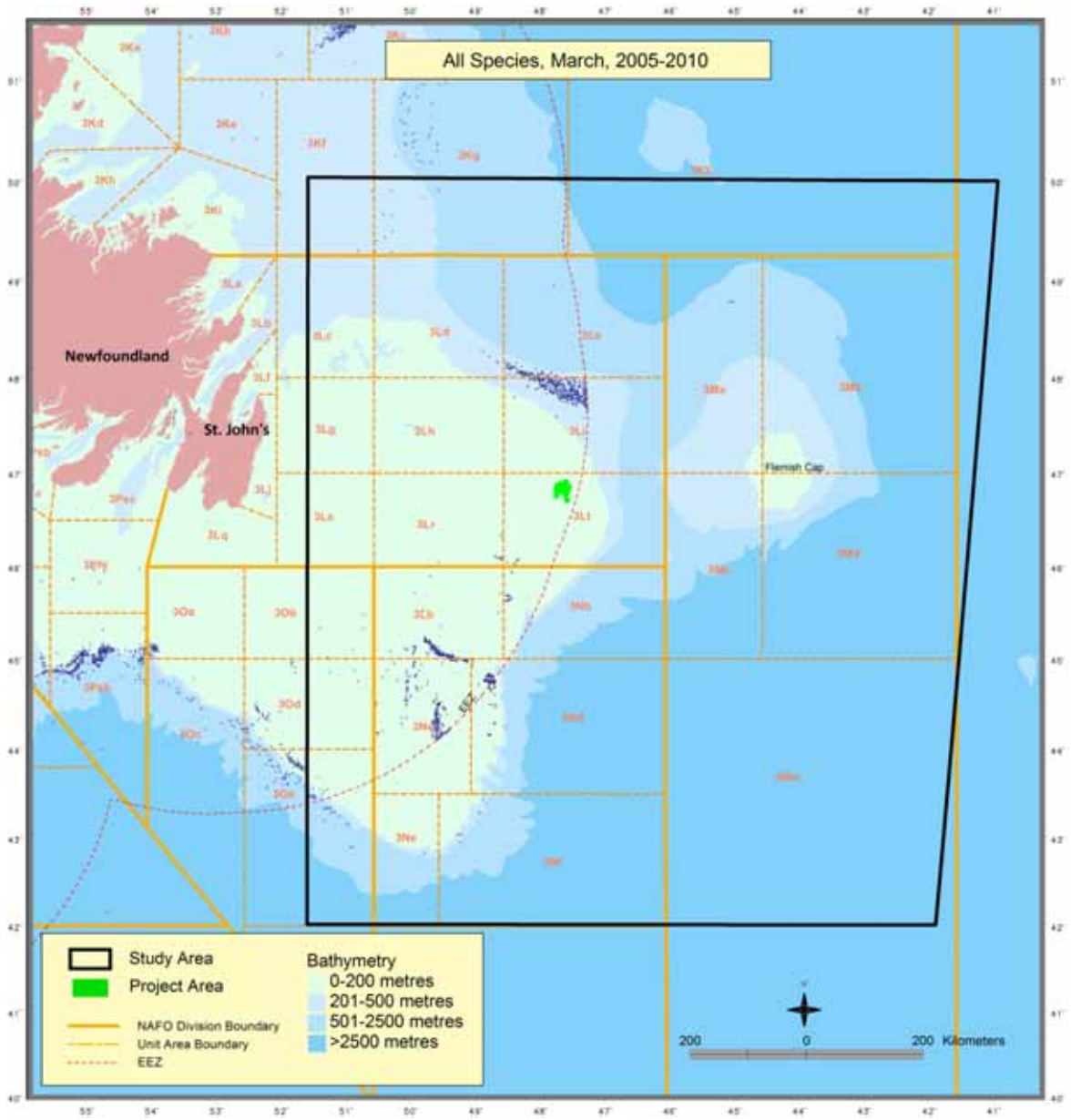

Source: DFO Geo-referenced Catch and Effort Data 2005 to 2010

**Figure 9-33 January Domestic Harvesting Locations, All Species, 2005 to 2010**



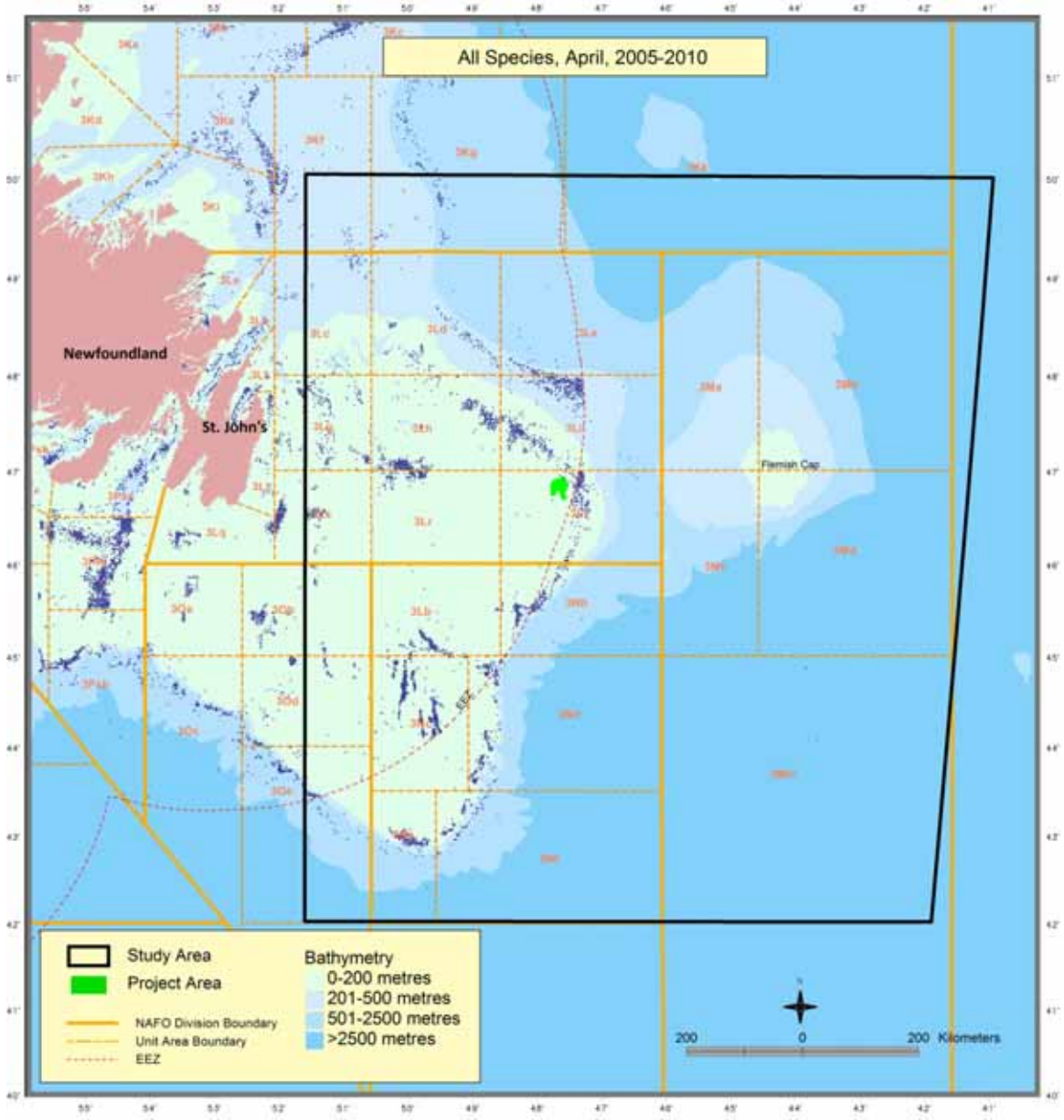

Source: DFO Geo-referenced Catch and Effort Data 2005 to 2010

**Figure 9-34 February Domestic Harvesting Locations, All Species, 2005 to 2010**



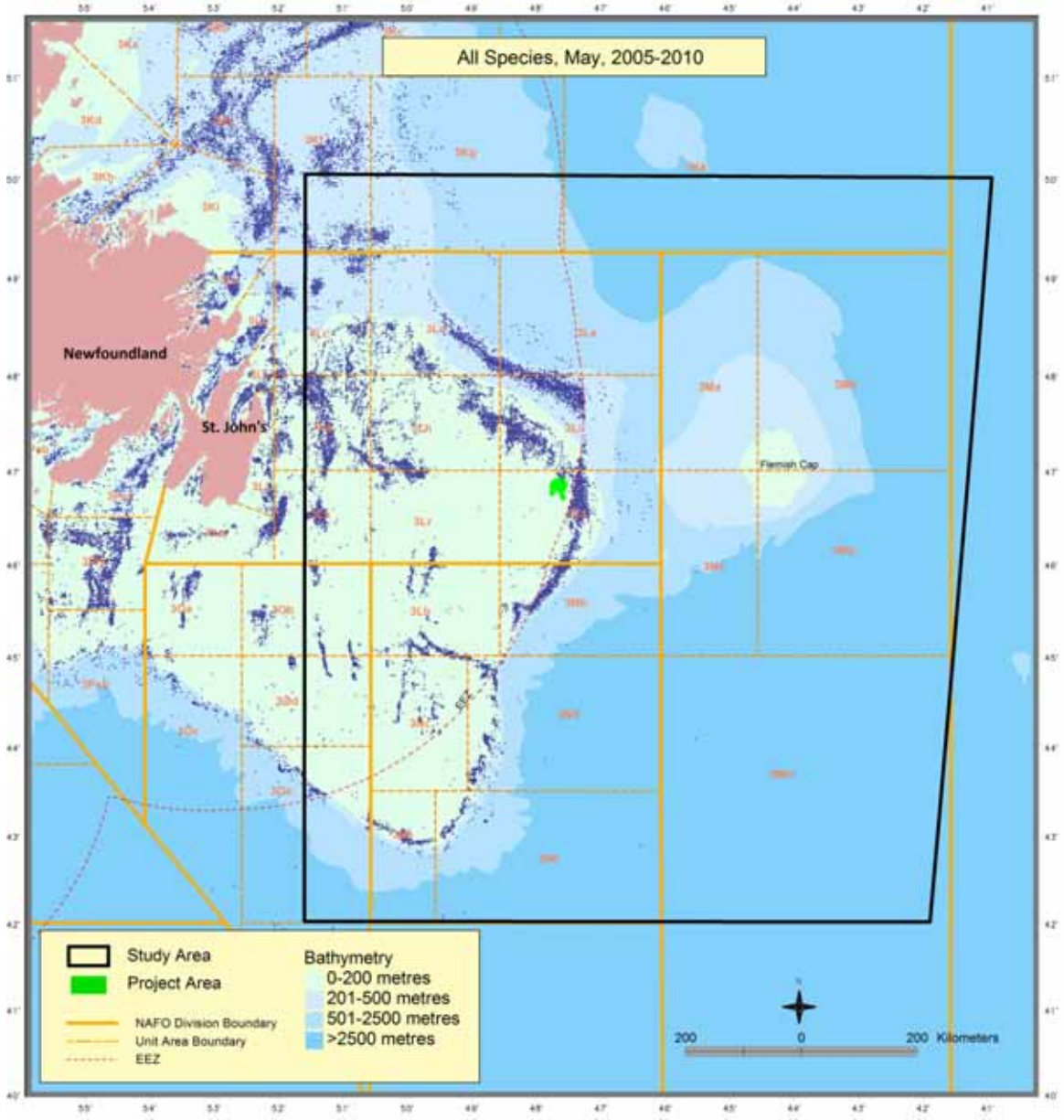

Source: DFO Geo-referenced Catch and Effort Data 2005 to 2010

**Figure 9-35 March Domestic Harvesting Locations, All Species, 2005 to 2010**



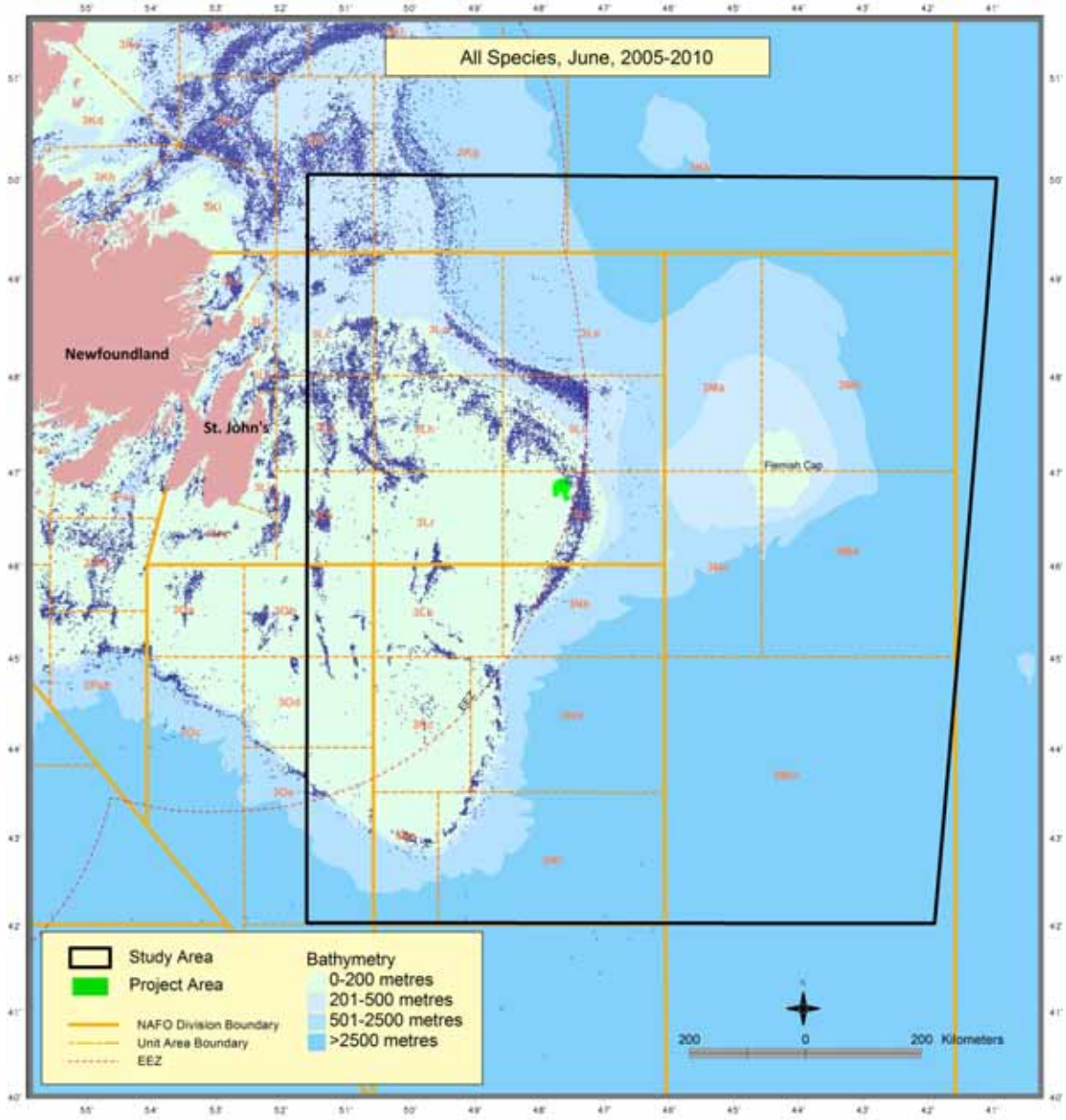

Source: DFO Geo-referenced Catch and Effort Data 2005 to 2010

**Figure 9-36 April Domestic Harvesting Locations, All Species, 2005 to 2010**



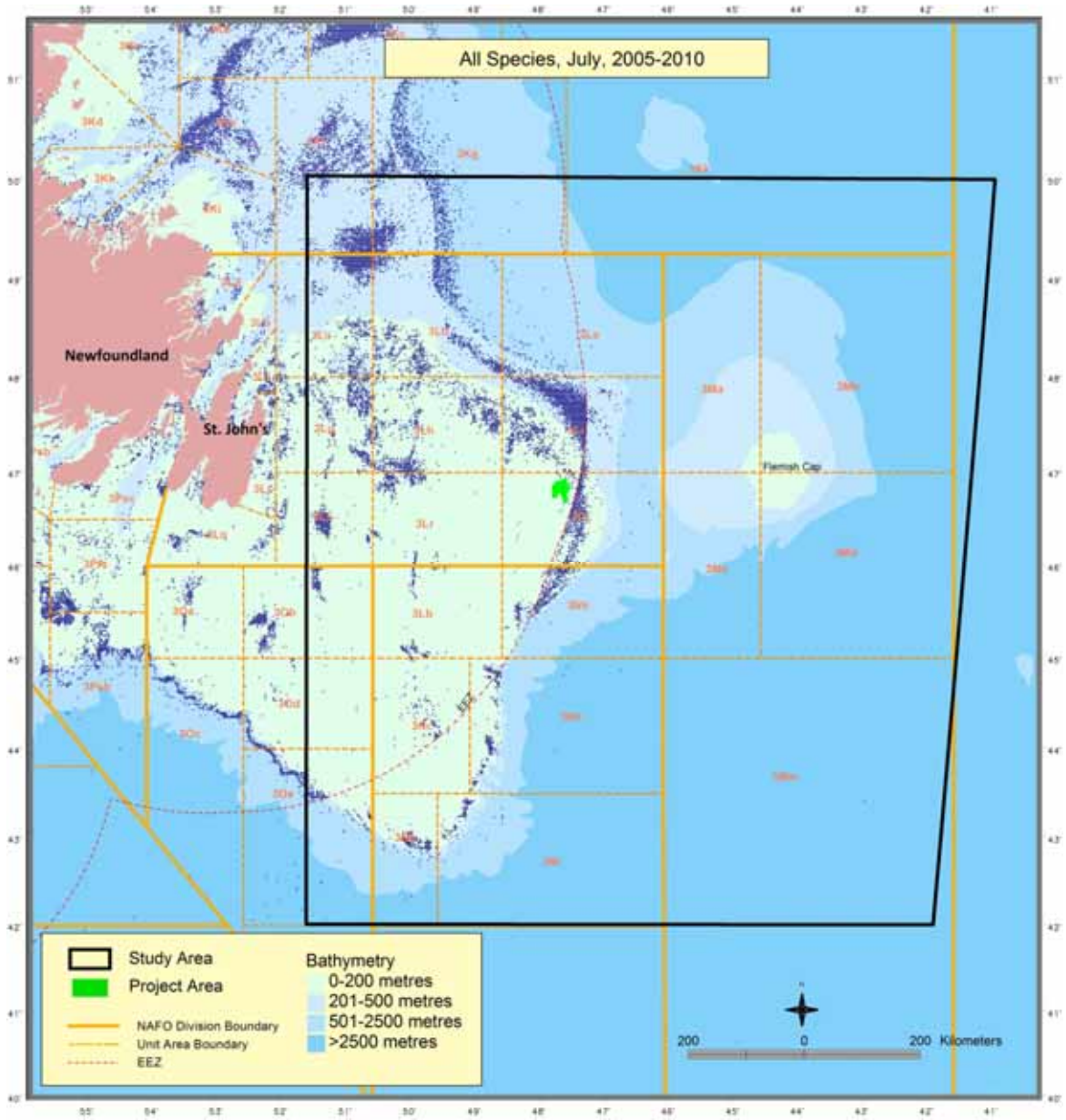

Source: DFO Geo-referenced Catch and Effort Data 2005 to 2010

**Figure 9-37 May Domestic Harvesting Locations, All Species, 2005 to 2010**



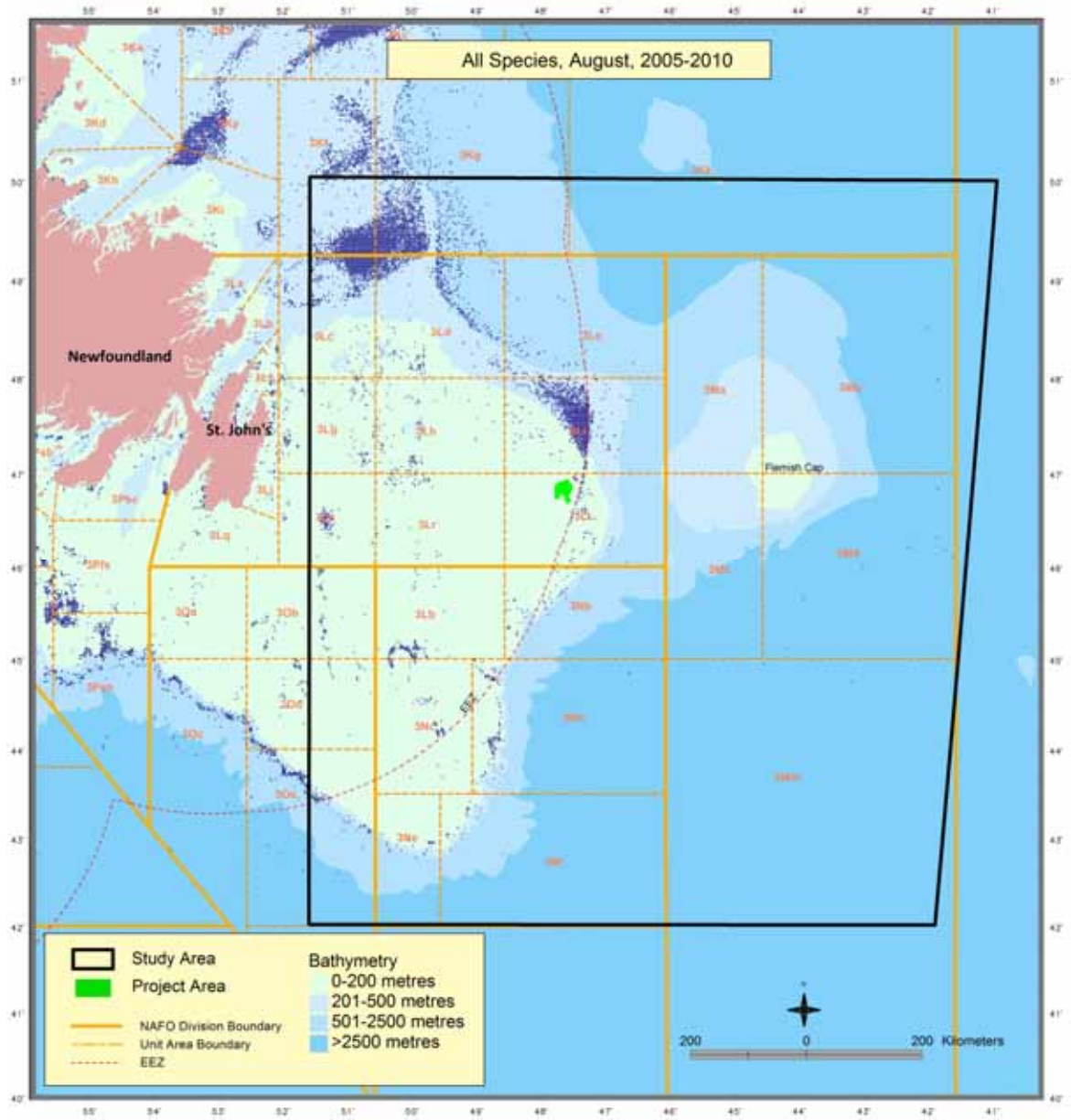

Source: DFO Geo-referenced Catch and Effort Data 2005 to 2010

**Figure 9-38 June Domestic Harvesting Locations, All Species, 2005 to 2010**



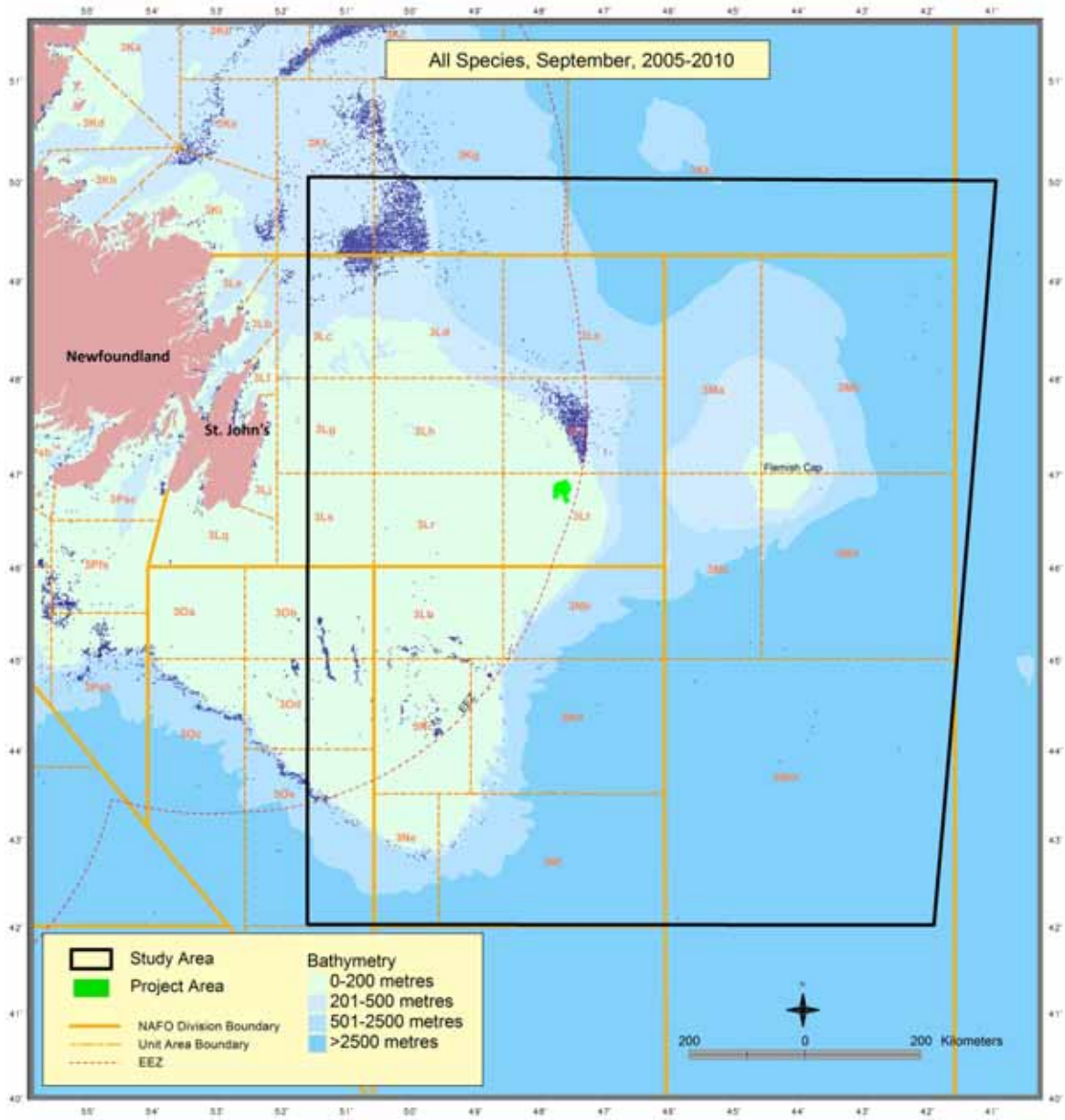

Source: DFO Geo-referenced Catch and Effort Data 2005 to 2010

**Figure 9-39 July Domestic Harvesting Locations, All Species, 2005 to 2010**



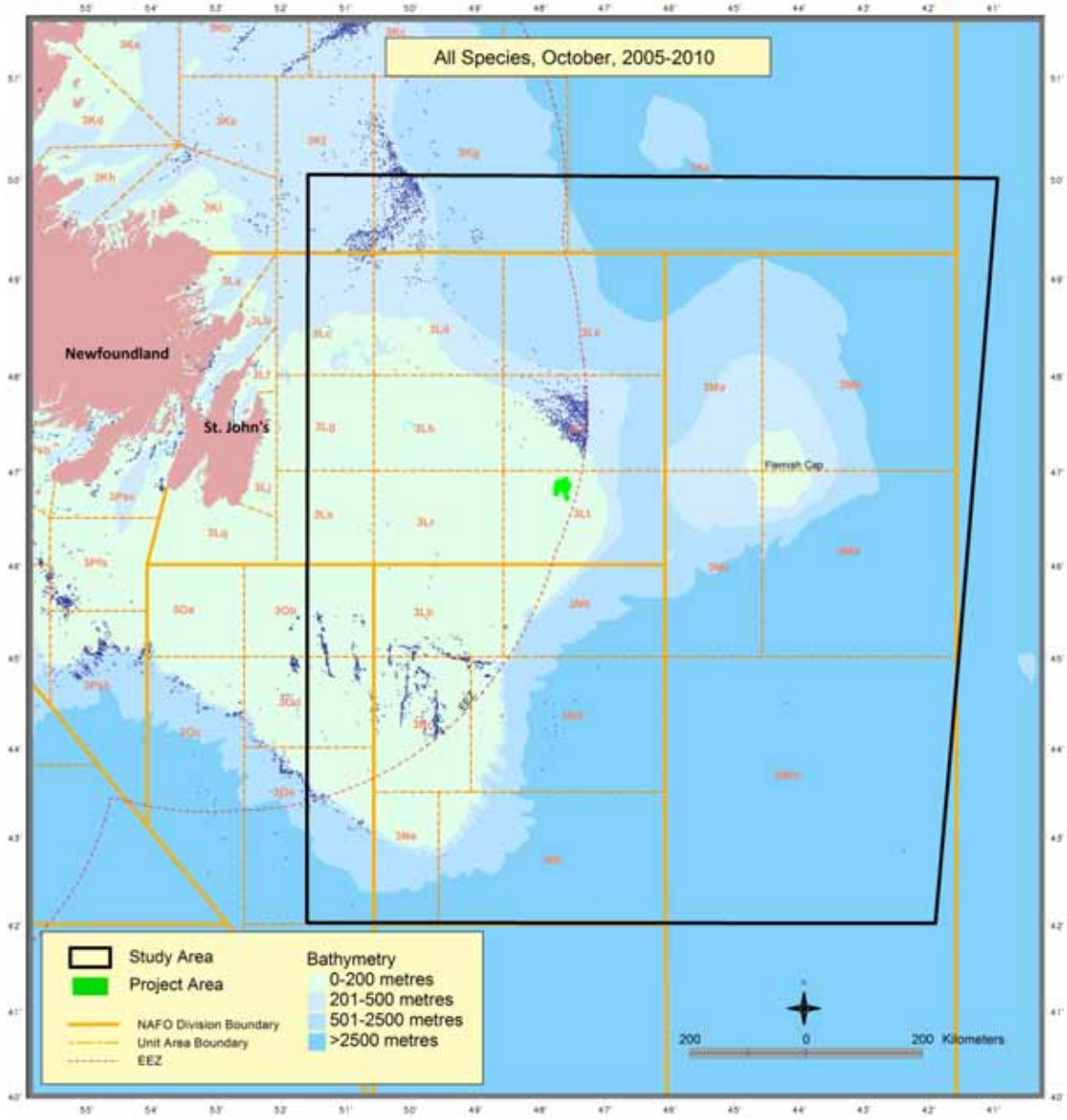

Source: DFO Geo-referenced Catch and Effort Data 2005 to 2010

**Figure 9-40 August Domestic Harvesting Locations, All Species, 2005 to 2010**



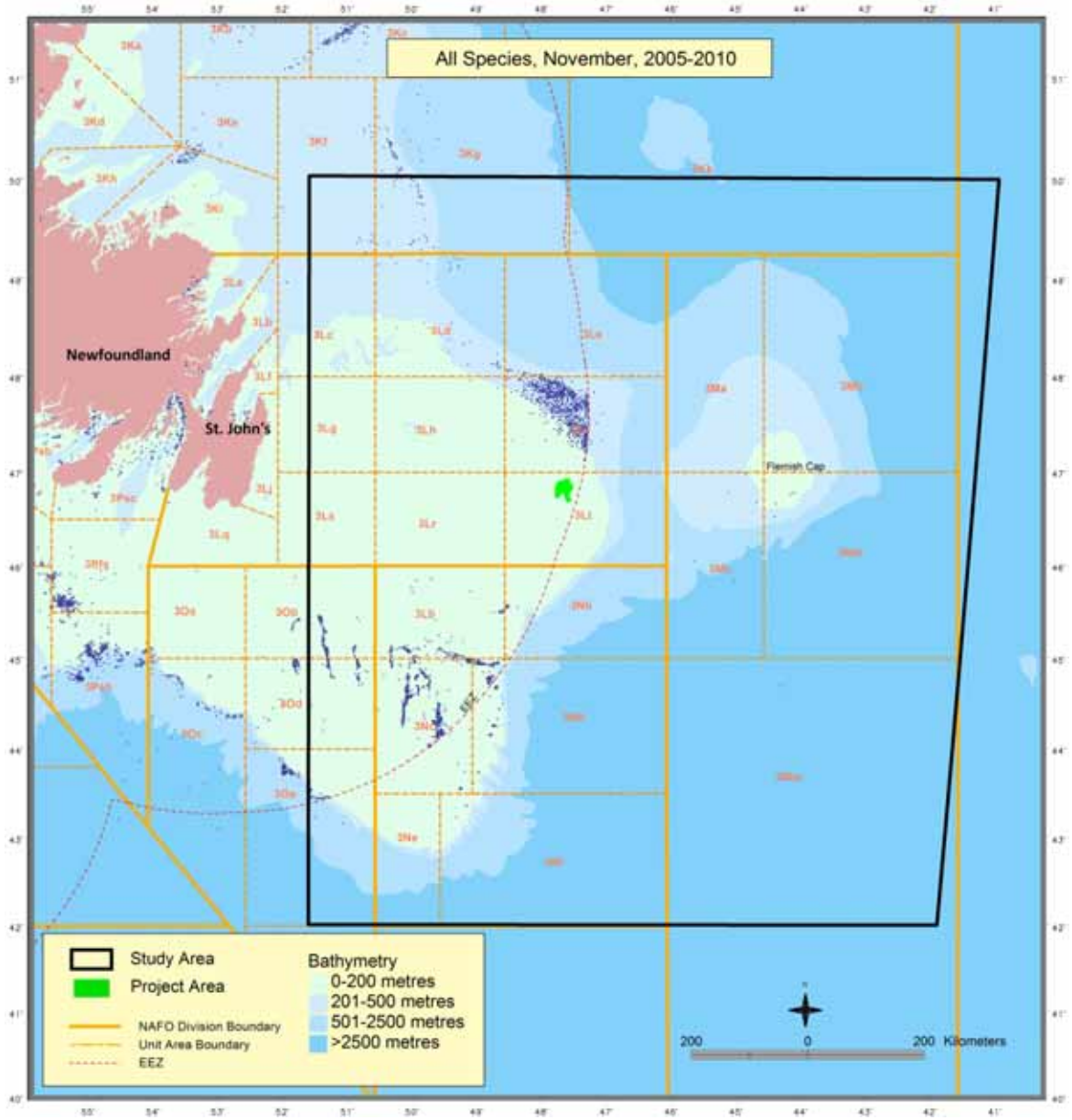

Source: DFO Geo-referenced Catch and Effort Data 2005 to 2010

**Figure 9-41 September Domestic Harvesting Locations, All Species, 2005 to 2010**



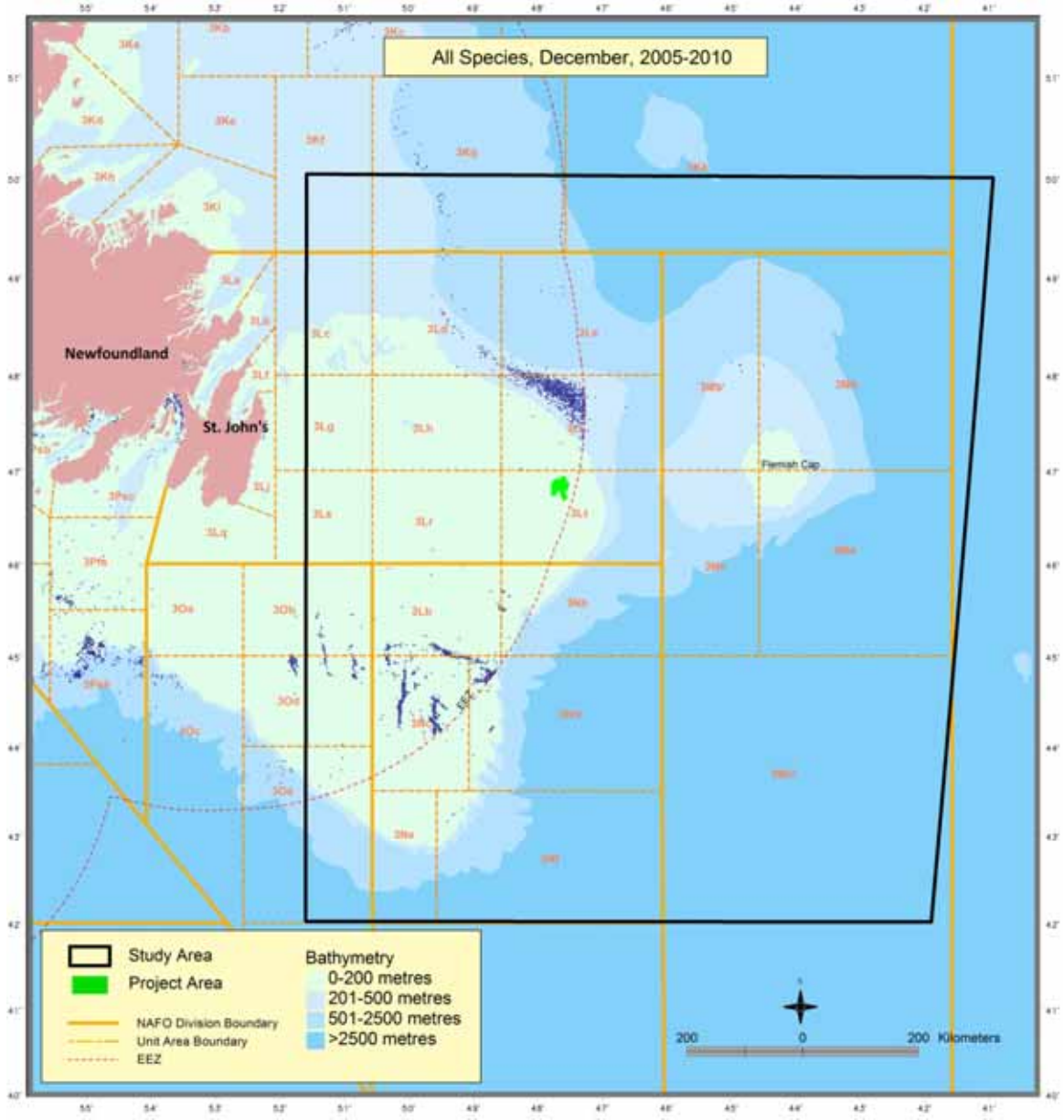

Source: DFO Geo-referenced Catch and Effort Data 2005 to 2010

**Figure 9-42 October Domestic Harvesting Locations, All Species, 2005 to 2010**




Source: DFO Geo-referenced Catch and Effort Data 2005 to 2010

**Figure 9-43 November Domestic Harvesting Locations, All Species, 2005 to 2010**




Source: DFO Geo-referenced Catch and Effort Data 2005 to 2010

**Figure 9-44 December Domestic Harvesting Locations, All Species, 2005 to 2010**

### 9.3.3.4 Fishing Gear and Boats

Except for groundfish, the gear types used in the Offshore Study and Project Areas are unique to the species or species type harvested – crab pots for snow crab, shrimp trawls for northern shrimp and dredges for bivalves (Table 9-11). Groundfish is harvested primarily with stern otter trawls and most of the remainder with gillnets and longlines. Longlines are also used for the small quantity of large pelagics (tunas, swordfish) caught in the Offshore Study Area.

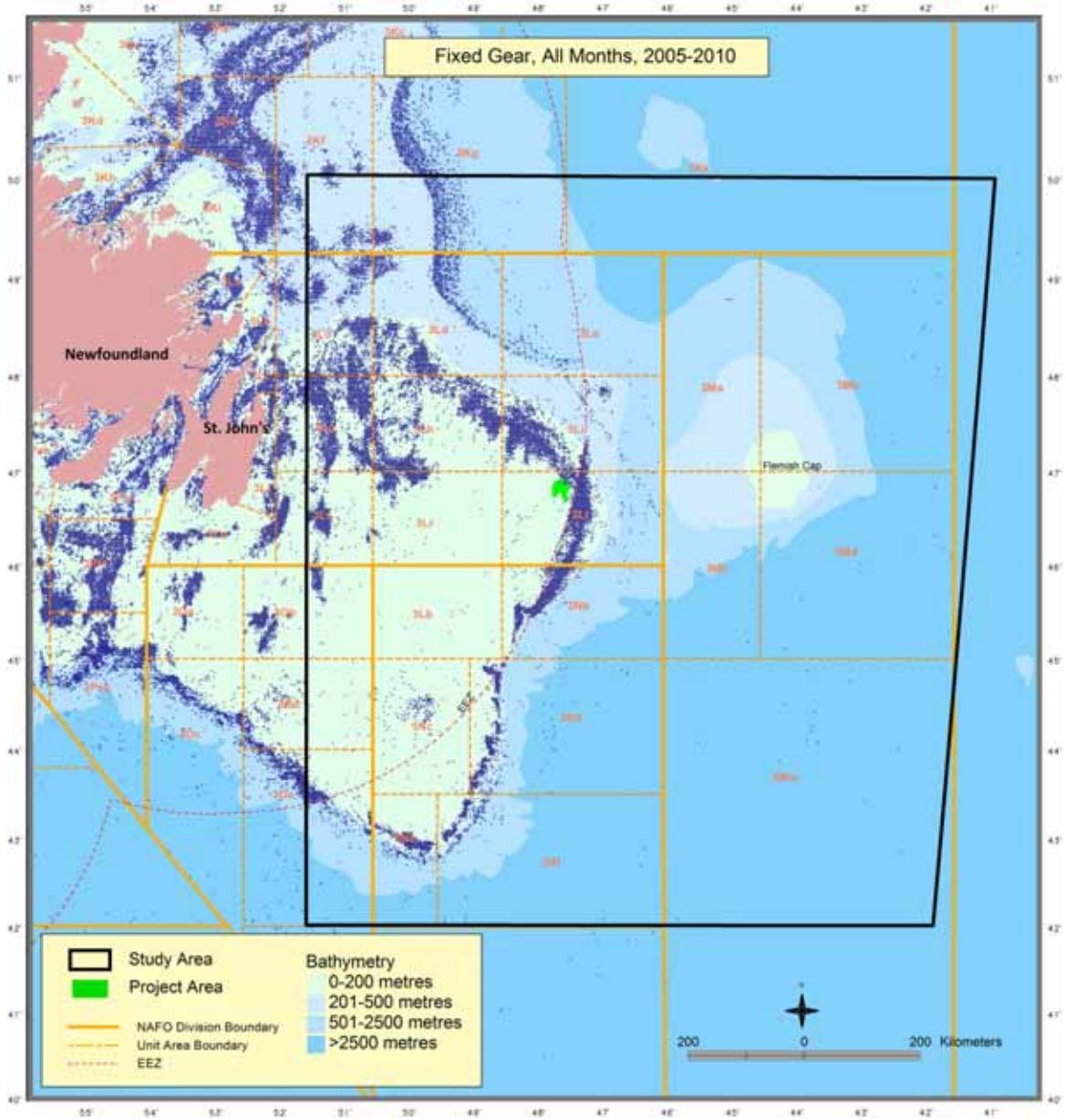
**Table 9-11 Offshore Project Area Harvest by Gear and Gear Type, 2005 to 2010 Annual Average, Quantity and Value**

| Gear | Type | T | % of Total by T | $ | % of Total by $ |
|---|---|---|---|---|---|
| Shrimp Trawl | Mobile | 27,235 | 43.9% | 32,653,517 | 29.7% |
| Crab Pot | Fixed | 20,335 | 32.7% | 62,048,429 | 56.5% |
| Bottom Otter Trawl (stern) | Mobile | 7,653 | 12.3% | 5,258,454 | 4.8% |
| Dredge (boat) | Mobile | 5,052 | 8.1% | 5,888,048 | 5.4% |
| Gillnet (set of fixed) | Fixed | 1,314 | 2.1% | 2,283,411 | 2.1% |
| Longline | Fixed | 463 | 0.7% | 1,656,787 | 1.5% |
| Purse Seine | Mobile | 26 | 0.0% | 7,860 | 0.0% |
| All Other Gears | Mixed | 17 | 0.0% | 62,176 | 0.1% |
| Tuck Seine | Fixed | 11 | 0.0% | 2,757 | 0.0% |
| Total | | 62,107 | 100.0% | 109,861,440 | 100.0% |
| Source: DFO Geo-referenced Catch and Effort Data 2005 to 2010 | | | | | |

The locations of fixed and mobile gear harvesting locations during 2004 to 2008, aggregated, are shown on Figures 9-45 and 9-46.

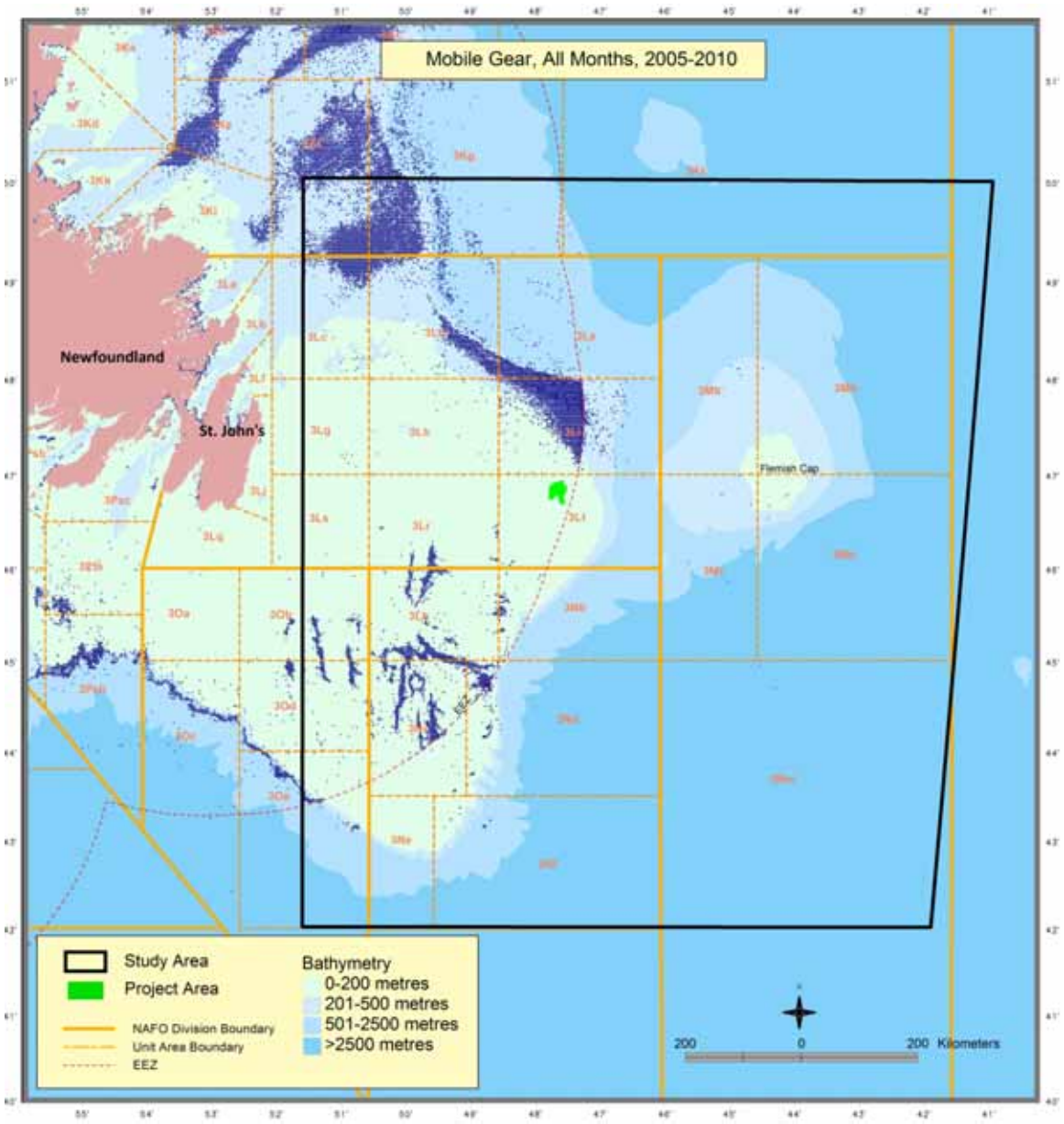
Information about the more common gear types is provided in the following sections.

Most of the harvest is taken by fishing vessels that are either mid-size (35 to 65 ft. long) or large (greater than 125 ft.) (Table 9-12). The largest ships are primarily harvesting clams, groundfish and shrimp, while the midsize boats are used mainly for crab and shrimp, although all vessel sizes harvest some groundfish.




Source: DFO Geo-referenced Catch and Effort Data 2005 to 2010

**Figure 9-45 Fixed Gear Domestic Harvesting Locations, All Species, 2005 to 2010**




Source: DFO Geo-referenced Catch and Effort Data 2005 to 2010

**Figure 9-46 Mobile Gear Domestic Harvesting Locations, All Species, 2005 to 2010**

**Table 9-12 Offshore Study Area Harvest by Vessel Length Class, 2005 to 2010 Annual Average, Quantity and Value**

| Length Class | Length | T | % of Total by Quantity | $ | % of Total by Value |
|---|---|---|---|---|---|
| 0 | Not Applicable | 53 | 0.1% | 217,145 | 0.2% |
| 1 | 1-34.9 ft | 74 | 0.1% | 241,204 | 0.2% |
| 2 | 35-44.9 ft | 6,332 | 10.2% | 16,488,334 | 15.0% |
| 3 | 45-64.9 ft | 35,786 | 57.6% | 65,693,567 | 59.8% |
| 4 | 65-99.9 ft | 1,084 | 1.7% | 2,283,554 | 2.1% |
| 5 | 100-124.9 ft | 523 | 0.8% | 1,628,521 | 1.5% |
| 6 | 125 ft or more | 18,254 | 29.4% | 23,309,114 | 21.2% |
| Total | | 62,107 | 100.0% | 109,861,440 | 100.0% |
| Source: DFO Geo-referenced Catch and Effort Data 2005 to 2010 | | | | | |

### Crab Pots

The amount of gear fishers are permitted to use varies by license category, and also by the area in which a license holder may be fishing. Crab pots are set on the seabed in strings buoyed at the surface. Crab gear generally has a highflyer (radar reflector) at one end and a large buoy at the other. Some fishers use highflyers at both ends. Depending on weather, they may be left unattended several days at a time. Fishers typically try to leave approximately 36.5 m (20 fathoms) on the seabed between each pot. Thus, allowing slack for the anchor ropes on either end of the string to extend upwards at an angle, the distance between the typical highflyer and end-buoy of a 50 to 60 pot string of crab gear, would be approximately 1.8 to 2.3 km.

### Shrimp Trawls

Shrimp harvesting uses mobile shrimp trawls. These are modified stern otter trawls, for both inshore and offshore vessels, though some use beam trawls.

### Hydraulic Dredges

Used for deep sea clams, these boat-based dredges are dragged along the sea bottom by the ship. Sea water is pumped through a large hose in front of the dredge as it is pulled along the sea floor. The jets of water temporarily fluidize the sand and allow the dredge to go through, picking up the clams.

### Stern Otter Trawls

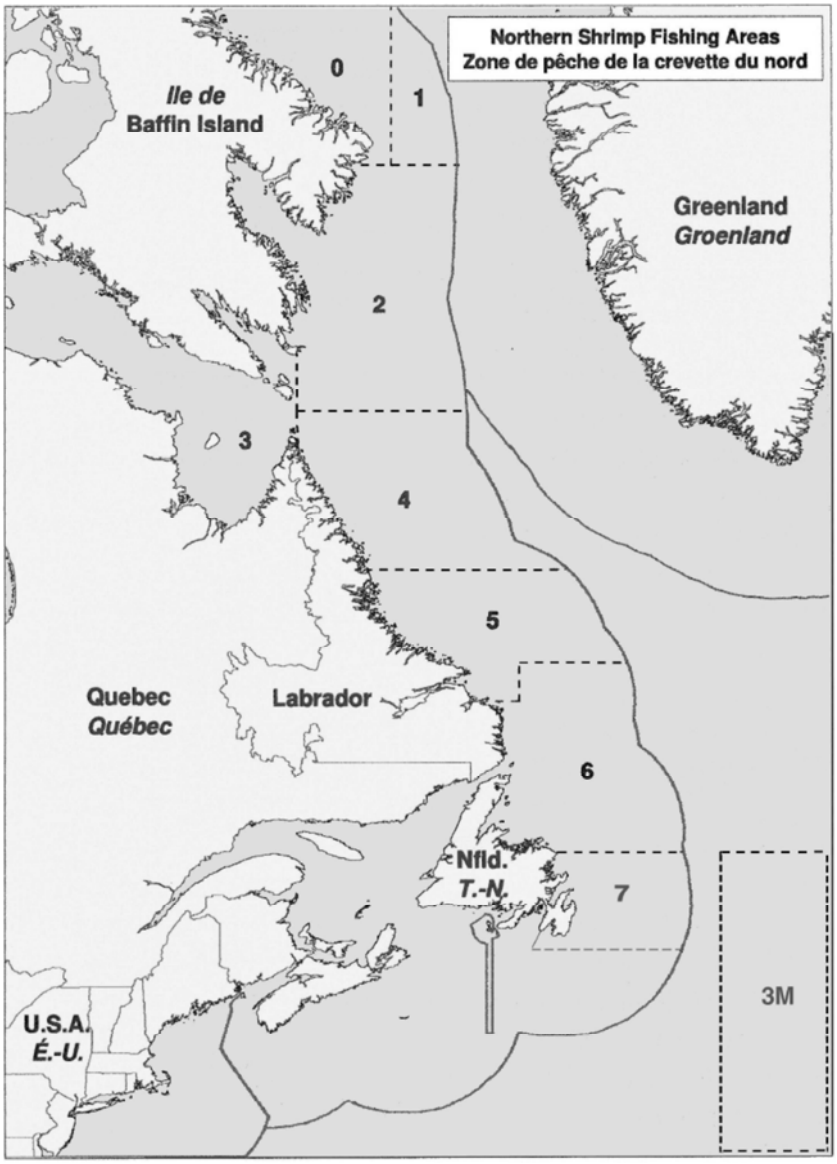
These are large bottom-tending nets towed behind vessels, most of which are approximately 46 to 61 m in length. After filling with fish, the net is winched aboard, emptied and re-deployed.

### 9.3.3.5 Details of Principal Fisheries

The following sections provide more detailed information about the principal fisheries in the Offshore Study and Project Areas.

## Northern Shrimp

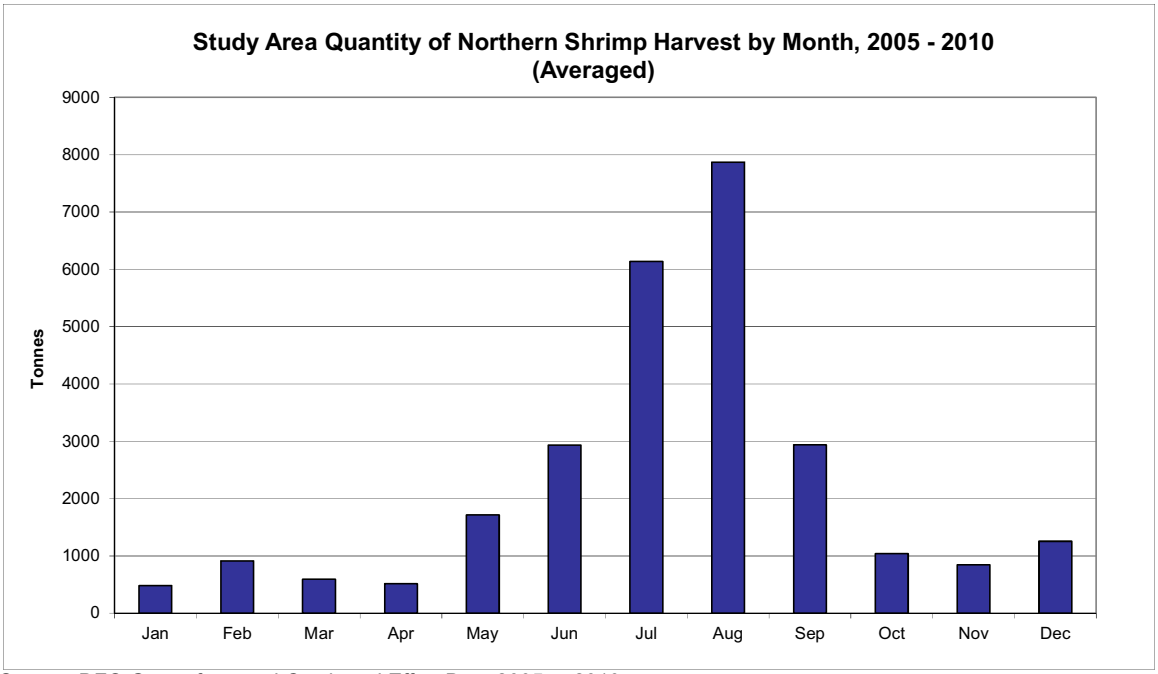
Shrimp is the largest fishery in the Offshore Study Area based on quantity of harvest, (nearly 44 percent by quantity and 30 percent by value). The Offshore Study Area overlaps shrimp fishing area (SFA) 7, a small part of SFA 6 and part of SFA 3M. The SFAs are shown in Figure 9-47.




Source: DFO/NAFO

**Figure 9-47 Shrimp Fishing Areas**

The shrimp harvest pursued in the Offshore Study Area by larger trawlers from Newfoundland and Nova Scotia can occur year-round, though the summer months (June and July) have been the most important time. The average northern shrimp harvest by month for 2005 to 2010 for the Offshore Study Area is shown in Figure 9-48.




Source: DFO Geo-referenced Catch and Effort Data 2005 to 2010

**Figure 9-48 Offshore Study Area Northern Shrimp Harvesting by Month, 2005 to 2010 Average**

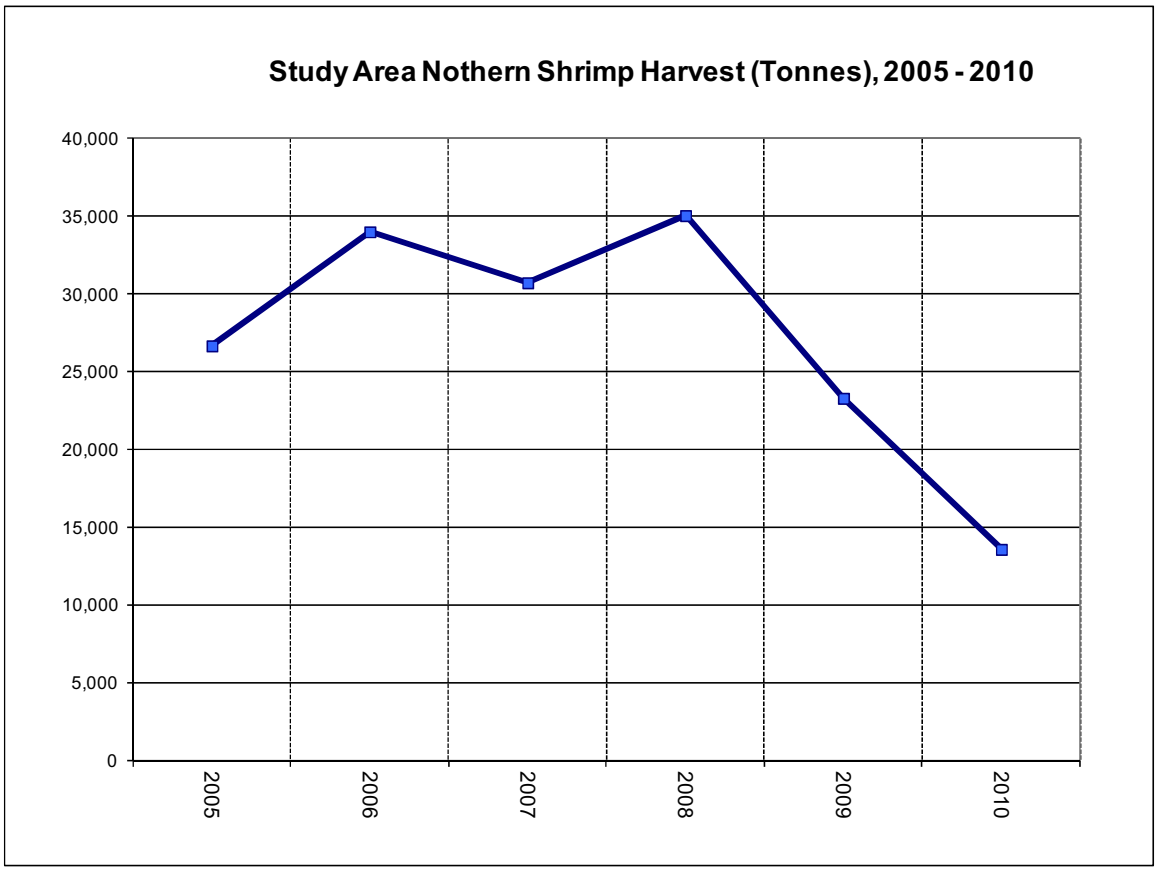
Shrimp quotas for 2007 to 2012 are listed in Table 9-13 to indicate the changes that have occurred with the Canadian allocated quotas in recent years. The quotas have dropped since 2009, with the greatest percentage drop in SFA 7 (3L). The greatest total reduction was in SFA 6 (3K), although there was some increase in SFA 6 (3K and 2J) in 2012 compared to 2011. Overall, the reductions have been the result of increasing science concerns about the status of the resource.

**Table 9-13 2007 to 2012 Canadian Northern Shrimp Quotas (Tonnes)**

| SFA | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 |
|---|---|---|---|---|---|---|
| SFA 6 (2J) | 41,193 | 43,362 | 44,226 | 36,993 | 30,837 | 34,204 |
| SFA 6 (3K) | 36,739 | 41,499 | 41,499 | 24,639 | 21,550 | 26,040 |
| Area 7 (3L) | 18,325 | 20,235 | 22,737 | 22,737 | 15,859 | 10,000 |
| Total | 96,257 | 105,096 | 108,462 | 84,369 | 68,246 | 70,244 |
| Source: DFO 2012d | | | | | | |

Within SFA 3M in international waters, all shrimp fishing has been banned. As the latest NAFO Annual Assessment of Northern Shrimp in Division 3M states, "*The stock is under effort regulation. The effort allocations were reduced by 50% in 2010 and a moratorium was imposed in 2011. … The 2011 survey biomass index indicates the stock … remains in a state of impaired recruitmen*t" (NAFO 2011).

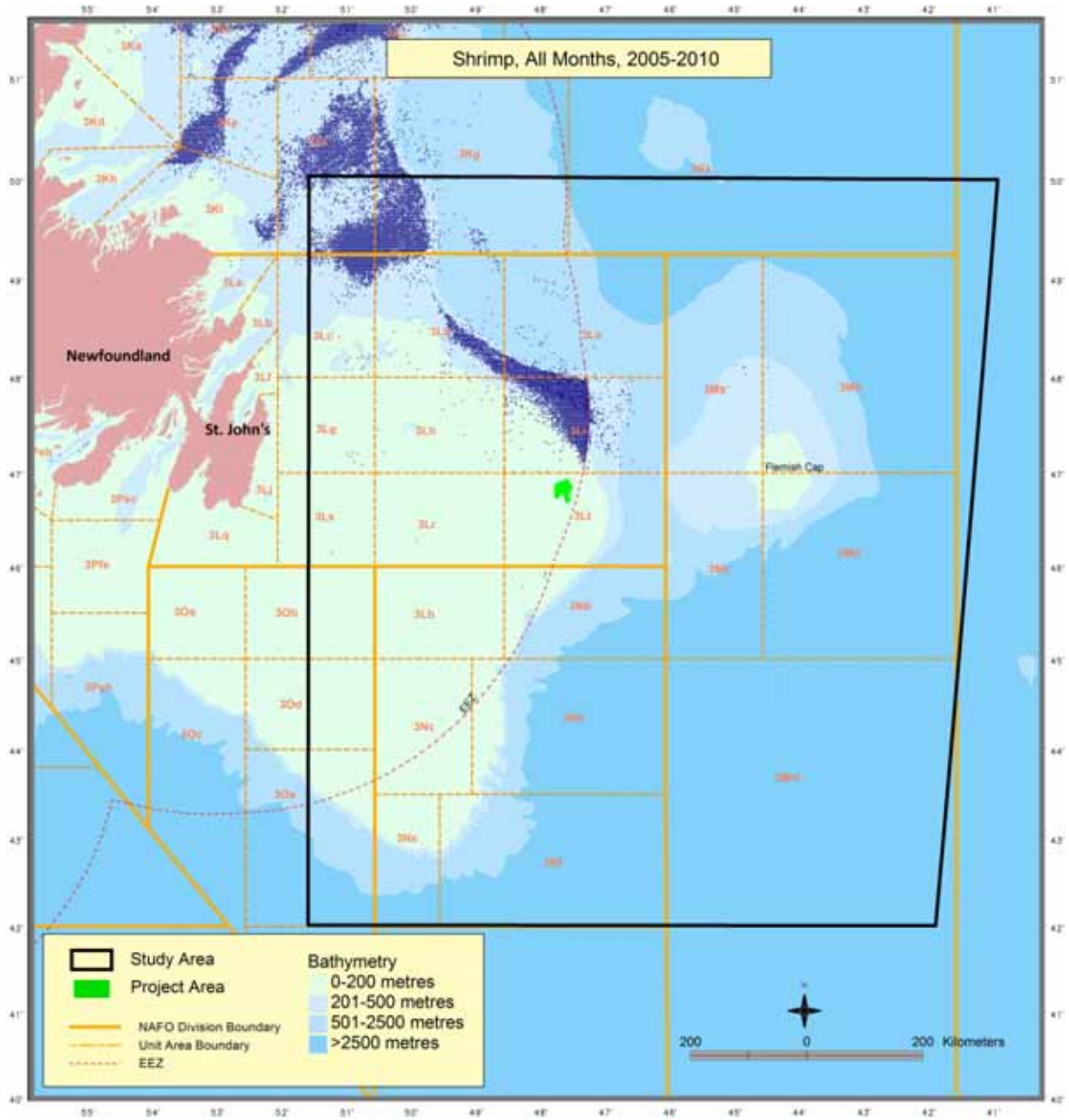
The quantity of the northern shrimp harvest taken from the Offshore Study Area between 2005 and 2010 is shown in Figure 9-49. The gradual increase in the early years was largely the result of increasing quotas. The drop in 2009 and 2010 was the result of declining resource availability and quota reductions




Source: DFO Geo-referenced Catch and Effort Data 2005 to 2010

**Figure 9-49 Offshore Study Area Quantity of Harvest by Year, Northern Shrimp, 2005 to 2010**

The domestic harvesting locations recorded for 2005 to 2010, all months, are shown in Figure 9-50.




Source: DFO Geo-referenced Catch and Effort Data 2005 to 2010

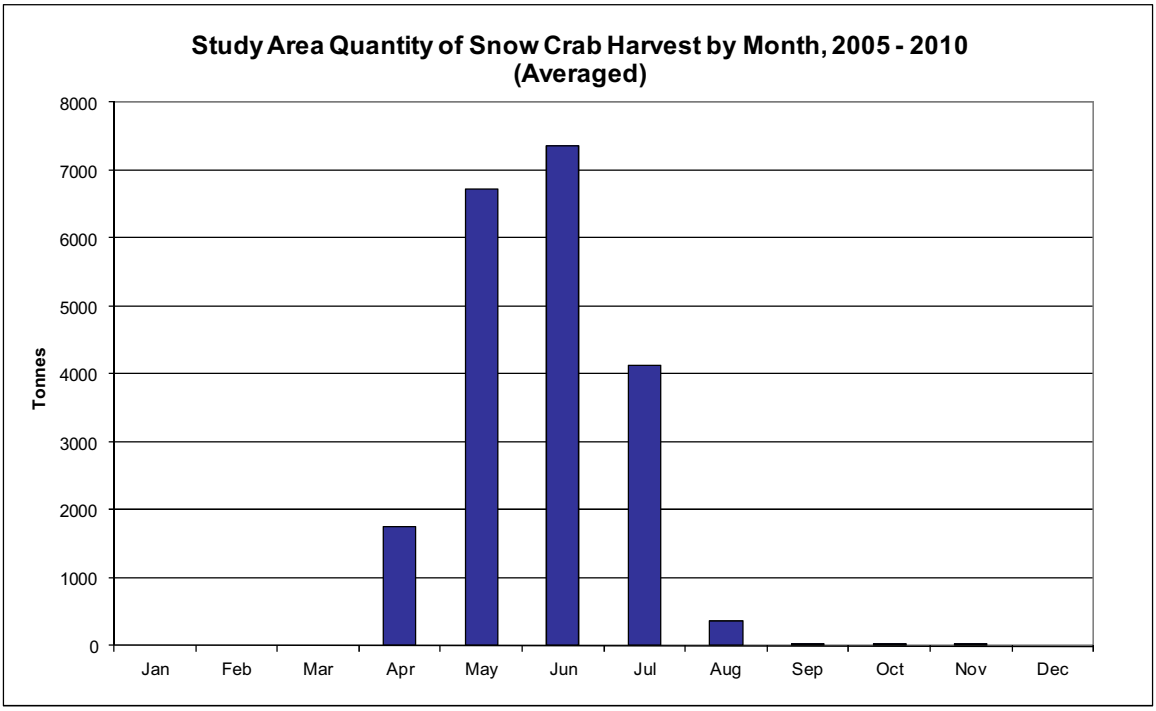
**Figure 9-50 Northern Shrimp Harvesting Locations, 2005 to 2010, Aggregated**

## Snow Crab

The snow crab fishery is the only species harvested within the Offshore Project Area in recent years and represents the highest value in the Offshore Study Area, and is the second largest in terms of quantity, accounting for 56.5 percent by value and almost 33 percent by quantity.

Snow crab seasons may vary somewhat each year by quota/license category, depending on when quotas are taken, or if other factors intervene, such as the presence of too much soft shell crab. However, it usually occurs within the April to July period. The

average harvest by month for the 2005 to 2010 for the Offshore Study Area is shown in Figure 9-51. The average monthly harvest of snow crab within the Offshore Project Area is presented in Figure 9-31, as this was the only species harvested during 2005 to 2010.




Source: DFO Geo-referenced Catch and Effort Data 2005 to 2010

**Figure 9-51 Offshore Study Area Snow Crab Harvesting by Month, 2005 to 2010 Average**

The Fisheries Resource Conservation Council 2005 *Strategic Conservation Framework for Atlantic Snow Crab* (Fisheries Resource Conservation Council 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 in all management areas, the different fleets have trap and trip limits, and fish-specified Crab Fishing Areas. Since 2004, electronic vessel monitoring systems are required on all offshore vessels to ensure compliance (DFO 2012e).

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. Prices have been lower in recent years compared to the late 1990s and early 2000s, reaching a recent high average price to fishers of about $5.30/kg ($2.40/lb) in 2005 but dropped in 2006 to average under $2.13/kg ($0.97/lb)[2]. In 2010, the average price was $3.04/kg ($1.38/lb) but in 2011 it increased again to $4.73/kg ($2.15/lb)[3].

The most recent DFO snow crab science advisory report (DFO 2012e) notes that "*Opposing survey trends create uncertainty about the exploitable biomass. Recruitment has recently peaked and will likely decrease over the next two to three years. Long-term recruitment prospects are unfavourable due to a warming oceanographic regime. The exploitation rate index increased in 2011 following a sharp decrease from 2008-2010 while the pre-recruit fishing mortality rate index has remained near its lowest level during the past three years*".

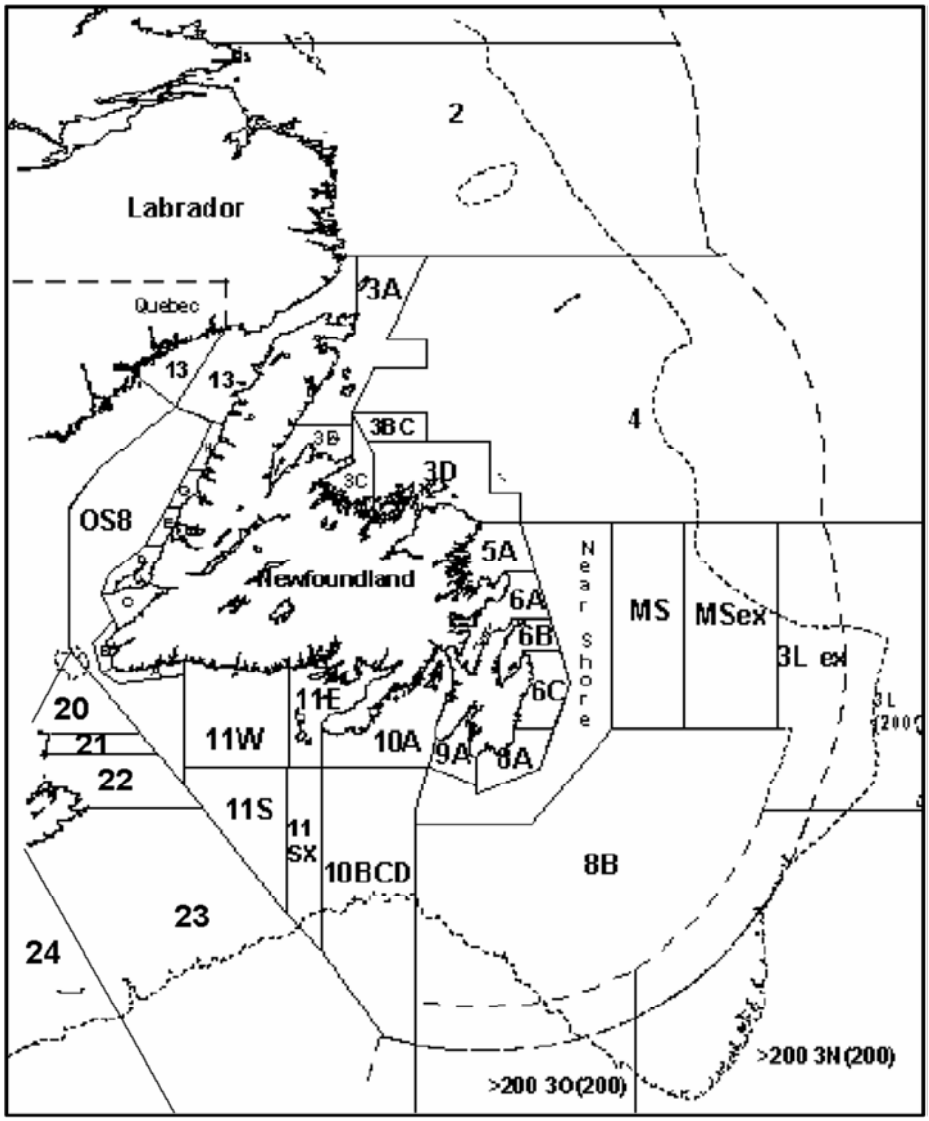
The quotas for the snow crab fishery in the areas that overlap the Study Area since 2007 are listed in Table 9-14 and the Crab Fishing Areas are shown in Figure 9-52. As the map indicates, within each NAFO Division there are several Crab Fishing Areas. Each of these has its own fleet sectors (by vessel size), quotas, and frequently different start and end dates, which may vary from year to year as well. The Divisional quota totals for the Offshore Study Area have been fairly stable overall within this period if comparing 2007 to 2012, though between these years there has been some significant variation within 3K (low of 9,438 and high of 16,475 t) and 3N (low of 1,961 and high of 3,060 t).

**Table 9-14 2007 - 2012 Snow Crab Quotas by Northwest Atlantic Fisheries Organization Division**

| Divisions | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 |
|---|---|---|---|---|---|---|
| 3K | 11,750 | 15,075 | 16,475 | 14,440 | 12,053 | 9,438 |
| 3L | 27,138 | 28,932 | 26,843 | 29,614 | 30,552 | 29,579 |
| 3N | 2,410 | 2,030 | 1,961 | 2,670 | 2,670 | 3,060 |
| Total | 41,298 | 46,037 | 45,279 | 46,724 | 45,275 | 42,077 |
| Source: DFO 2012c | | | | | | |

[2] Historically, the prices paid to fishers for Newfoundland and Labrador snow crab has been lower than those paid for other Atlantic Canada snow crab, but the prices tend to fluctuate together across the region.

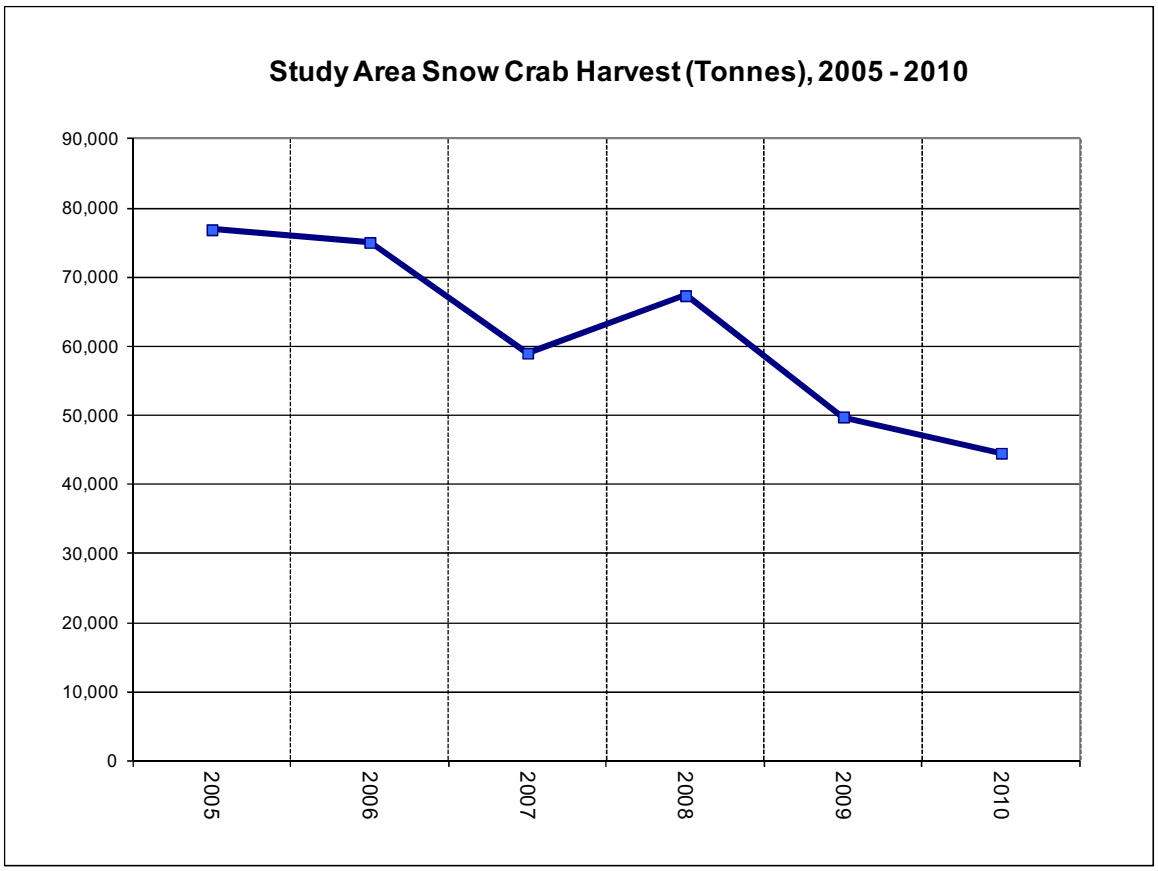
[3] See Gardner Pinfold (2006) and http://www.nfl.dfo-mpo.gc.ca/publications/reports_rapports/Land_All_Vessels_Debarquer_Tous_Les_Navires_2011_eng.htm




Source: DFO

**Figure 9-52 Newfoundland and Labrador Snow Crab Fishing Areas**

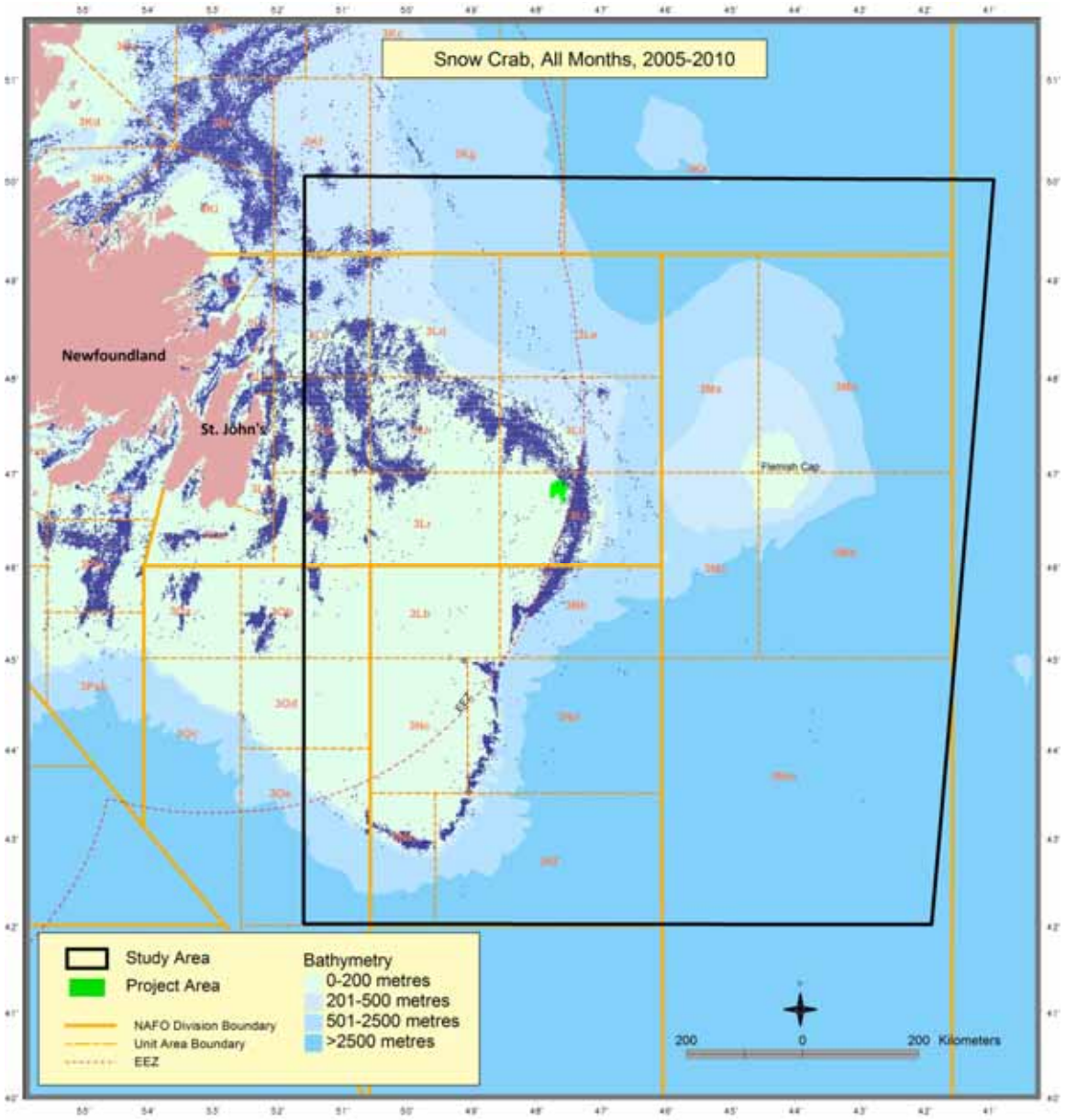
The actual snow crab harvest recorded in the Study Area between 2005 and 2010 is presented in Figure 9-53.




Source: DFO Geo-referenced Catch and Effort Data 2005 to 2010

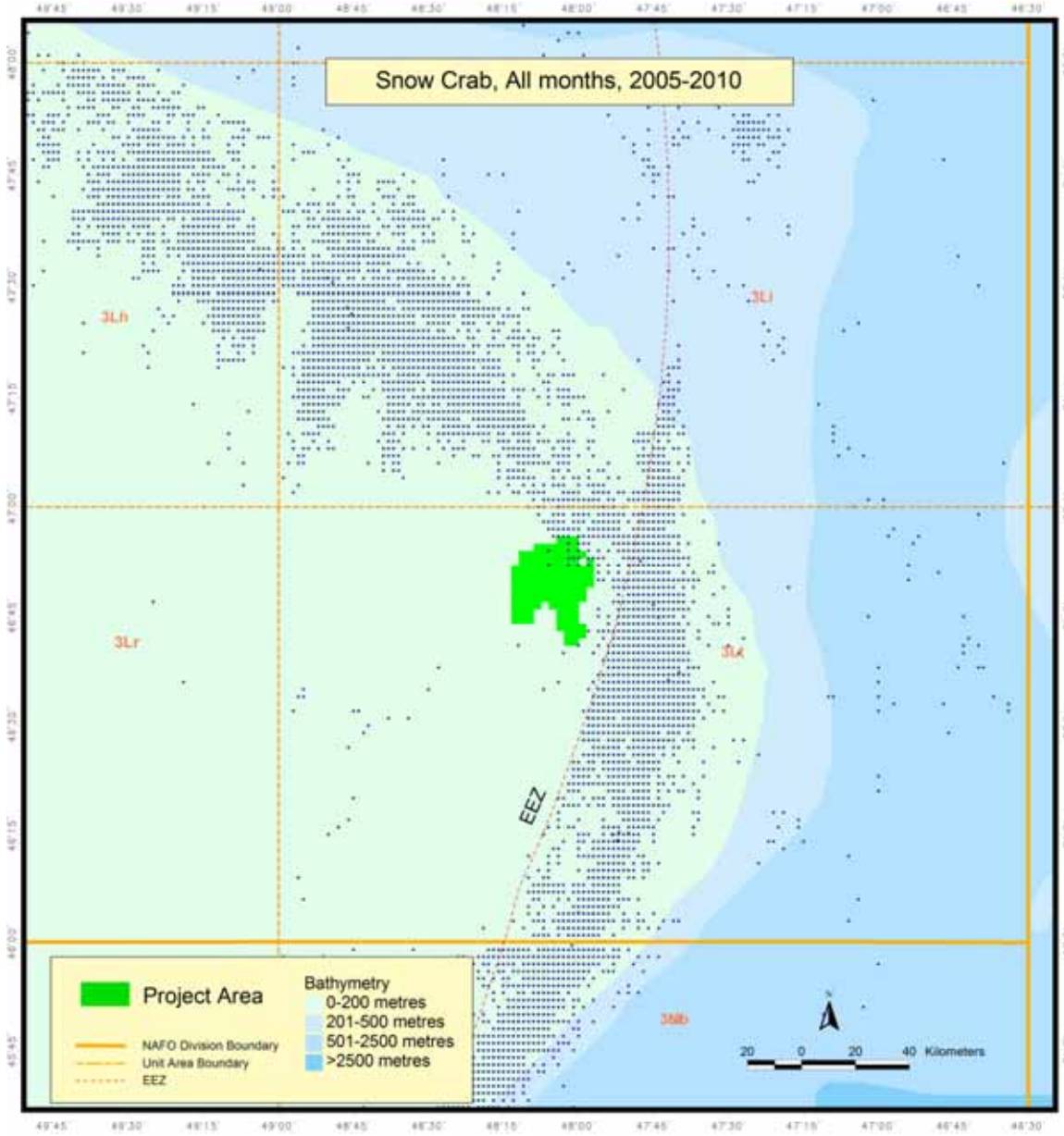
**Figure 9-53 Offshore Study Area Quantity of Harvest by Year, Snow Crab, 2005 to 2010**

Snow crab harvesting locations recorded for 2005 to 2010, aggregated for all years, during all months, are shown in Figure 9-54 in relation to the Offshore Study Area. As illustrated in Figure 9-54, snow crab effort (placement of fixed gear crab pots) is consistently focused on specific grounds, and this is based on both license restrictions and resource availability. Within the Offshore Study Area, the main focus is along and near the shelf break, either just inside or outside the 200 nm Exclusive Economic Zone boundary, which also matches Crab Fishing Area license conditions. The same data are presented in Figure 9-55, but is focused on the Offshore Project Area, and they indicate that all of the fishing effort within the Offshore Project Area is concentrated in a relative small area in the north-northeast.




Source: DFO Geo-referenced Catch and Effort Data 2005 to 2010

**Figure 9-54 Snow Crab Harvesting Locations, 2005 to 2010, Aggregated**




Source: DFO Geo-referenced Catch and Effort Data 2005 to 010

**Figure 9-55 Snow Crab Harvesting Locations, 2005 to 2010, Aggregated, Offshore Project Area View**

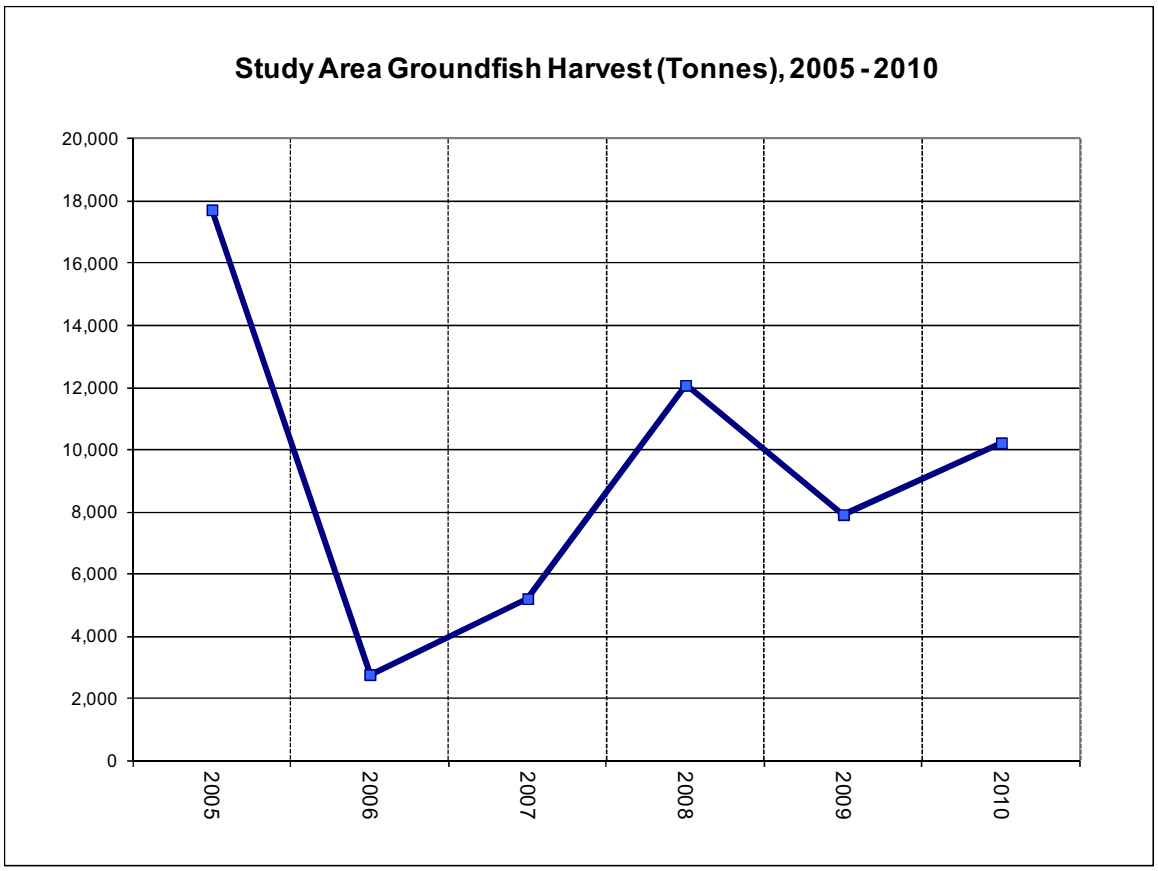
## Groundfish

Groundfish harvests made up 15 percent of the Offshore Study Area harvest by quantity and 8 percent by value during the 2005 to 2010 period. Many groundfish species are harvested together, either as directed or by-catch fisheries. The main groundfish fisheries in these years in the Offshore Study Area was for yellowtail flounder and turbot (Greenland halibut), although Atlantic halibut has also been important because of its high relative value. The quantity and value of the individual groundfish species harvested

within the Study Area are presented in Table 9-15. The variability of the groundfish harvest from year to year during the period is shown in Figure 9-56.

**Table 9-15 Offshore Study Area Groundfish Harvest, 2005 – 2010 Annual Average, Quantity and Value**

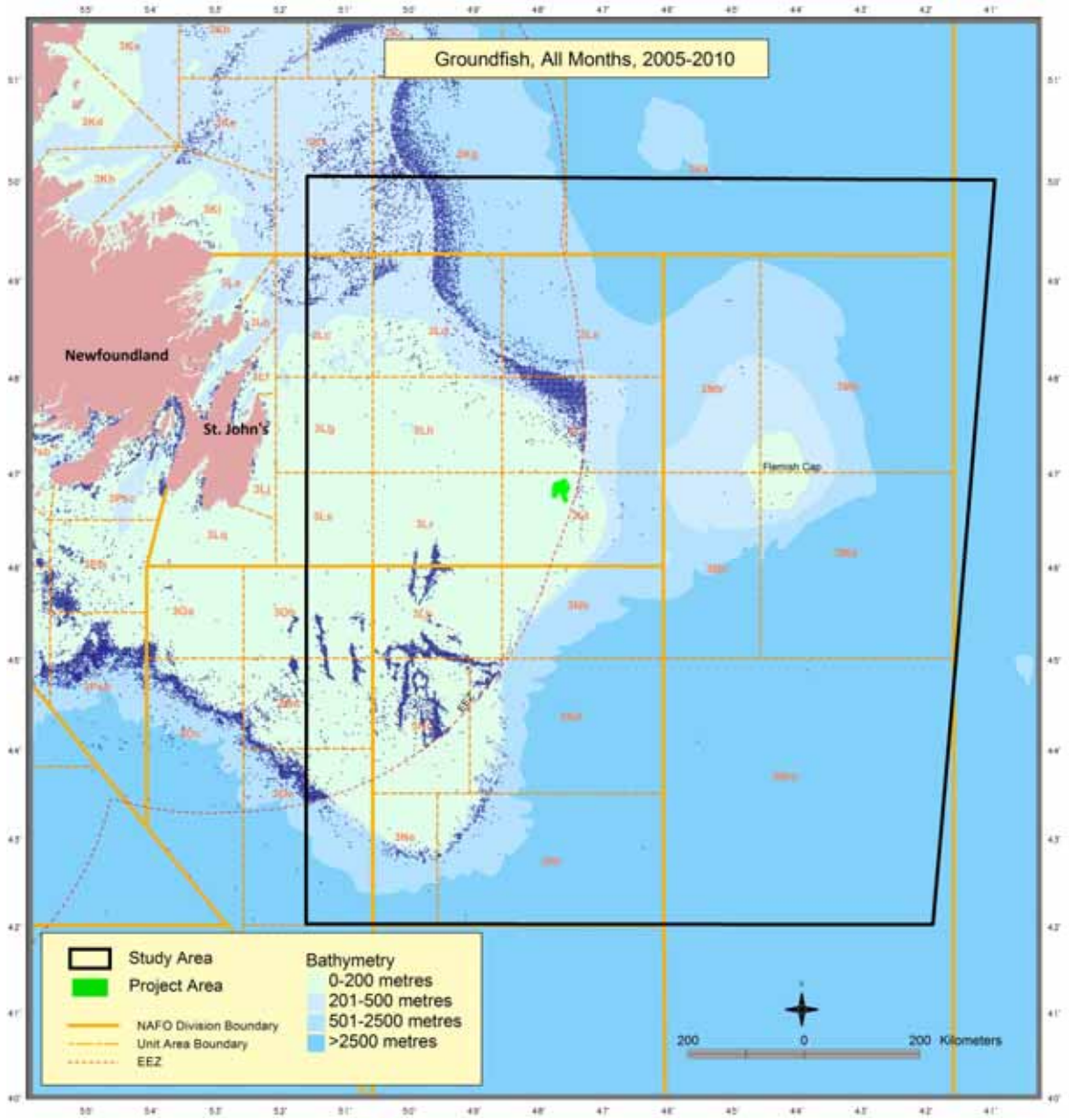
| Species | T | % of Total by Quantity | $ | % of Total by Value |
|---|---|---|---|---|
| Yellowtail Flounder | 6,146 | 65.9% | 3,622,219 | 41.9% |
| Turbot/Greenland Flounder | 1,519 | 16.3% | 3,006,553 | 34.8% |
| American Plaice | 754 | 8.1% | 410,726 | 4.8% |
| Redfish | 247 | 2.7% | 132,102 | 1.5% |
| White Hake | 205 | 2.2% | 148,074 | 1.7% |
| Cod | 174 | 1.9% | 212,621 | 2.5% |
| Atlantic Halibut | 123 | 1.3% | 1,022,577 | 11.8% |
| Skate | 50 | 0.5% | 13,243 | 0.2% |
| Greysole-Witch Flounder | 48 | 0.5% | 27,764 | 0.3% |
| Roughhead Grenadier | 24 | 0.3% | 10,010 | 0.1% |
| Monkfish | 17 | 0.2% | 28,496 | 0.3% |
| Haddock | 12 | 0.1% | 9,499 | 0.1% |
| Other Groundfish | 7 | 0.1% | 4,581 | 0.1% |
| Total | 9,320 | 100.0% | 8,643,885 | 100.0% |
| Source: DFO Geo-referenced Catch and Effort Data 2005 to 2010 | | | | |




Source: DFO Geo-referenced Catch and Effort Data 2005 to 2010

**Figure 9-56 Offshore Study Area Quantity of Harvest by Year, Groundfish, 2005 to 2010**

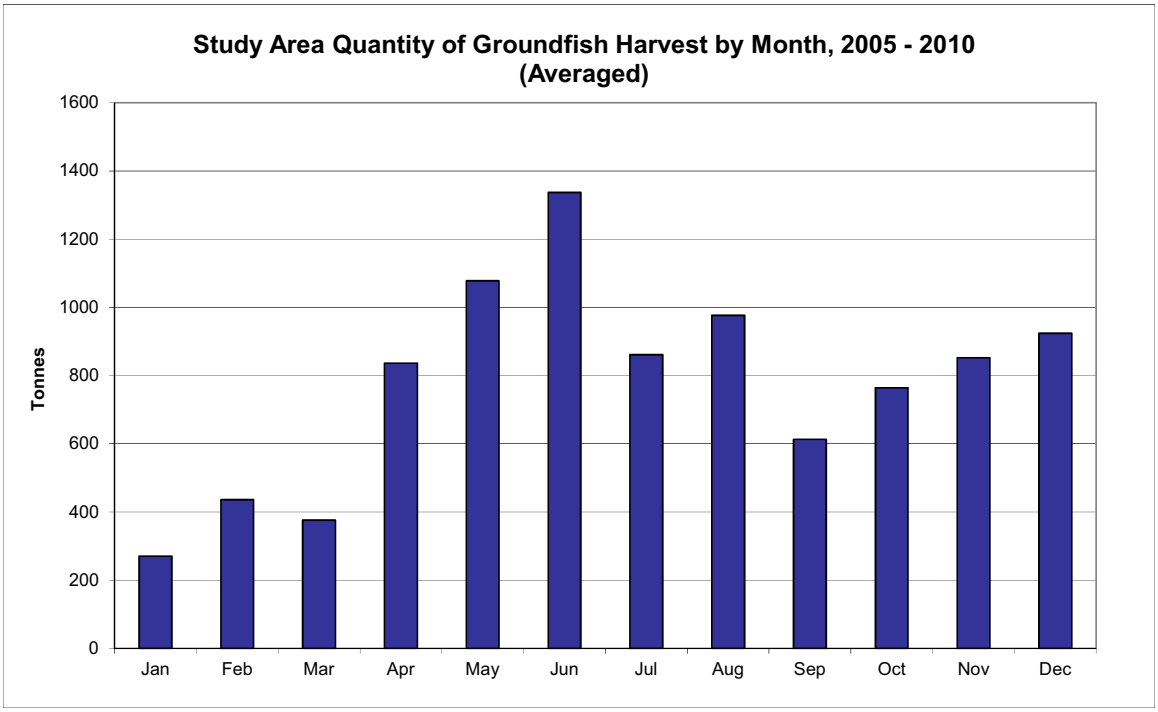
The domestic harvesting locations for all groundfish species for 2005 to 2010 are shown in Figure 9-57. As indicated in Figure 9-57, most fishing occurs in the northern and west parts of the Offshore Study Area, and very little in the Offshore Project Area.




Source: DFO Geo-referenced Catch and Effort Data 2005 to 2010

**Figure 9-57 Groundfish Harvesting Locations, 2005 to 2010, Aggregated**

The average timing of groundfish harvesting for 2005 to 2010 in the Offshore Study Area is shown in Figure 9-58. As this graph illustrates, groundfish are harvested in all months of the year.

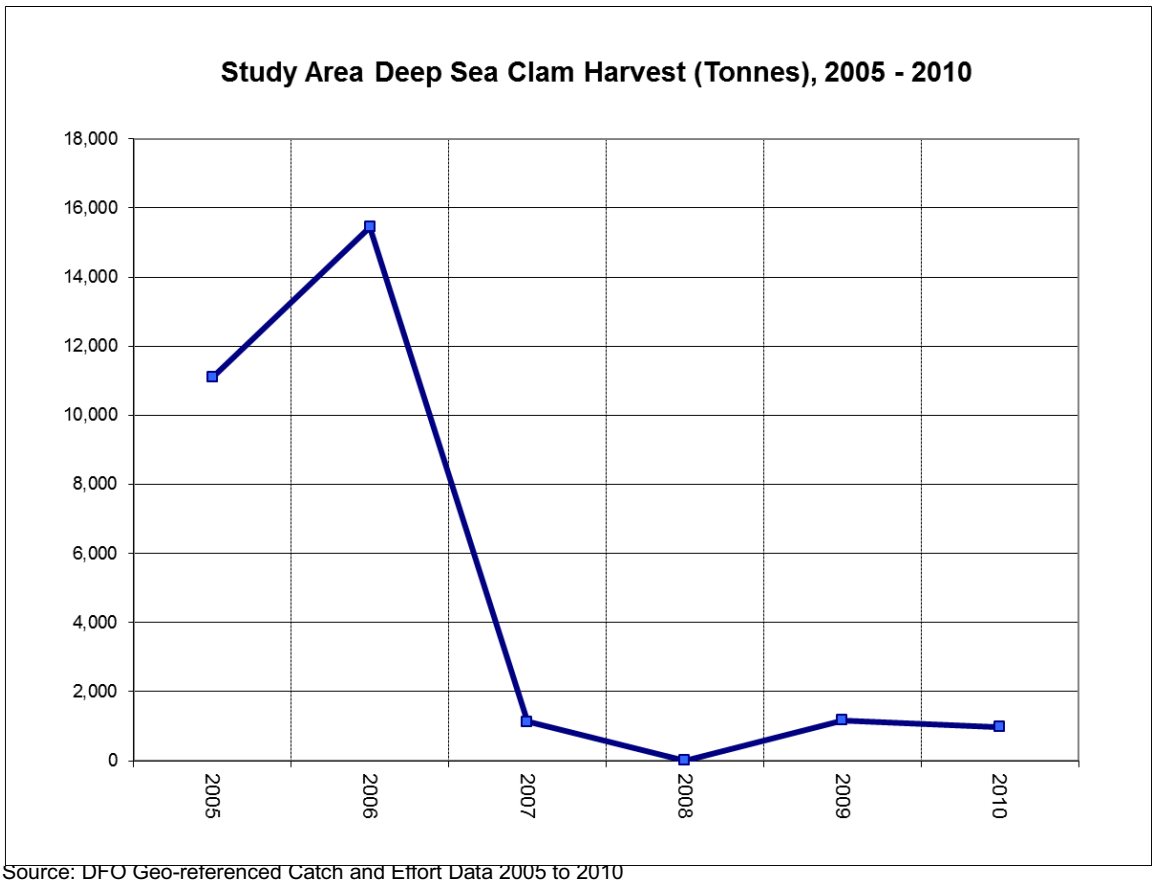



Source: DFO Geo-referenced Catch and Effort Data 2005 to 2010

**Figure 9-58 Offshore Study Area Groundfish Harvesting by Month, 2005 to 2010 Average**

## Deep Sea Clams

In recent years, the majority of this fishery has been harvested by a Newfoundland-based vessel (from Grand Bank) operated by Clearwater Ltd. Partnership, which holds all three of the Atlantic Canadian licences for this group of species. The fishery is primarily deep sea Greenland cockles, Stimpson's (Arctic) surf clams and propeller clams. These constituted the third most substantive fishery in the Offshore Study Area (an average of 8 percent by quantity and 5.3 percent by value) for 2005 to 2010. It would have had a higher average value except that in several recent years, owing to ship logistics and other issues, the single harvesting company involved in this fishery focused on the western deep sea clam grounds on the eastern Scotian Shelf, rather than on the Newfoundland grounds (C. Boyd, pers. comm., 2010) (see Figure 9-59).

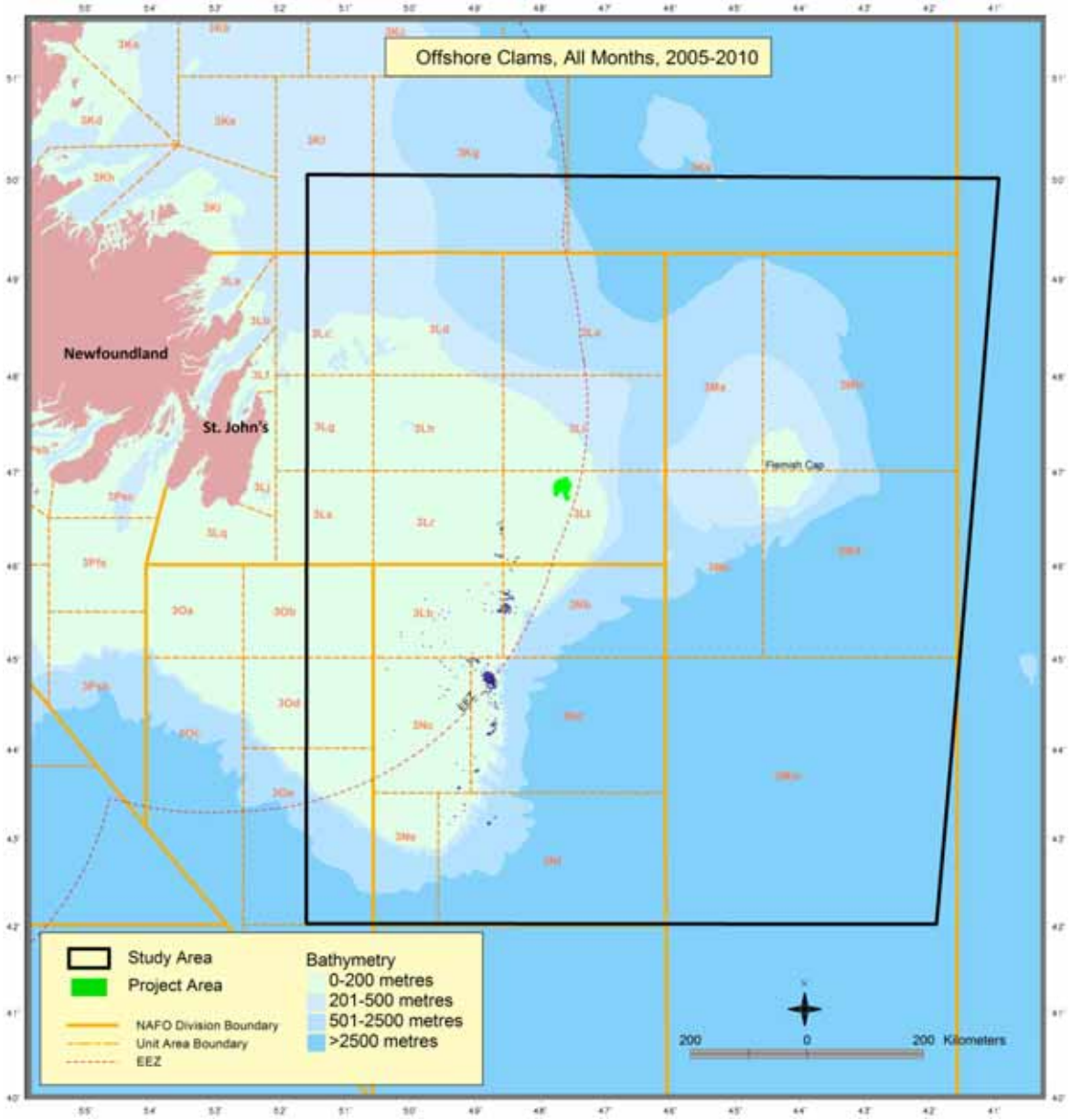



Source: DFO Geo-referenced Catch and Effort Data 2005 to 2010

**Figure 9-59 Offshore Study Area Quantity of Harvest by Year, Deep Sea Clams, 2005 to 2010**

As described in the latest management plan (DFO 1998), the three vessels in the fishery are specialized large factory freezer vessels, equipped to operate year round. Each vessel has equal allocations for each commercial fishing area (on Nova Scotia's Banquereau Bank and on Newfoundland's Grand Banks), and each vessel lands product for further processing at separate plants. Because these bivalves are slow-growing species, the harvesting usually occurs on different beds from one year to the next to allow time for the grounds to recover.

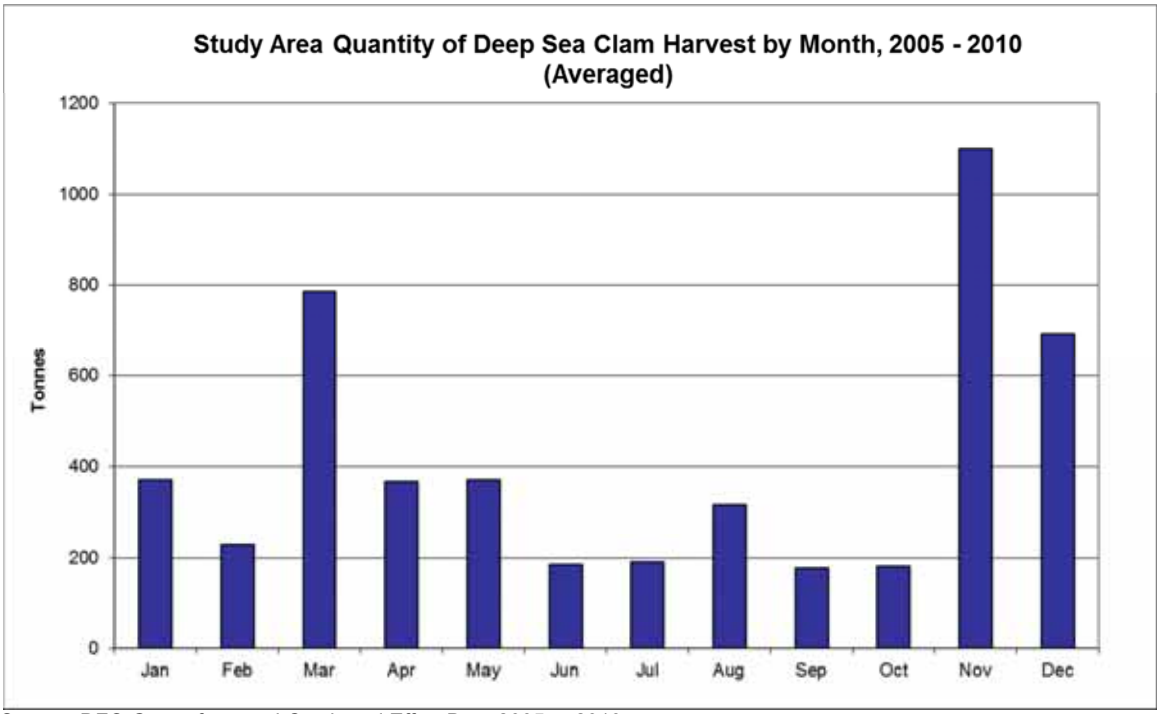
Recorded locations for 2005 to 2010 are shown in Figure 9-60. Over the past decade or so, the Grand Banks portion of this fishery has been largely confined to localized areas within NAFO Division 3N, mainly within UA 3Nd, but in 2006 the harvest expanded northward into 3Lr and 3Lt (see Figure 9-60). Another fairly recent change in this fishery has been an increase in the Greenland cockle harvest, which accounted for 65 percent of the Grand Banks deep sea clams harvested in 2006. In contrast, before 2004, no cockles were reported. As a result of the increase in cockle harvesting, the overall deep sea clam fishery increased by more than 50 percent by 2006, compared to the average recorded harvest from 2000 to 2005.




Source: DFO Geo-referenced Catch and Effort Data 2005 to 2010

**Figure 9-60 Deep Sea Clam Harvesting Locations, 2005 to 2010, Aggregated**

The fishery may be conducted year-round, commencing January 1 of each year. The average timing of the harvest in the Study Area for the 2005 to 2010 period is shown in Figure 9-61.



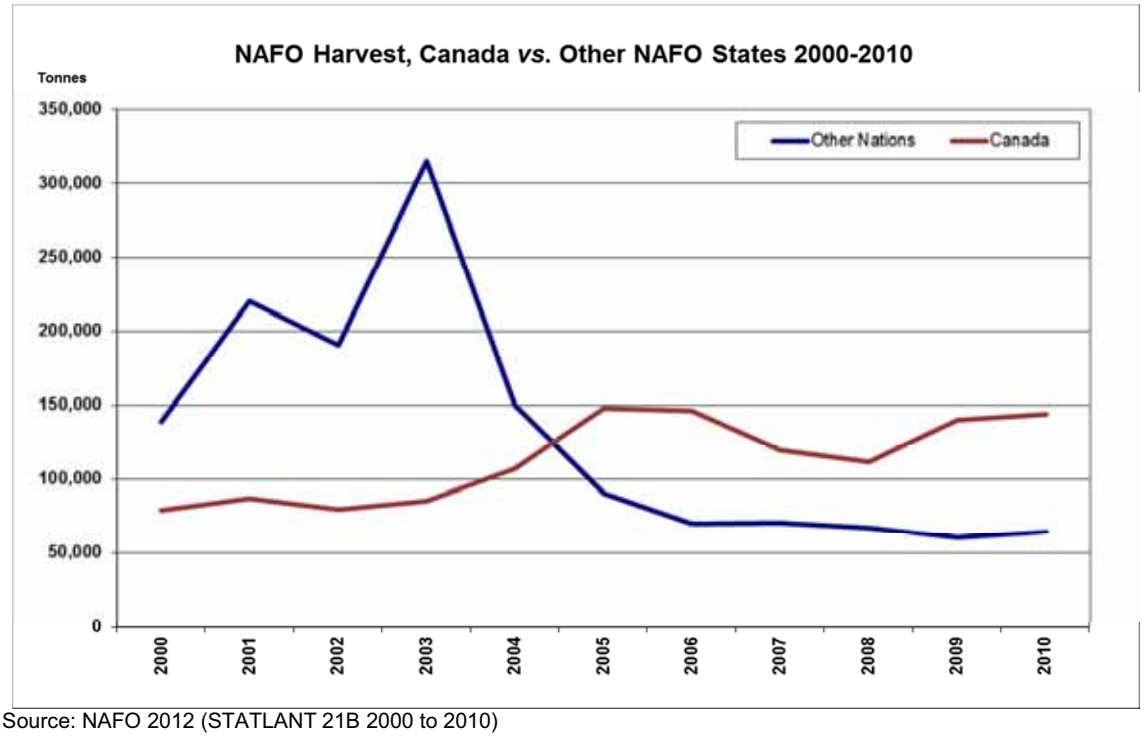

Source: DFO Geo-referenced Catch and Effort Data 2005 to 2010

**Figure 9-61 Offshore Study Area Deep Sea Clam Harvesting by Month, 2005 to 2010 Average**

### 9.3.3.6 International Fisheries

Several NAFO Convention nations have harvested a variety of fish stocks in the UAs to the north and west of the Offshore Project Area. This is primarily in the area of the NAFO Divisions 3LMN from the waters outside Canada's Exclusive Economic Zone. Harvests by foreign and (for comparison) domestic harvesters from these Divisions (most of which are within the Offshore Study Area) are shown in Figure 9-62.

The principal species harvested during this period, included in Figure 9-62, were northern shrimp and other groundfish (mainly turbot and yellowtail flounder). Snow crab are not managed by NAFO and are not shown in Figure 9-62. The data indicate that - other than Canadian ships - those fishing in these areas during this time included fishing vessels from Denmark, Iceland, Cuba, Japan, South Korea, Russia and various other European Union nations (US data are not included in the NAFO STATLANT 21b data). As illustrated in Figure 9-62, foreign vessels have been harvesting increasingly less, while Canadian vessels take proportionally more in recent years.




Source: NAFO 2012 (STATLANT 21B 2000 to 2010)

**Figure 9-62 Harvest (2000 to 2010) from Divisions 3LMN, Foreign vs. Domestic, Northwest Atlantic Fisheries Organization-managed Stocks**

### 9.3.4 Offshore Fisheries Research Surveys

DFO research surveys in 3K, 3L, 3N and/or 3O overlap with parts of the Offshore Study Area. The preliminary schedule for any year is usually available in the early spring, and the spring survey is typically conducted within NAFO Division 3LNO in May to June. The fall survey usually operates in these areas from early October to mid-December. Often, the one research ship will be used during the spring surveys and another in the fall. More specific plans are typically available as the season moves forward in the year, and may be modified as circumstances change (W. Brodie, pers. comm., 2010).

A typical schedule from recent years is provided in Table 9-16. In any year of WREP activity, contact will need to be maintained to receive the current season's schedule and to be informed of updates and changes.

**Table 9-16 Typical Fisheries Research Schedules, Grand Banks**

| Scientist | Survey | Start Date | End Date |
|---|---|---|---|
| ***R/V Templeman* or *R/V Needler*** | | | |
| Brodie | Multi-species 3LNO | 06-May | 20-May |
| Brodie | Multi-species 3LNO | 21-May | 03-Jun |
| Brodie | Multi-species 3LNO | 04-Jun | 17-Jun |
| Brodie | Multi-species 3LNO | 18-Jun | 28-Jun |
| Brodie | Multi-species - 3KLNO | 01-Oct | 07-Oct |
| Brodie | Multi-species - 3KLNO | 08-Oct | 21-Oct |
| Brodie | Multi-species - 3KLNO | 22-Oct | 04-Nov |
| Brodie | Multi-species - 3KLNO | 05-Nov | 18-Nov |
| Brodie | Multi-species - 3KLNO | 19-Nov | 02-Dec |
| Brodie | Multi-species - 3KLNO | 03-Dec | 16-Dec |
| ***R/V Teleost*** | | | |
| Brodie | Multi-species 3KLMNO | 03-Dec | 16-Dec |

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 Industry-DFO 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. Most of these stations occur within the Offshore Study Area, and all are within the 200 nm limit (R. Lee, pers. comm., February 2011; E. Dawe, pers. comm., February-March 2011).

## 9.4 Project-Valued Environmental Component Interactions and Knowledge of Environmental Effects

Potential interactions between fishing activities and each of the WREP components and phases are considered, and include both the WHP and subsea drill centre development options. As noted above, the Nearshore Study Area interactions and potential effects would only occur if the WHP option is pursued.

The fishing activities considered include all those conducted in order to generate fishing income. These activities include deploying, setting and/or accessing gear on fishing grounds, retrieving/hauling the gear to harvest the fish and getting the catch back to port where they can be sold. Interactions resulting in effects that might interrupt or prevent any part of that process, such as having grounds closed to fishing, impediments en route to or from fishing grounds, lost fishing gear, or lost or reduced catch, are the focus of the assessment contained in this chapter.

Economic effects could also result from physical effects on fish species and their habitats, but they are not considered here since WREP effects on Fish and Fish Habitat are considered to be not significant with the appropriate mitigations in place (see Chapter 8).

The potential interactions and environmental effects considered in this section are based on experience with similar kinds of development applications and comprehensive studies (e.g., Hibernia, Sable Offshore Energy, Terra Nova and Hebron) and on issues raised by both inshore and offshore fishers during the consultations for similar projects, particularly in the Jeanne d'Arc Basin and/or specifically for this environmental assessment (Chapter 6 contains reports of the discussions for the WREP; during these exchanges, issues related to habitat loss, water quality deterioration and harm to fish were also raised but these are dealt with in Chapter 8 so are not discussed again here).

Because DFO and industry science surveys are conducted by "fishing" for species (e.g., with trawls and fixed gear sets), potential interactions with and effects on fisheries science research surveys (industry-led and DFO) would be the same as in commercial fisheries.

Specific mitigations to address these issues and potential effects are identified in Section 9.5.

### 9.4.1 Nearshore

#### 9.4.1.1 Graving Dock and Concrete Gravity Structure Construction

- Seabed material removal operations, especially within Corridor 2, may exclude, prevent or impede harvesting activities directly within the affected area(s), or in nearby fishing grounds, during the four to six weeks planned for these activities.

- Fishing gear set close to planned dredging operations, or in the general vicinity of Argentia Harbour, could be damaged by WREP-associated vessels (i.e., the dredging barge or smaller support boats assisting this vessel).

#### 9.4.1.2 Concrete Gravity Structure Tow-out and Mating at the Deep-water Site

- During the 48 hours needed for the CGS transit to the deep-water site in late spring/early summer 2016, some fishing gear (e.g., crab pots) may need to be removed from the tow route. This will vary depending on which deep-water mating site has been selected. Affected fishers may incur additional expenses in moving their gear, and/or they might encroach on grounds being used by other fishers located some distance from the transit route. Gear remaining in the water along the route of the tow might be lost or damaged.

- During the planned six to eight weeks of topsides mating activities, enterprises which usually fish crab or cod in the selected deep-water mating site would lose access to their grounds within the estimated 1,500 m radius safety zone that will be established around the CGS, anchor chains and anchors. Consequently, they would have to find alternative fishing grounds that were not already occupied by other harvesters. Relocating fishing gear to alternative fishing grounds might result in extra fishing costs or reduced catches.

- Fishers using grounds some distance from the deep-water site may find their traditional grounds being encroached upon by fishers displaced from the area(s) occupied by deep-water mating site operations.

- Increased project service/supply vessels traffic traveling between Argentia and the deep-water mating site may interfere with harvesting activities, including fishing vessel transits and gear set in or near the transit routes.

#### 9.4.1.3 Wellhead Platform Tow-out

- During the two days it is expected to take for the assembled WHP to be towed from the deep-water mating site to the open waters outside Placentia Bay, fishing gear along this route may need to be removed. Affected fishers may incur additional expenses moving this gear, and some of this gear may be moved briefly to adjacent locations, where it could encroach on grounds occupied by other fishers. Gear remaining in the water along this tow route may be damaged if it comes in contact with towing operations.

### 9.4.2 Offshore

#### 9.4.2.1 Wellhead Platform Tow-out from Placentia Bay to Offshore Site

- The tow-out of the assembled WHP from Placentia Bay to the Offshore Project Area is expected to take 12 to 15 days, in total. The WREP Project Description notes that it will be towed to the Offshore Project Area at “the maximum possible water depth to minimize wave action”, likely sometime between the end of May and the end of September. A minimum 500 m radius safety zone is expected to be in effect around the work vessels and WHP at all times. Depending on the final route chosen and the exact timing in relation to fish harvesting, there is a potential for fixed fishing gear to be damaged if it is set directly on the route and has not been moved. Gear would be damaged if towing operations comes in contact with it (Note that this is an issue only if the WHP option is selected).

#### 9.4.2.2 Installation of Wellhead Platform and/or Drill Centres

- During installation of WREP-related assets fishers expect there will be extra traffic to and from the White Rose field from Newfoundland or mainland ports. This could result in damage to fixed gear caused by construction and supply traffic or operational interference with ships towing mobile fishing gear, and result in a loss of catch because of damage or reduced efficiency.

- Although the offshore construction activities will occur within the existing White Rose field safety zone, fishers expressed concern regarding the lack of protocols and standards for establishment of Closest Point of Approach zones around oil and gas activities, including established safety zones. Although fishers reported that the existing oil production installations occupy a relatively small total area, they feel that the operational “zone of influence” extends well beyond the boundaries of the official safety zone of each installation. Fishers stated that the combined restraints of existing DFO quota areas and existing oil operations already force them to operate within a relatively narrow band of fishing grounds. Fishers are of the view that the WREP development and operations will exacerbate this situation, adding to their risks and costs.

- Noise from construction related activities (including any VSP or wellsite surveys) could scare fish and thereby reduce catchability, resulting in economic loss.

#### 9.4.2.3 Operation and Maintenance

- Fishing gear damage and the subsequent loss of catch may result from regular support vessel operations, as well as from other activities such as iceberg towing or geophysical surveys. Most gear damage incidents involve fixed gear (e.g., crab pots); mobile gear (e.g., shrimp trawls) is rarely affected. In most cases, the owner of gear damaged by an oil-related vessel activity is identified and compensated, after submitting a claim to the responsible operator through gear compensation programs currently in place. However, fishers say there is an increase in the number of “un-attributable” damage incidents, for which no claim is provable because it cannot be linked to petroleum industry operations, even though fishers are convinced that project vessels are responsible. Many of these cases involve the loss of small items (e.g., a 90” balloon buoy). Fishers say that while each such incident can be viewed as a nuisance - a regular component of the “cost of doing business” offshore - the rising number of these incidents contributes to the overall sense of unease and distrust among fishers.

  Fishers stress that gear replacement is often not the biggest part of their resulting economic loss. It may not be possible for the enterprise to make up the lost fishing time associated with a gear damage incident. The entire trip may be lost, or the enterprise may fail to make its quota for the season. Fishers indicated in such cases there should be some mechanism in place to compensate for the lost catch, as well as for the damaged gear. Fishers noted that, as fishing seasons become more confined, the potential economic consequences of lost fishing time will increase. Fishers believe that certain routine oil industry activities already compound this situation. For example, the busiest months for the offshore crab fishery are generally April to July when iceberg deflection operations are undertaken in many of the same areas fishers set their crab gear.

- As discussed above, fishers feel that there is an inadequate level of understanding and communication between the two industries at sea. For their part, fishers admit they are not always informed about the “rules of the road”, why particular rules or protocols were developed, or what their rights and responsibilities are when operating in the general vicinity of an offshore production facility. For example, fishers are not sure what their Closest Point of Approach should be when they are transiting waters adjacent to an operator’s safety zone. Some operators apparently require fishing vessel to maintain a Closest Point of Approach of 9.2 km (5 nm), while others ask them to maintain a Closest Point of Approach of 18.5 lm (10 nm). Without a common understanding, agreement on compliance and enforcement is difficult.

- Fishers stated a growing concern that the ongoing development of the Jeanne d’Arc Basin oil field area is beginning to have a negative effect on their ability to harvest fisheries resources in adjacent areas of the Grand Banks. It appears to fishers that the size of the area in which they can fish safely and efficiently is shrinking, resulting in reduced fishing opportunity.

- Fishers state that the lack of well-understood protocols are having a negative economic effect on their operations, because fishing vessels are forced to steam around an oil field area to get from one quota area to the next, rather than being able to transit through that area while maintaining a reasonably safe distance

(i.e., Closest Point of Approach) from the installation, resulting in lost fishing time and increased fuel costs. Fishers frequently cited the need to maximize fishing time as the most critical issue they face. They noted that preventing any such loss of opportunity in the first case is preferable to financial compensation for that loss after the fact.

#### 9.4.2.4 Decommissioning and Abandonment

- The potential interactions and effects for this phase are the same as the installation phase concerns.

#### 9.4.2.5 Potential Future Activities

- Noise from future activities such as additional drill centre construction and installation and VSP and wellsite surveys could scare fish and reduce catchability. Any surveys going outside the safety zone could cause gear damage.

- Expansion of the safety zone would be a concern, especially if it resulted in loss of access to present (or future) fishing grounds.

### 9.4.3 Accidental Events

- Fishers stated concern about the commitment of oil companies to compensate the fishing industry in the event of an oil spill, and a blowout in particular. They stated that they believe the oil industry does not “have a good reputation about cleaning up its messes”. They would like to see more information made available about how a compensation program for an oil spill would actually work. They want to know more about what concrete steps would be taken following an oil spill, how claims would be submitted and assessed, etc.

- Fishers have expressed concerns that even if a spill did not reach a particular fishing area and prevent or reduce harvesting, bad publicity might affect market prices and thereby reduce fishing income (see Argue 2010).

### 9.4.4 Summary of Potential Interactions and Effects Pathways

Each of the fisheries issues and potential effects identified by fishers relate to possible reductions in fishing income, and specifically to net fishing income losses. Income losses might occur because of decreased revenues (reduced catches, prices or marketability) or because of increased expenses (higher fuel costs, replacing damaged gear), or both. As the previous discussion indicates, these losses might arise from a variety of different effects pathways. For the purpose of this environmental assessment, these pathways are considered under four categories:

- Access to Fishing Grounds: Those activities that prevent access to former or potential fishing grounds (loss of access to areas such as the safety zones)

- Fishing Vessel Operations: Those activities that might result in temporary or ongoing interference with fishing activities (vessel traffic or other WREP marine activities beyond the safety zones that impede or otherwise interfere with fishing)

- Fishing Gear: Those activities which could damage, foul or cause the loss of fishing gear, including consequent catch losses (vessel traffic beyond safety zones, or escaped debris)

- Catchability/Marketability: Those activities which might affect the catchability of the species (issues related to scaring fish from the harvesting area or away from fishing gear), thus reducing the value of the harvest; and events (primarily as a result of a spill) that reduce the value of the commercial catch by affecting the market price paid for the fish.

The planned WREP activities that have the potential to interact with each of the preceding categories, organized by location (nearshore and offshore) and phase (construction, installation, production/operations, etc.) are provided in Table 9-17. It should be noted that, except for vessel transits, all WREP activities and operations will be wholly contained within safety zones where fishing cannot occur, and therefore, most of the specific WREP activities that take place in these areas will not interact with fisheries activities. Accidental events (such as spills) and associated potential effects on the fisheries are discussed and assessed in Section 9.5.3; cumulative environmental effects are discussed and assessed in Section 9.5.4.

**Table 9-17 Potential White Rose Extension Project-Valued Ecosystem Component Interactions: Fisheries**

| Potential WREP Activities, Physical Works, Discharges and Emissions | Access to Fishing Grounds | Fishing Vessel Operations | Fishing Gear | Catchability/ Marketability |
|---|---|---|---|---|
| ***CGS Construction and Installation*** | | | | |
| *Marine (Argentia and Deep-water Mating Site)* | | | | |
| Additional nearshore surveys (e.g., geotechnical, geophysical, environmental) | x | x | x | x |
| Dredging | | x | x | x |
| CGS towing to deep-water site | x | x | x | |
| Noise from topsides mating | | | | x |
| Safety zone | x | | | |
| Operation of supply, support, standby, mooring and tow vessels/ barges/ROVs | | x | x | |
| Topsides delivery | x | x | x | |
| WHP tow-out through Placentia Bay | x | x | x | |
| **Offshore** | | | | |
| ***Wellhead Platform Installation/Commissioning*** | | | | |
| Tow-out/offshore installation | x | x | x | |
| Operation of vessels/barges | | x | x | |
| Safety zone | x | | | |
| Drilling-associated seismic (VSPs and wellsite surveys) | | | | x |

| Potential WREP Activities, Physical Works, Discharges and Emissions | Access to Fishing Grounds | Fishing Vessel Operations | Fishing Gear | Catchability/ Marketability |
|---|---|---|---|---|
| ***Subsea Drill Centre Excavation/Installation* (Previously assessed; LGL 2007a)** | | | | |
| Operation of supply, support, standby and tow vessels/barges | | x | x | |
| Safety zone | x | | | |
| Drilling-associated seismic (VSPs and wellsite surveys) | | | | x |
| ***Production/Operation and Maintenance*** | | | | |
| Safety zone | x | | | |
| Operation of supply, support, standby and tow vessels/barges/ROVs | | x | x | |
| Surveys ( geotechnical, geophysical and environmental) | | x | x | x |
| ***Decommissioning and Abandonment*** | | | | |
| Operation of Vessels (supply/support/standby/tow vessels/barges/diving/ROVs) | | x | x | |
| Safety zone | x | | | |
| Surveys (geotechnical, geophysical and environmental) | | x | x | x |
| **Potential Future Activities** | | | | |
| Safety zone | x | | | |
| Surveys (e.g., geophysical, geological, geotechnical, environmental, ROV, diving) (if outside safety zone) | | x | x | x |
| Noise from drilling from MODU at potential future drilling centres | | | | x |
| **Accidental Events** | | | | |
| Graving dock breach | | | x | x |
| Marine diesel fuel spill from support vessel | x | x | x | x |
| Subsea hydrocarbon blowout | x | x | x | x |
| Hydrocarbon surface spill | x | x | x | x |
| Other spills (e.g., fuel, waste materials) | x | x | x | x |
| Marine vessel incident (including collisions) (i.e., marine diesel fuel spill) | x | x | x | x |
| **Cumulative Environmental Effects** | | | | |
| Commercial fisheries (nearshore and offshore) | -- | -- | -- | -- |
| Marine traffic (nearshore and offshore) | | x | x | |
| Offshore Exploration Seismic Activity | | x | x | x |

## 9.5 Environmental Effects Analysis and Mitigation

This section presents the assessment of effects on the fisheries, based on the potential interactions identified, organized by relevant pathway category for each area and each relevant WREP phase/activity. These are followed by mitigations that will be implemented to address each of the potential interactions, where mitigation of effects is required. These mitigations are in addition to the design elements and procedures that

have been incorporated into the WREP, which are intended to avoid, reduce or eliminate effects on the fisheries. These include the use of environmentally sound construction and operational methods and materials, the application of best practices and location and timing considerations.

### 9.5.1 Nearshore

#### 9.5.1.1 Graving Dock and Concrete Gravity Structure Construction

**Access to Fishing Grounds**

Because there is currently no fishing in the shoreline area where the graving dock will be constructed there should be no loss of access to established fishing grounds. CGS construction will occur inside the graving dock. The graving dock will not require a safety zone.

**Fishing Gear**

Additional WREP vessel traffic to and from the Argentia site and escaped construction debris could pose an increased risk of gear damage if they stray out of the existing and well-established marine traffic routes to the port of Argentia, such as those used by the interprovincial ferries operated by Marine Atlantic.

**Fishing Vessel Operations**

The additional WREP vessel traffic during the construction phase is not expected to be more than a few vessels and therefore unlikely to interfere with fishing vessel transits in or near fishing grounds in Placentia Bay.

**Catchability/Marketability**

Fish scaring could occur in the vicinity of the Argentia graving dock site as a result of WREP-related noise (pile driving); however, because there is no fishing in the immediate area now, it should not affect any fishing success. If the noise were to temporarily scare any fish in the area away from the site, it might temporarily increase availability in areas that are fished. Please see Chapter 8 for a discussion on the potential effects on fish behaviour.

**Mitigations**

Vessel Traffic Routing. Strict adherence to previously established traffic routes by Project vessels should help prevent both gear damage and vessel traffic interactions.

Fishing Gear and Vessel Damage Program. Fishing Gear Damage Program. Husky will apply the established Fishing Gear and Vessel Compensation Program to address loss of or damage to fishing gear or vessels resulting from WREP activities. This gear and vessel compensation program will document claims made through a central location, known to fishers in the area, which were developed in discussions with fisheries industries representatives. The purpose of the program is to provide fair and timely compensation to fishers who sustain actual damage as a result of Project-related activities within Placentia Bay, providing they are not operating in contravention of any

established or agreed protocols. Appropriate precautions will also be in place during work at the Argentia site to prevent the escape of debris and other materials that might damage fishing vessels or gear.

#### 9.5.1.2 Concrete Gravity Structure Tow-out and Mating at the Deep-water Site

**Access to Fishing Grounds**

Dredging vessel(s) will have a 500 m safety zone, and all fisheries activities will be excluded from this area for the 6 to 8 weeks needed to complete dredging operations on the route to or at the chosen deep-water mating site. This will allow these operations to take place in a safe and efficient manner.

During the tow from Argentia to the deep-water mating site, there will also be a temporary safety zone around the CGS and the vessels towing it. However, this will be an estimated 2 to 4 days and will be continually moving as the flotilla makes its way across part of the Bay to the chosen mating site.

Once it has been positioned at the deep-water mating site, an estimated 1,500 m radius safety zone will be established around the moored CGS. This safety zone (shown in Figure 9.1 and 9.17 for both candidate deep-water mating sites) will extend from the centre of the CGS location. During CGS-topsides mating operations (6 to 8 weeks in duration) any harvesters normally fishing there will be temporarily prohibited from setting gear in the safety zone. Fishing and recreational vessels may be permitted to transit nearby, whichever deep-water mating site is used. However, as stipulated in Transport Canada regulations (Rule 43 of the *Collision Regulations* under the *Canada Shipping Act, 2001*), no vessels other than those involved in Project operations will be permitted to operate within 500 m of the operations. While the establishment of a deep-water mating site safety zone will create a temporary loss of access to fishing grounds within these areas, it will serve as a key mitigation to avoid or prevent interaction and to help ensure the safety of workers, fishers and other marine users.

The deep-water mating site safety zone will remain in place until the WHP is towed out of the Bay and the anchor/chains are removed. The perimeter of the deep-water mating site safety zone will be clearly marked with buoys, and fishers will be kept informed of its existence throughout the topsides mating operation’s period.

**Fishing Vessel Operations**

Some Project activities will take place outside the designated safety zones (e.g., vessel transits between the port of Argentia and the CGS/topsides mating area). During the six to eight weeks topsides mating period, there will be an accommodation vessel for the estimated 100 workers engaged in this component of the work. The accommodation vessel will have an assistant tug of approximately 5,000 horsepower, with a supply boat of similar size used for logistic runs to the port of Argentia. It is anticipated that the supply vessel will visit the Port of Argentia approximately three to four times per week. At all times, the accommodation vessel and tug will remain inside the deep-water mating site safety zone.

As noted, the confinement of most activities within safety zones will reduce the potential for interference with day-to-day fishing operations. For those activities that do occur outside these areas, several further mitigations will be established to minimize impacts on fishing vessel operations (see below).

**Fishing Gear**

Project construction-related ships operating outside the deep-water mating site safety zone (e.g., tugs involved in the CGS tow-out, the topsides delivery vessels, routine supply vessel traffic, dredging and tug vessel operations occurring beyond the safety zone) could make contact with and damage fishing gear. Such contacts are more likely to involve fixed fishing gear (e.g., crab pots) than mobile gear since those vessels can actively avoid contact.

As noted, the establishment of a deep-water mating site construction safety zone will reduce the likelihood of contact with gear and vessels because, with the exception of vessels transporting supplies between Argentia and the deep-water mating site, most construction-related vessel activities will be confined to that zone.

During WHP tow-out through Placentia Bay it is expected that the platform and four attendant tugs will join and follow the existing VTSS route out of the bay.

**Catchability/Marketability**

Project activities might result in the scaring of fish causing them to avoid an area, thereby affecting the “catchability” of species. Noise will be created by dredging activities required to deepen the tow-out channel for the CGS, excavation of the graving dock or dredging, or possibly from sheet/pile driving at that site. Noise and lighting associated with mating operations could also affect fish behaviour and movement in the immediate vicinity of those activities (refer to Sections 8.5.1.1 and 8.5.1.2).

Depending on the placement of fishing gear in relation to the noise source, the effects on a particular harvesting opportunity might be either positive or negative for finfish species, such as groundfish or pelagics. These highly mobile species might be either driven away from or towards waiting fishing gear. Similar effects are not usually documented for benthic invertebrates such as lobster and crab (see Christian et al. 2004; Parry and Gason 2006). Biophysical and behavioural effects of sound on biota, including commercial and prey species, are considered in Chapter 8 where effects are assessed as not significant with mitigations in place.

Given the distance between construction activities at the deep-water mating site and the perimeter of the safety Zone there will be a sound attenuation buffer between construction activities and fisheries operations beyond the boundary of the safety zone.

## Mitigations

The following are proposed measures to address the potential effects discussed above, where mitigation is required.

Deep-water Mating Site Safety Zone. Although the establishment of the safety zone at the selected deep-water mating site will create a no-fishing area, it will contain most of the potential deep water construction interactions and effects, and will safeguard fishing vessels and fishing gear by keeping these Project activities within a well-defined and identified area.

Communications/Notification. Husky will use several mechanisms to keep fishers informed, in advance, of all relevant marine operations. Once the final deep-water mating site choice is determined and before CGS tow-out operations begin (scheduled for 2016), Husky will actively engage fishers to keep them informed about the timing and locations of these safety zones. In addition, Husky, in consultation with Project Area fishers, will implement mitigations to reduce disruption to their usual fish harvesting activities. A key component of these communications protocols will be the Fisheries Liaison Committee (FLC), described below.

Fisheries Liaison Committee. Before any marine construction activities begin, Husky will establish an area FLC to facilitate and formalize its ongoing fisheries consultation and communications process. It will also employ a Fisheries Liaison Manager (see below). The FLC will be a key mechanism for facilitating information exchange and communications between the WREP and fisheries representatives, and for identifying and resolving other concerns and issues as they arise during WREP work in Placentia Bay, and facilitating cooperation between both industries in the area. WREP representatives, local area fishers and the FFAW will be invited to be on this FLC.

Fisheries Liaison Manager. A Fisheries Liaison Manager, knowledgeable about the area's fisheries, will be hired through the FLC to facilitate a good working relationship between Husky, its subcontractors and fishers, and maintain a day-to-day dedicated contact with fishers regarding the on-going marine construction activities in the Nearshore Project Area and Placentia Bay.

Fishing Gear and Vessel Damage Program. (see description above, Section 9.5.1.1). The existing compensation program would also apply to any gear damage or loss that might be associated with CGS tow-out to the deep-water mating site, the topsides delivery vessel and WHP tow-out activities. Precautions will also be in place during topsides mating operations to prevent the escape of debris and other materials that might damage fishing vessels or gear.

Fisheries Compensation Program. To mitigate any actual economic loss as a result of the temporary deep-water mating site safety zone closure, Husky has a fisheries compensation program. The compensation program was developed based on precedents and experience of similar programs developed in Atlantic Canada jointly with the fisheries industries, and discussions at the FLC. The program will be for the actual loss of fishing income or increased expenses caused by the closure of the safety zone areas. Eligibility will be based on the historical use of these areas by relevant fishers.

### 9.5.2 Offshore

Since the categories of potential effects (e.g., access to fishing grounds, fishing vessel operations, fishing gear and catchability) are essentially the same during all phases of the WREP, many of the mitigations are also the same. Thus, the effects and mitigations for these phases are discussed together in the following sections. The tow-out would be a factor only if the WHP development option is selected.

#### 9.5.2.1 Tow-out, Installation, Operations, Maintenance and Potential Future Activities

**Access to Fishing Grounds**

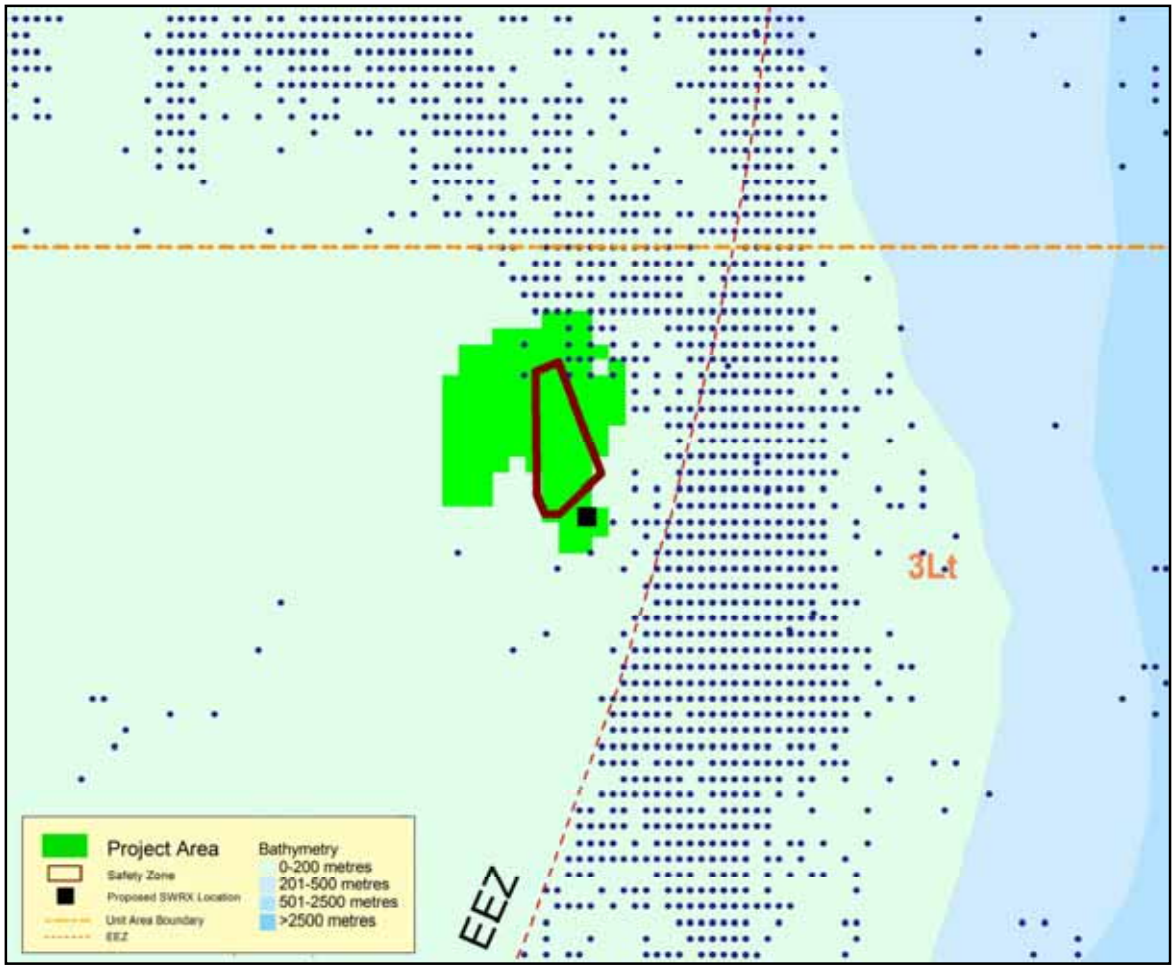
With the exception of vessel traffic to and from ports, including the route that will be used during the tow-out of the WHP from Placentia Bay, all planned activities during the installation, operations and maintenance phases and the decommissioning phase will be contained within the existing White Rose safety zone, established in accordance with safety requirements. Because fishing is already excluded from this area, there will be no additional area where commercial fishing will be excluded as a result of the WREP. This safety zone extension would prohibit fishing in that area as well; however, analysis of past fishing activities indicates no harvesting has usually occurred within the zone and that the area is not currently used by the industry as fishing grounds (see Figure 9-63).

A recent initiative by One Ocean involved the creation of a factsheet highlighting the safety zones for each offshore production facility. Husky will work with One Ocean to update these factsheets to ensure that the safety zone for potential future activities (i.e., additional drill centres other than at West White Rose) in the White Rose field is well documented.

During the tow-out of the WHP, there will also be a temporary exclusion/safety zone around the platform and the ships tending it. However, this will be of short duration and will be continually moving.

**Fishing Vessel Operations**

Most installation and operations-related activities that could affect fishing vessel operations will occur within the existing safety zone. Therefore, there will be no interaction with fishing operations. Activities that have a potential to interfere with fishing activities include supply ships, as well as the initial platform tow-out to the offshore site. There may also be a need for localized surveys, some of which might extend outside the safety zone in both phases.




Source: DFO Geo-referenced Catch and Effort Data 2005 to 2010

**Figure 9-63 Offshore Project Area, Existing Safety Zone, South White Rose Extension Drill Centre and Harvesting Locations, All Species, 2005 to 2010, Aggregated**

## Fishing Gear

Ships and other vessels traversing marine areas outside the safety zone (including some potential future activities, such as geophysical surveys) and the WHP during tow-out have the potential to make contact with and damage fishing gear or cause its loss. As discussed, typically such contact involves fixed fishing gear such as snow crab pots, the dominant gear near the Offshore Project Area. Considering the relatively low level of fish harvesting in the Offshore Project Area in recent decades, gear contacts are more likely to occur on routes between seaports and the offshore work area than near the Offshore Project Area, especially in waters to the west and south of the White Rose area.

The potential for fishing gear interactions during the WHP tow-out from Placentia Bay to the Offshore Project Area will be further analyzed when the tow-out route has been determined. If the route targets the deep waters beyond the shelf break, as suggested in the Project Description (i.e., the maximum possible water depth to minimize wave action), it would avoid most of the usual fixed gear fishing locations (see Figure 9-45) during the transit.

### Catchability/Marketability

As discussed in more detail in Section 9.5.1, fish may move from an area because of loud noises underwater. During offshore construction, this could be the result of noise associated with WREP installation activities or with geophysical, geological and geotechnical surveys. Noise does not appear to affect invertebrate harvests (such as snow crab; see Section 8.5.1), which is the only recorded harvest in the Offshore Project Area for many years.

Because most activities producing sound will be limited to the safety zone during construction and operations, effects of sound will be minimal.

### Mitigations

The restriction of most activities within the safety zone will avoid most of the potential for interference with fishing vessel operations, fishing gear and catchability issues, and enhance safety. For those activities that occur outside the safety zone, mitigation measures will be established to minimize effects on fishing vessel operations. For geophysical, geological and geotechnical activities specifically, the current *Geophysical, Geological, Environmental and Geotechnical Program Guidelines* (C-NLOPB 2012d) provide guidance aimed at minimizing, specifically, any impacts of VSP/wellsite surveys on commercial fish harvesting. The relevant Guidelines (Appendix 2, Part II, Interaction with Other Ocean Users) state:

- The operator should implement operational arrangements to ensure that the operator and/or its survey contractor and the local fishing interests are informed of each other's planned activities. Communication throughout survey operations with fishing interests in the area should be maintained.

- The operator should publish a CCG “Notice to Mariners” and a “Notice to Fishers” via the CBC Radio program Fisheries Broadcast.

- Operators should implement a gear and/or vessel damage compensation program, to promptly settle claims for loss and/or damage that may be caused by survey operations. The scope of the compensation program should include replacement costs for lost or damaged gear and any additional financial loss that is demonstrated to be associated with the incident. The operator should report on the details of any compensation awarded under such a program. Procedures must be in place on the survey vessel(s) to ensure that any incidents of contact with fishing gear are clearly detected and documented (e.g., time, location of contact, loss of contact and description of any identifying markings observed on affected gear). As per Section 5.2 of these Guidelines, any incident should be reported immediately as per the *Guideline for the Reporting and Investigation of Incidents* (C-NLOPB and CNSOPB 2009).

The following describe how the Project will implement these guidelines, as appropriate, as well as other measures designed to mitigate potential effects in the offshore area.

Vessel Traffic Routes. In the offshore area, traffic associated with Project installation, operations and maintenance will transit within traffic routes used by existing operators, in particular those used for the existing White Rose Project. This will also reduce the potential for gear contacts.

Operational Protocols. One Ocean is exploring concerns raised by fishers regarding such operational issues as restrictions on fishing vessel transits in the vicinity of offshore installations. Husky will continue to work with One Ocean and the fishing industry in this initiative.

Communications and Notification. Communications will be maintained directly at sea by Project Vessels via Marine Radio to facilitate information exchange with fishers. Relevant information regarding Project activities occurring outside the established safety zone will be publicized, when appropriate, using established communication mechanisms such as the Notice to Mariners. There will be ample notification about the timing and route of the tow-out to the fishing industry.

On-Board Fisheries Liaison Officer. The requirement for a Fisheries Liaison Officer (FLO) during certain offshore Project activities will be determined in consultation with the FFAW and in accordance with the Risk Management Matrix Guidelines developed by One Ocean. The Risk Management Matrix Guidelines provides guidance on the requirements for FLOs and/or Fisheries Guide Vessels based on the level of fishing activity in a given area and the activity being undertaken by the oil and gas operator.

Single Point of Contact. As required, a single point of contact (SPOC) will be engaged to facilitate communications regarding gear loss/damage or other compensation claims pursuant to an offshore gear damage compensation program.

Fishing Gear and Vessel Compensation Program. Husky will apply the established Fishing Gear and Vessel Compensation Program to address loss of or damage to fishing gear or vessels resulting from WREP activities (see more information in the nearshore mitigations, Section 9.5.1.1).

#### 9.5.2.2 Fisheries Science Research Surveys

As discussed in Section 9.3.4, the commercial fisheries science surveys on the eastern Grand Banks are conducted by capturing species of interest using harvesting type gears, so that the potential effects and mitigations are similar to those for commercial fisheries.

For WREP activities inside the existing White Rose safety zone, there is no potential for interactions, since no fisheries research is conducted there, other than WREP-specific monitoring.

#### Mitigations

For activities outside the safety zone that have a potential for interactions, the *Geophysical, Geological, Environmental and Geotechnical Program Guidelines* (C-NLOPB 2012d) quoted above will be followed. For activities that have a potential for overlap, the WREP and DFO/industry will need to exchange detailed locational information.

#### 9.5.2.3 Decommissioning/Abandonment

During decommissioning operations, the effects and the mitigations will be similar to those during construction, with whatever additional measures the situation (considering the then-current fisheries) requires.

### 9.5.3 Accidental Events

Accidental events that might affect fisheries and fisheries research in both the Nearshore and Offshore Study Areas are mostly related to the unplanned release of hydrocarbons, whether refined or crude product. Others are the accidental release of construction debris, which might damage fishing gear beyond the safety zones, and a breach in the graving dock, which could release debris and a sediment plume which could foul gear and affect catch quantity and/or quality.

Chapter 8 concludes that biophysical effects on fish from a spill or blowout will be not significant. However, economic impacts might still occur if a spill prevented or impeded a harvester's ability to access fishing grounds (because of areas temporarily excluded during the spill or spill clean-up), caused damage to fishing gear (through oiling) or resulted in a negative effect on the marketability of fish products (because of market perception resulting in lower prices).

While there is little fish harvesting in the Offshore Project Area, in the case of an uncontrolled release from the platform, a slick could reach an active fishing area (e.g., to the north or east of the drill centres or WHP in summer). In that case, it is likely that fishing would be halted, owing to the possibility of fouling gear. If the release site is some distance from snow crab fishing grounds, there would be time to notify fishers of the occurrence and prevent the setting or hauling of gear and thus prevent or minimize gear damage.

Exclusion from the spill area would be expected to be short-term, as typical sea and wind conditions in the Offshore Project Area would promote fairly rapid evaporation and weathering of the slick, and fishing vessels would likely be able to return within several days. Nevertheless, if fishers were required to cease fishing, harvesting might be disrupted (though, depending on the extent of the slick, alternative fishing grounds might be available in a nearby area). An interruption could result in reduced catches, or extra costs associated with having to relocate crab harvesting effort.

Effects due to market perceptions of poor product quality (no buyers or reduced prices, etc.) are more difficult to predict, since the actual (physical) effects of the spill might have little to do with these perceptions. It would only be possible to quantify these effects by monitoring the situation if a spill were to occur and if it were to reach snow crab harvesting areas. In some circumstances, a shortage of raw materials supply because of a spill has been observed to drive up prices paid for fish (e.g., in the *Deepwater Horizon* spill in the Gulf of Mexico) because of supply shortages.

Financial compensation would be provided for any actual loss in fishing income resulting from a spill, and Husky's fishing gear and vessel compensation program will include spill related damage (such as fouling) to mitigate for gear damage that may result from an accidental WREP event.

### 9.5.4 Cumulative Environmental Effects

During consultations (reported in Section 6.2), fish harvesters indicated concerns about the offshore hydrocarbon developments related to the combined effects with other petroleum industry activities in the Jeanne d'Arc Basin oil field area. They cited concerns about reduced fishing opportunity resulting from general activities, such as extensive vessel hailing zones around each installation, ice deflection activities and surveys. Fishers report that the current situation is forcing fishing vessels to steam farther in order to get around activities and installations to reach grounds, costing fishing time and increasing expenses, and that additional activity will exacerbate conditions. In particular, fishers cited growing levels of frustration, misunderstanding and miscommunication between fishing industry and petroleum industry operations.

As noted above, service and supply ships for the WREP will use routes currently followed by existing White Rose field vessels going to the area. Husky is committed to work with the One Ocean, relevant offshore fishers, FFAW representatives and other agencies to ensure good relations, cooperation and partnering between all offshore marine user groups to address any other potential effects.

### 9.5.5 Summary

The environmental effects of the WREP on Fisheries, the mitigations to be implemented and the evaluation criteria used for assessing residual adverse environmental effects are summarized in Tables 9-18 and 9-19.

**Table 9-18 Nearshore Environmental Effects Assessment Summary for Fisheries**

| Project Activity | Potential Positive (P) or Negative (N) Environmental Effect | Mitigation Measure | Evaluation Criteria for Assessing Environmental Effects [A] | | | | | | Significance Rating | Level of Confidence |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | Magnitude | Geographic Extent | Frequency | Duration | Reversibility | Ecological/Socio-cultural/Economic Significance | | |
| **CGS Construction and Installation** | | | | | | | | | | |
| Nearshore surveys (e.g., geotechnical, geophysical, environmental) | Access to fishing grounds (N)<br>Fishing vessel operations (N)<br>Fishing gear (N)<br>Catchability/marketability (N) | FLC<br>FLO<br>SPOC<br>Communication/notifications<br>Gear damage compensation | L | 3 | 1 | 1 | R | 2 | NS | H |
| Dredging/spoils disposal | Fishing vessel operations (N)<br>Fishing gear (N)<br>Catchability/marketability (N) | FLC<br>Communication/notifications<br>Gear damage compensation | L | 1 | 1 | 2 | R | 2 | NS | H |
| CGS towing to deep-water site | Access to fishing grounds (N)<br>Fishing vessel operations (N)<br>Fishing gear (N) | FLC<br>Communication/notifications<br>Gear damage compensation | N | 2 | 1 | 1 | R | 2 | NS | H |
| Noise from topsides mating | Catchability/marketability (N) | safety zone | N | 1 | 1 | 1 | R | 2 | NS | H |
| Safety zone | Access to fishing grounds (N) | Loss of access compensation | L | 1 | 6 | 2 | R | 2 | NS | H |
| Operation of supply, support, standby, mooring and tow vessels/ barges | Fishing vessel operations (N)<br>Fishing gear (N) | Use of agreed routes/VTSS<br>Communication/ notifications<br>Gear damage compensation | L | 1 | 6 | 3 | R | 2 | NS | H |
| Topsides delivery | Access to fishing grounds (N)<br>Fishing vessel operations (N)<br>Fishing gear (N)) | Use of / VTSS<br>Communication/notifications<br>Gear damage compensation | 1 | 1 | 1 | 1 | R | 2 | NS | H |
| WHP tow-out through Placentia Bay | Access to fishing grounds (N)<br>Fishing vessel operations (N)<br>Fishing gear (N) | Use of VTSS<br>FLO<br>Communication/notifications<br>Gear damage compensation | L | 1 | 1 | 1 | R | 2 | NS | H |
| **Accidental Events** | | | | | | | | | | |
| Marine diesel fuel spill from support vessel | Access to fishing grounds (N)<br>Fishing vessel operations (N)<br>Fishing gear (N)<br>Catchability/marketability (N) | Clean-up<br>Compensation | L | 2 | 1 | 1 | R | 2 | NS | H |

| Project Activity | Potential Positive (P) or Negative (N) Environmental Effect | Mitigation Measure | Evaluation Criteria for Assessing Environmental Effects [A] | | | | | | Significance Rating | Level of Confidence |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | Magnitude | Geographic Extent | Frequency | Duration | Reversibility | Ecological/Socio-cultural/Economic Significance | | |

Key:

Magnitude:
N = Negligible (essentially no effect)
L = Low: does not have a measurable effect on commercial fishery net incomes or recreational activities
M = Medium: has a measurable effect on commercial fishery net incomes or recreational activities, but is temporary and/or is highly localized
H = High: has a measurable and sustained effect on commercial fishery net incomes or recreational activities

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

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

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

Reversibility (population level):
R = Reversible
I = Irreversible

Ecological/Socio-cultural/Economic Significance:
1 = Relatively pristine area not affected by human activity
2 = Evidence of existing adverse activity
3 = High level of existing adverse activity

Significance Rating:
S = Significant
NS = Not Significant
P = Positive

Level of Confidence:
L = Low level of confidence
M = Medium level of confidence
H = High level of confidence

(A) Where there is more than one potential environmental effect, the evaluation criteria rating is assigned to the environmental effect with the greatest potential for harm

**Table 9-19 Offshore Environmental Effects Assessment Summary for Fisheries (including fisheries research)**

| Project Activity | Potential Positive (P) or Negative (N) Environmental Effect | Mitigation Measure | Evaluation Criteria for Assessing Environmental Effects [A] | | | | | | Significance Rating | Level of Confidence |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | Magnitude | Geographic Extent | Frequency | Duration | Reversibility | Ecological/Socio-cultural/Economic Significance | | |
| **WHP Installation/Commissioning** | | | | | | | | | | |
| Tow-out/offshore installation | Access to fishing grounds (N)<br>Fishing vessel operations (N)<br>Fishing gear (N) | Route analysis/selection<br>FLO<br>SPOC<br>Communication/notification<br>Gear damage compensation | N | 1 | 1 | 1 | R | 2 | NS | H |
| Operation of vessels/barges | Fishing vessel operations (N)<br>Fishing gear (N) | Route selection<br>Communication/notification<br>Gear damage compensation | N | 2 | 3 | 3 | R | 2 | NS | H |
| Safety zone | Access to fishing grounds (N) | None required | L | 2 | 6 | 5 | R | 2 | NS | H |
| Drilling-associated seismic (VSPs and wellsite surveys) | Catchability/marketability (N) | FLO<br>SPOC<br>Communications/notifications<br>Gear damage compensation | N | 2 | 1 | 1 | R | 2 | NS | H |
| **Subsea Drill Centre Excavation/Installation** | | | | | | | | | | |
| Operation of supply, support, standby and tow vessels/ barges | Fishing vessel operations (N)<br>Fishing gear (N) | Route selection<br>Communication/notification<br>Gear damage compensation | N | 1 | 2 | 2 | R | 2 | NS | H |
| Safety zone | Access to fishing grounds (N) | None required | L | 2 | 6 | 3 | R | 2 | NS | H |
| Drilling-associated seismic (VSPs and wellsite surveys) | Catchability/marketability (N) | FLO<br>SPOC<br>Communications/notifications<br>Gear damage compensation | N | 2 | 1 | 1 | R | 2 | NS | H |
| **Production/Operation and Maintenance** | | | | | | | | | | |
| Safety zone | Access to fishing grounds (N) | None required | L | 2 | 6 | 5 | R | 2 | NS | H |
| Operation of supply, support, standby and tow vessels/ barges | Fishing vessel operations (N)<br>Fishing gear (N) | Route selection<br>Communication/notifications<br>Gear damage compensation | N | 2 | 4 | 5 | R | 2 | NS | H |
| Surveys (geotechnical, geophysical and environmental) | Fishing vessel operations (N)<br>Fishing gear (N)<br>Catchability/marketability (N) | FLO<br>SPOC<br>Communication/ notifications<br>Gear damage compensation | L | 2 | 1 | 1 | R | 2 | NS | H |
| **Decommissioning and Abandonment** | | | | | | | | | | |
| Operation of Vessels (supply/support/standby/tow vessels/barges/diving/ROVs) | Fishing vessel operations (N)<br>Fishing gear (N) | Route selection<br>Communications/notifications<br>Gear damage compensation | N | 1 | 6 | 2 | R | 2 | NS | H |

| Project Activity | Potential Positive (P) or Negative (N) Environmental Effect | Mitigation Measure | Evaluation Criteria for Assessing Environmental Effects [A] | | | | | | Significance Rating | Level of Confidence |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | Magnitude | Geographic Extent | Frequency | Duration | Reversibility | Ecological/Socio-cultural/Economic Significance | | |
| Safety zone | Access to fishing grounds (N) | None required | L | 2 | 6 | 3 | R | 2 | NS | H |
| Surveys | Fishing vessel operations (N)<br>Fishing gear (N)<br>Catchability/marketability (N) | FLO<br>SPOC<br>Communication/notifications<br>Gear damage compensation | L | 1 | 2 | 2 | R | 2 | NS | H |
| **Potential Future Activities** | | | | | | | | | | |
| Surveys (e.g., geophysical, geological, geotechnical, environmental, ROV, diving) | Fishing vessel operations (N)<br>Fishing gear (N)<br>Catchability/marketability (N) | FLO<br>SPOC<br>Communications/notifications<br>Gear damage compensation | N | 2 | 1 | 2 | R | 2 | NS | H |
| Safety zone (extended for additional drill centre(s)) | Access to fishing grounds (N) | None required | N | 1 | 6 | 5 | R | 2 | NS | H |
| Noise from drilling from MODU at potential future drilling centres | Catchability/marketability (N) | Safety zone | N | 2 | 1 | 2 | R | 2 | NS | H |
| **Accidental Events** | | | | | | | | | | |
| Graving dock breach | Fishing gear (N)<br>Catchability/marketability (N) | Clean-up<br>Compensation | M | 2 | 1 | 2 | R | 2 | NS | H |
| Subsea hydrocarbon blowout | Access to fishing grounds (N)<br>Fishing vessel operations (N)<br>Fishing gear (N)<br>Catchability/marketability (N) | Clean-up<br>Compensation | H | 4 | 1 | 3 | R | 2 | NS | H |
| Hydrocarbon surface spill | Access to fishing grounds (N)<br>Fishing vessel operations (N)<br>Fishing gear (N)<br>Catchability/marketability (N) | Clean-up<br>Compensation | H | 4 | 1 | 3 | R | 2 | NS | H |
| Other spills (e.g., fuel, waste materials) | Access to fishing grounds (N)<br>Fishing vessel operations (N)<br>Fishing gear (N)<br>Catchability/marketability (N) | Clean-up<br>Compensation | L | 2 | 1 | 1 | R | 2 | NS | H |
| Marine vessel incident (including collisions) (i.e., marine diesel fuel spill | Access to fishing grounds (N)<br>Fishing vessel operations (N)<br>Fishing gear (N)<br>Catchability/marketability (N) | Clean-up<br>Compensation | L | 2 | 1 | 1 | R | 2 | NS | H |

| Project Activity | Potential Positive (P) or Negative (N) Environmental Effect | Mitigation Measure | Evaluation Criteria for Assessing Environmental Effects [A] | | | | | | Significance Rating | Level of Confidence |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | Magnitude | Geographic Extent | Frequency | Duration | Reversibility | Ecological/Socio-cultural/Economic Significance | | |

Key:

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Ecological/Socio-cultural/Economic Significance:
1 = Relatively pristine area not affected by human activity
2 = Evidence of existing adverse activity
3 = High level of existing adverse activity

Significance Rating:
S = Significant
NS = Not Significant
P = Positive

Level of Confidence:
L = Low level of confidence
M = Medium level of confidence
H = High level of confidence

(A) Where there is more than one potential environmental effect, the evaluation criteria rating is assigned to the environmental effect with the greatest potential for harm

### 9.5.6 Determination of Significance

With the described mitigations in place, the effects of WREP-related construction/ installation and operations/maintenance activities on access to fishing grounds, fishing vessel operations (movements and harvesting), fishing gear and catchability of species (and thereby on inshore net fishing incomes) within the Nearshore Project Area will be not significant.

The offshore safety zone is already an area where harvesting cannot occur. Considering the relatively low level of fish harvesting in the overall Offshore Project Area, and the type of fisheries in recent decades, few gear contact or catchability effects are likely to occur. The greatest potential for interactions and effects is along the route from ports servicing the WREP and the Offshore Project Area; however, the WREP will use existing routes used by current White Rose field vessels. With the mitigations identified above in place, the effects of WREP-related installation and operations/ maintenance activities on access to fishing grounds, fishing vessel operations (movements and harvesting), fishing gear and catchability of species within the Offshore Project Area during construction, installation, operations and maintenance (and thereby on offshore net fishing incomes) will be not significant. This also applies to fisheries research activities. Potential future WREP activities that would be accorded similar mitigations and also be not significant.

Economic effects from accidental events, including hydrocarbon spills (caused by loss of access, gear damage or changes in market value) could be considered significant to the commercial fisheries. However, the application of appropriate mitigative measures (e.g., economic compensation) would reduce the potential effect to not significant. The same is true for damage sustained because of debris release, with the Gear and Vessel Damage Compensation Program in place.

The cooperative development of appropriate and mutually agreed protocols and procedures through One Ocean working with the two industries will minimize potential additive or synergistic economic effects that could result from other industrial use of the area, so cumulative environmental effects would be not significant.

The significance of potential residual adverse environmental effects, including cumulative environmental effects, resulting from the interaction between WREP-related activities and Fisheries, after taking into account any proposed mitigation, is summarized in Table 9-20.

**Table 9-20 Residual Environmental Effects Summary: Fisheries**

| Phase | Residual Adverse Environmental Effect Rating (A) | Level of Confidence | Probability of Occurrence (Likelihood) |
|---|---|---|---|
| Construction (B) | NS | NA | NA |
| Installation of WHP or Drill Centre | NS | NA | NA |
| Operation and Maintenance | NS | NA | NA |
| Decommissioning and Abandonment (C) | NS | NA | NA |
| Accidental Events | NS | NA | NA |
| Cumulative Environmental Effects | NS | NA | NA |

KEY

Residual Environmental Effects Rating:
- S = Significant Adverse Environmental Effect
- NS = Not Significant Adverse Environmental Effect
- P = Positive Environmental Effect

Level of Confidence in the Effect Rating:
- L = Low level of Confidence
- M = Medium Level of Confidence
- H = High level of Confidence

Probability of Occurrence of Significant Effect:
- L = Low Probability of Occurrence
- M = Medium Probability of Occurrence
- H = High Probability of Occurrence

NA = Not Applicable

(A) As determined in consideration of established residual environmental effects rating criteria

(B) Includes all Argentia activities (engineering, construction, tow-out) of the WHP option only

(C) Includes decommissioning and abandonment of the CGS and offshore site

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# 10.0 MARINE BIRDS

## 10.1 Environmental Assessment Boundaries

Marine Birds have been selected as a VEC for the following reasons:

- They are abundant in the Nearshore and Offshore Study Areas
- The potential for interaction with WREP activities
- They are sensitive to oiling
- They are protected under the *Migratory Birds Convention Act, 1994* (migratory birds)
- As high-level predators, marine birds can play an ecologically important role in indicating the health of the marine ecosystem

The Marine Birds VEC includes species of birds that typically use the nearshore/coastal marine and offshore environments that are not considered at risk species by SARA or COSEWIC (bird species at risk assessed in Chapter 12), nor considered endangered, threatened or vulnerable species by the provincial *Endangered Species Act*. The groups considered under the Marine Birds VEC are seaducks (eiders and other duck species), cormorants, fulmars and other shearwaters, storm-petrels, gannets, phalaropes, larids (jaegers, skuas, gulls and terns) and alcids (e.g., dovekie, murres and puffins). Bald Eagles, although not marine birds *per se,* are considered here as well since they are known to feed in the Placentia Bay marine environment.

### 10.1.1 Spatial Boundaries

The spatial boundaries of the Nearshore and Offshore Project and Study Areas are defined in the Effects Assessment Methods section (Chapter 5). The Study Areas are illustrated in Figures 5-2 and 5-4 for the Nearshore and Offshore. The Affected Areas for the WREP have been determined based on the results of

### 10.1.2 Temporal Boundaries

The temporal boundaries for the assessment are defined in Chapter 5 and outlined in Table 10-1.

**Table 10-1 Temporal Boundaries of Nearshore and Offshore Study Areas**

| Study Area | Temporal Boundary |
|---|---|
| Nearshore | • In the case of the WHP development option, site preparation, graving dock construction, construction of CGS, dredging, topsides mating and tow-out will occur over an estimated 30 to 38 months from 2013 to 2016. Various activities will occur at all times of year until completion.<br>• In the case of the subsea drill centre development option, no nearshore activities will occur |
| Offshore | • In the case of the WHP development option, site preparation, installation of the WHP, and initial production/maintenance will occur from 2016 to 2017. The WHP will be decommissioned and abandoned in accordance with standard practices at the end of its production life, which is anticipated to be 25 years.<br>• The subsea drill centre option is scheduled to begin construction in 2014, with first oil expected in 2015. Under this option, the wells will be plugged and abandoned at the end of its production life (anticipated to be 20 years), and the subsea infrastructure removed or abandoned in accordance with relevant regulations |

### 10.1.3 Administrative Boundaries

Most migratory and many non-migratory bird species are protected under the federal *Migratory Birds Convention Act, 1994*. The Act states, in part, that "No person or vessel shall deposit a substance that is harmful to migratory birds, or permit such a substance to be deposited, in waters or an area frequented by migratory birds or in a place from which the substance may enter such waters or such an area" (section 5.1(1) of the Act). Bird species at risk are protected under the federal SARA (refer to Chapter 12) and the *Endangered Species Act*.

## 10.2 Definition of Significance

A significant adverse residual environmental effect is one that affects marine birds resulting in a decrease in abundance or alteration in distribution of the population over more than one generation within the Nearshore and/or Offshore Study Area. Natural recruitment may not reestablish the populations(s) to baseline conditions within several generations, or avoidance of the area become permanent.

An adverse environmental effect that does not meet the above criteria is evaluated as not significant.

## 10.3 Existing Environment

The Marine Birds VEC includes species of birds that typically use the coastal marine and offshore environments. The groups considered under the Marine Birds VEC are Anatidae (sea ducks), Phalacrocoracidae (cormorants), Procellariidae (fulmars and shearwaters), Hydrobatidae and Oceanitidae (northern and southern storm-petrels), Sulidae (gannets), Charadriiformes (plovers, sandpipers and phalaropes), Laridae (gulls, and terns), Stercorariidae (jaegers and skuas) and Alcidae (murres, guillemots and puffins). Bald Eagles are also discussed, as they nest adjacent to the Nearshore Project Area and are known to feed in Placentia Bay.

### 10.3.1 Nearshore Overview

Placentia Bay is one of the richest bays in coastal Newfoundland for marine birds. There are four Important Bird Areas (IBA) at the mouth of Placentia Bay (Figure 10-1), all of which are outside the Study Area, but are mentioned here for completeness (see also the Sensitive Areas Chapter; Section 13.3.1.5). An 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). Cape St. Mary's Ecological Reserve, designated pursuant to the provincial *Wilderness and Ecological Reserves Act* and situated at the southeast corner of Placentia Bay, is one of the most important seabird nesting colonies in Newfoundland and Labrador. It contains the largest Northern Gannet nesting colony (14,696 pairs (2011) (CWS unpublished data)), the largest Thick-billed Murre colony and third largest Common Murre colony (14,789 pairs (2009) (CWS unpublished data)) in Newfoundland and Labrador (Table 10-2). The only sustained breeding site for Manx Shearwater in eastern North America is located at the Middle Lawn Islands, Burin Peninsula (Figure 10-1) (Roul 2011). Both Corbin Island and Green Island on the Burin Peninsula support more than 100,000 pairs of breeding Leach's Storm-Petrel (Figure 10-1; Table 10-2). Placentia Bay supports large numbers of non-breeding Great Shearwaters during the capelin spawning season. As a result, the southeastern quarter of the bay is designated an Important Bird Area (see the Sensitive Areas Chapter). There are over 365 islands in Placentia Bay, many of which support small colonies of terns, gulls and cormorants. In the winter months, several thousand Common Eider and other sea duck species winter along the coast of Placentia Bay. Cape St. Mary's is an important wintering area for the eastern Harlequin Duck, currently listed as a species of Special Concern on Schedule 1 of SARA and Vulnerable under the *Endangered Species Act* of Newfoundland and Labrador. Harlequin Duck are discussed in Section 12.3.3.1.

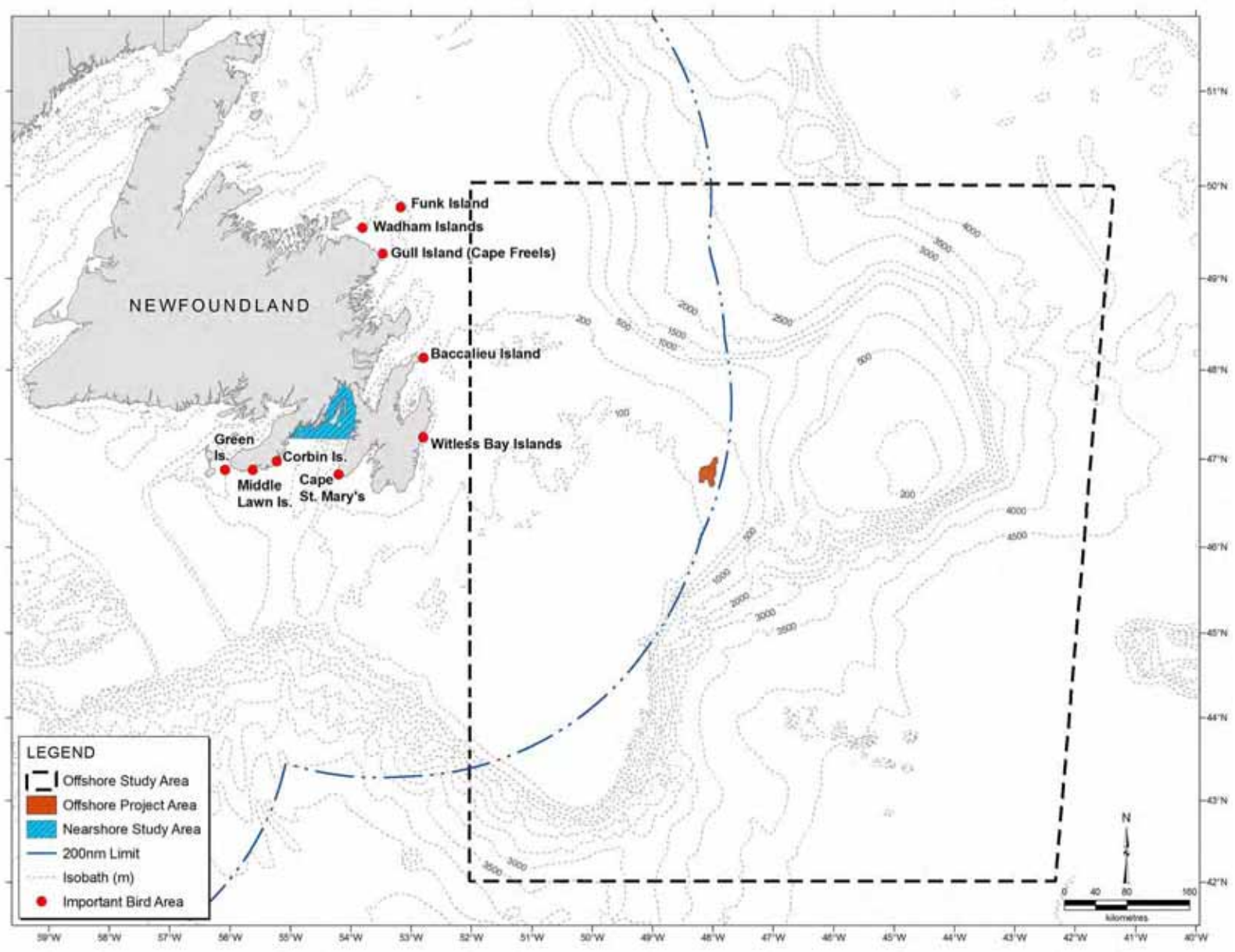



**Figure 10-1 Locations of Seabird Nesting Colonies at Important Bird Areas in Relation to the Study Areas**

**Table 10-2 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] | - | 14,696 [L] | - | - | - |
| Herring Gull | - | 500 [J] | - | Present [A] | 4,638 [E,J] | Present [J] | 20 [J] | 5,000 [J] | Present [M] |
| 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,N] | - | 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] | 14,789 [K] | - | - | - |
| 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** | **1,052,544** | **40,585** | **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] Canadian Wildlife Service (CWS) (unpublished data) (2007); [L] CWS (unpublished data) (2011); [M] Russell (2008); [N] Count scheduled for 2013 (S. Wilhelm, pers. comm.)

Monthly surveys for seabirds at sea in Placentia Bay over a one-year period from 2006 to 2007 were conducted for an environmental assessment of a proposed oil refinery on Placentia Bay (Goudie et al. 2007). These surveys largely overlapped the Nearshore Study Area.

The major breeding colonies have been identified and censussed (Cairns et al. 1989; Lock et al. 1994; Chardine 2000). Aerial surveys of smaller breeding colonies of seabirds such as gulls, terns and cormorants have been conducted for Placentia Bay as recently as 2005 by the Canadian Wildlife Service (Canadian Wildlife Service (CWS), unpublished data). An aerial survey of wintering eiders in Placentia Bay was conducted as recently as February 2006 (CWS, unpublished data). However, the abundance and distribution of seabirds at sea distant from the breeding colonies in summer, especially during the non-breeding season, are poorly understood.

Placentia Bay supports one of the highest densities of Bald Eagles in eastern North America (Dominguez et al. 2002). The species has a year-round presence in Placentia Bay. The Newfoundland and Labrador Wildlife Division has developed a long-term monitoring program for nesting Bald Eagle in Placentia Bay. The survey area includes Merasheen Island, Long Island and part of the western shoreline of Placentia Bay. Extensive surveying has been conducted on at least 13 separate occasions since the late 1980s. The number of nesting pairs fluctuates from year to year, but is consistently between 20 to 30, with a breeding concentration of 0.1 occupied nests per km of shoreline (*n* = 300 to 400 km in 1996 and 1997) (J. Brazil, Wildlife Division, pers. comm., in Goudie and Mactavish 2007) and exhibiting stable reproductive performance (82 percent occupancy, 71 percent nest success, and 1.1 eaglets/occupied nest) (Dominguez 1999). The eastern side of Placentia Bay from Arnolds Cove to Cape St. Mary's was surveyed on 7 June 2006 by LGL Limited as part of an environmental assessment for VBNC (Goudie and Mactavish 2007). This area, which had not been previously surveyed by the Wildlife Division, included an additional eight active nests and a total of 52 Bald Eagles (44 adult and 8 sub-adult). Satellite transmitters attached to Placentia Bay Bald Eagles have demonstrated that they travel to other parts of the island of Newfoundland, but do not leave the province.

### 10.3.2 Offshore Overview

The Offshore Study Area includes the southern Orphan Basin, Flemish Cap, most of the Grand Banks and deep-water area southeast of the Grand Banks. Those features include continental shelf, slope and deep-water habitats, as well as cold Labrador Current and warm Gulf Stream waters, all of which influence the distribution and abundance of marine birds. Marine birds are not spread evenly over the ocean but tend to be concentrated over anomalies such as shelf edges and areas where currents mix. Mixing in the water column at these edges creates a productive environment for plankton, which is the base of marine food webs. The food resources of the Grand Banks support many locally breeding birds. Several million seabirds nest along the coasts of the Avalon Peninsula and elsewhere along southeastern Newfoundland, and forage on the Grand Banks during and following the nesting season. In addition to local breeding birds, there are many non-breeding seabirds on the Grand Banks during the summer months. Most of the world's population of Great Shearwater is thought to migrate to the Grand Banks and eastern Newfoundland to moult and feed during summer months after completion of nesting in the Southern Hemisphere. During the winter months, seabirds from the Arctic and subarctic of eastern Canada, and from

Greenland, gather on the Grand Banks. All species of seabirds require more than a single year to become sexually mature. Many of those non-breeding sub-adult seabirds, especially Northern Fulmar and Black-legged Kittiwake, are present on the Grand Banks year-round.

Little is known about the occurrence of birds in the deeper waters of the southeastern portions of the Study Area, away from the shelf and slope. However, such habitats typically are less productive and thus support far fewer numbers and variety of seabirds than the shelf and slope.

### 10.3.3 Data Sources and Survey Effort for Marine Birds in the Study Areas

Seabird surveys in the Offshore Study Area and surrounding areas have been conducted by the CWS and oil industry related seabird monitoring. Prior to 2000 seabird surveys were sparse on the Orphan Basin, northern Grand Banks and Flemish Cap. Original baseline information has been collected by CWS through PIROP (Programme intégré de recherches sur les oiseaux pélagiques). These data have been published for 1969-1983 (Brown 1986) and 1984-1992 (Lock et al. 1994). It is not possible to derive densities from these data because they were collected as number of bird per linear kilometre. Since the late 1990s additional seabird observations have been collected on the northeast 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). Seabird surveys were conducted from vessels conducting seismic surveys or control source electromagnetic (CSEM) surveys within the Study Area from 2004 to 2008 as part of the marine bird monitoring program required by the C-NLOPB (Moulton et al. 2005, 2006a; Lang et al. 2006; Lang 2007; Lang and Moulton 2008; Abgrall et al. 2008a, 2008b, 2009). The offshore research, seismic-related and CSEM cruises on which standard Tasker surveys and other marine bird observations were conducted are listed in Table 10-3. Although seismic and CSEM surveys with shipboard seabird surveys have been conducted since then, the data reports have not been released publically. The geographic distribution of Tasker surveys in and around the Offshore Study Area is illustrated in Figure 10-2.

**Table 10-3 Offshore Study Area Marine Bird Observations 2004 to 2008**

| Project | Time Period | Location (Relative to Project Area and/or Study Area) | Approximate Water Depth (m) | Species with Highest Relative Abundances during Observations |
|---|---|---|---|---|
| CCGS *Hudson* Research Expedition | June 2004 | South Grand Banks (southwestern Study Area) | <100 | Greater Shearwater |
| CCGS *Hudson* Research Expedition | June 2004 | Salar Basin (southwestern Study Area) | >1,000 | Greater Shearwater Northern Fulmar |
| CCGS *Hudson* Research Expedition | June 2004 | Western Slope of Southern Flemish Pass (north-central Study Area) | ~ 500 | Northern Fulmar Greater Shearwater Sooty Shearwater |
| CCGS *Hudson* Research Expedition | June 2004 | Sackville Spur (northeast of Study Area) | ~ 1,000 | Northern Fulmar Greater Shearwater Great Black-backed Gull |
| CCGS *Hudson* Research Expedition | June-July 2004 | Orphan Basin (north of Study Area) | >2,000 | Northern Fulmar Greater Shearwater Great Black-backed Gull Leach's Storm-Petrel |

| Project | Time Period | Location (Relative to Project Area and/or Study Area) | Approximate Water Depth (m) | Species with Highest Relative Abundances during Observations |
|---|---|---|---|---|
| CCGS *Hudson* Research Expedition | July 2004 | North Grand Banks (northwestern Study Area) | 200 to 1,000 | Greater Shearwater Manx Shearwater |
| Seismic Program for Chevron Canada Resources and ExxonMobil Canada Limited | June-September 2004 | Orphan Basin (north of Study Area) | 1,850 to 2,500 | Northern Fulmar Greater Shearwater Leach's Storm-Petrel Sooty Shearwater Black-legged Kittiwake (Aug-Sept) |
| Seismic Program for Chevron Canada Resources and ExxonMobil Canada Limited | May-September 2005 | Orphan Basin (north of Study Area) | 1,108 to 2,747 | Northern Fulmar Leach's Storm-Petrel Greater Shearwater Black-legged Kittiwake, Dovekie, and Thick-billed Murre (May-June) Great Black-backed Gull (Aug-Sept) |
| Seismic Program for Husky. | October-November 2005 | Approximately 75 km northwest of Terra Nova FPSO (northwestern Study Area) | 68 to 376 | Northern Fulmar Dovekie Black-legged Kittiwake Thick-billed Murre |
| Petro-Canada`s *Terra Nova* Hull Cleaning | May-June 2006 | 46 km radius around Terra Nova FPSO | 65 to 190 | Leach's Storm-Petrel |
| Seismic Program for Husky | July-August 2006 | 1) 95 km north and 2) 15 km east of Terra Nova FPSO | 86 to 387 | Greater Shearwater Leach's Storm-Petrel |
| CSEM Program for ExxonMobil Canada Limited | August-September 2006 | Orphan Basin (north of Study Area) | 2,076 to 2,603 | Greater Shearwater Leach's Storm-Petrel Black-legged Kittiwake Northern Fulmar |
| Seismic Program for Petro-Canada | June-July 2007 | Approximately 17 km northwest of Terra Nova FPSO (northwestern Study Area) | 61 to 171 | Greater Shearwater Northern Fulmar Leach's Storm-Petrel |
| CSEM Program for ExxonMobil Canada Limited | July-September 2007 | Orphan Basin (north of Study Area) | 1,122 to 2,789 | Leach's Storm-Petrel Greater Shearwater Northern Fulmar |
| Seismic Program for Petro-Canada, StatOil Hydro, and Husky | May-September 2008 | Jeanne d'Arc Basin | 66 to 119 | Greater Shearwater Northern Fulmar Leach's Storm-Petrel |

Source: Lang and Moulton 2004, 2008; Moulton et al. 2005, 2006a; Lang et al. 2006; Lang 2007; Abgrall et al. 2008a, 2008b, 2009.

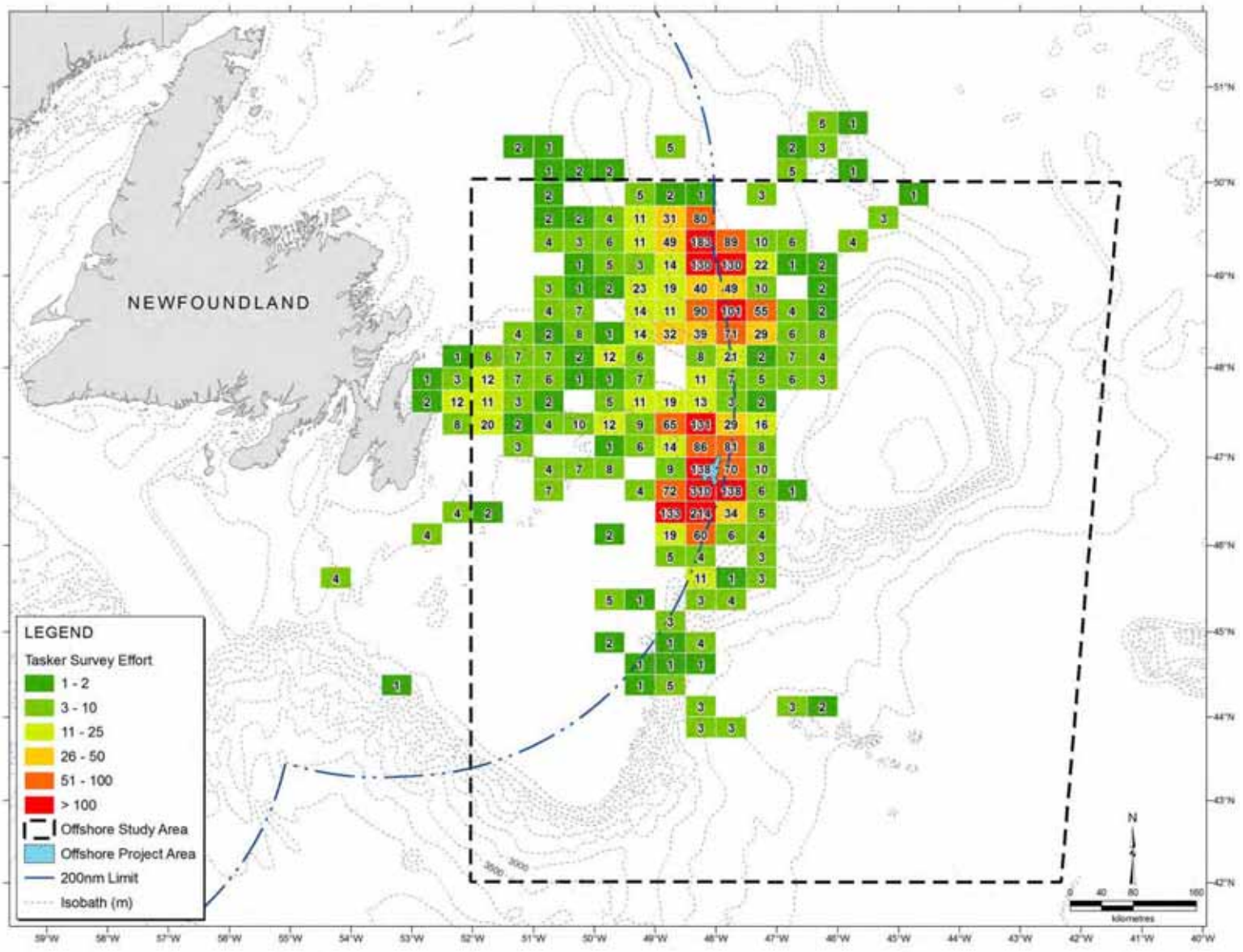



**Figure 10-2 Geographic Distribution of Tasker Surveys (number of 10-minute counts) conducted during 2004 through 2008 in and around the Offshore Study Area**

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, called Eastern Canadian Seabirds at Sea (ECSAS) (Fifield et al. 2009). A total of 76 surveys totaling over 150,000 hours of effort were conducted from 2006 to 2009, including many surveys of the Grand Banks and Orphan Basin. Survey coverage and densities of all seabird species combined are presented in Figures 10-3 (spring migration), 10-4 (breeding season), 10-5 (fall migration) and 10-6 (winter).

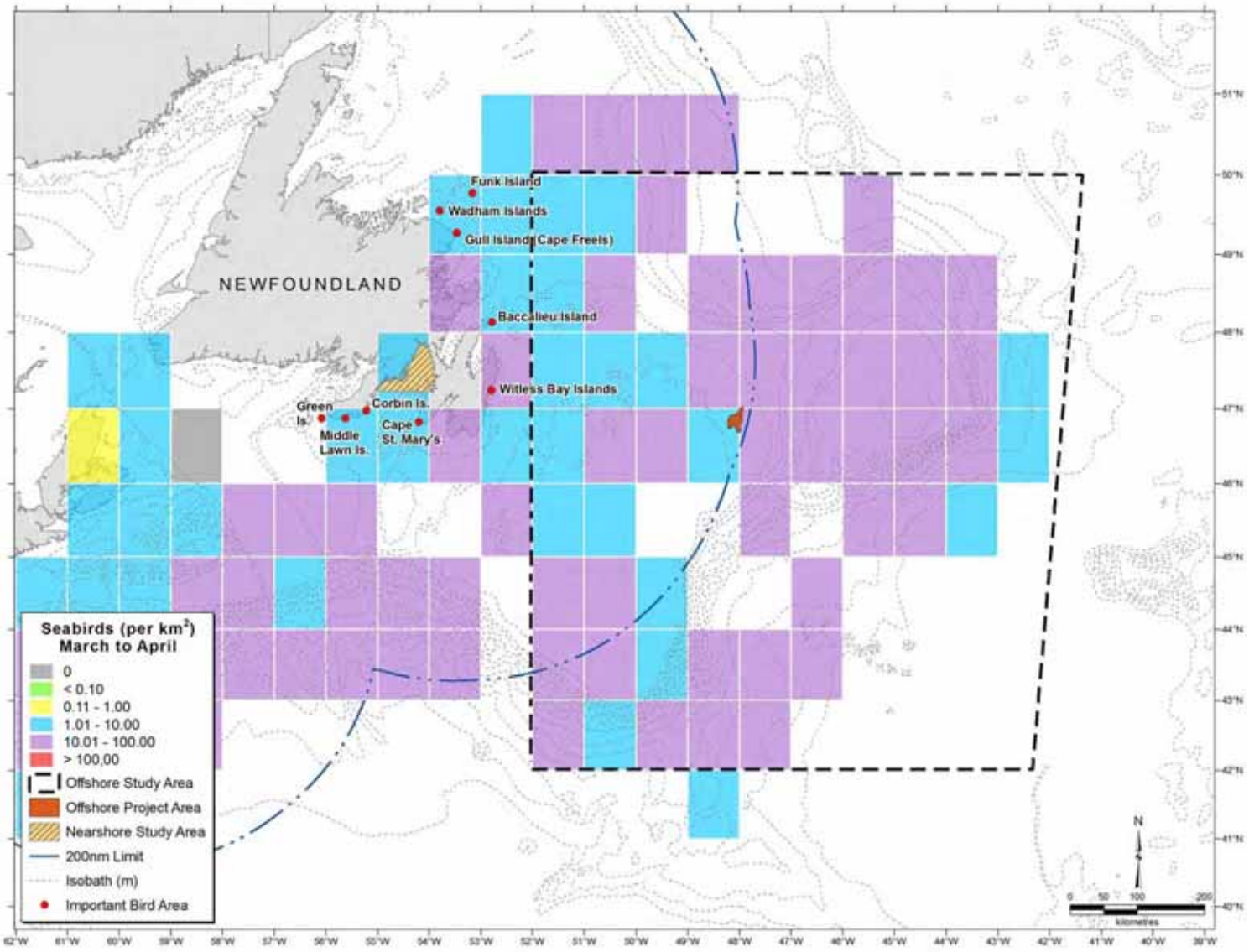
Most data on marine bird abundance and distribution in the Offshore Study Area were collected as described in the preceding paragraphs from June through September. Marine bird surveys conducted by environmental observers on offshore installations in the Terra Nova field during 1999 to 2009 fill in some of the data gaps for the October to May period. Marine bird surveys conducted from the drill platform in the Terra Nova field from 1999 to 2009 used variable survey methods from 2-minute to 10-minute counts of all birds within a 300 m radius of the drill platform. Relative abundances, as well as spatial and temporal distribution of marine birds were derived from these data (Suncor unpublished data 2009). There are data gaps for all seasons for the Flemish Cap, the deep waters east of the Flemish Cap and southeast of the Grand Banks.

Monthly surveys for seabirds at sea in Placentia Bay over a one-year period from 2006 to 2007 were conducted for an environmental assessment of a proposed oil refinery on Placentia Bay (Goudie et al. 2007). These surveys largely overlapped the Nearshore Study Area.

### 10.3.4 General Patterns of Marine Bird Occurrence in the Offshore Study Area

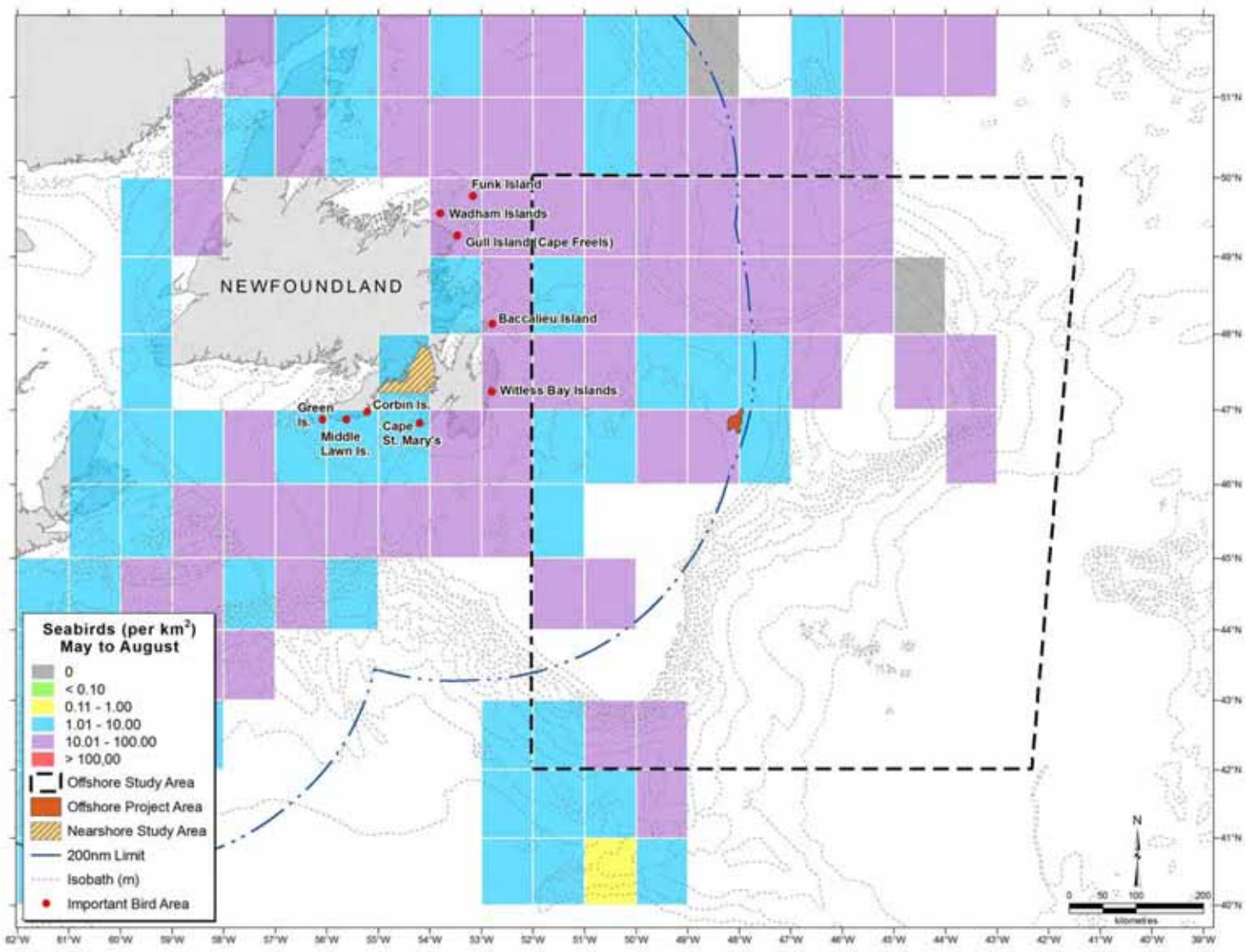
Knowledge of marine bird occurrence in the Offshore Study Area relates primarily to those parts that have been subjected to survey effort (i.e., the Grand Banks (shelf and slope) and the Orphan Basin). Little is known about the distribution and abundance of marine birds in other parts of the Offshore Study Area.

The Grand Banks supports large numbers and diversity of marine birds in every season (Brown 1986; Lock et al. 1994). In all seasons, densities of birds generally are higher along the shelf break. This is likely also true of the Flemish Cap and its slopes, given that the same factors promoting increased productivity (upwelling and mixing) are present. Approximately 27 species of marine birds occur annually on the Grand Banks and adjacent areas. The species and general monthly abundance expected on the Continental Shelf and slope waters of the Offshore Study Area are provided in Table 10-4.



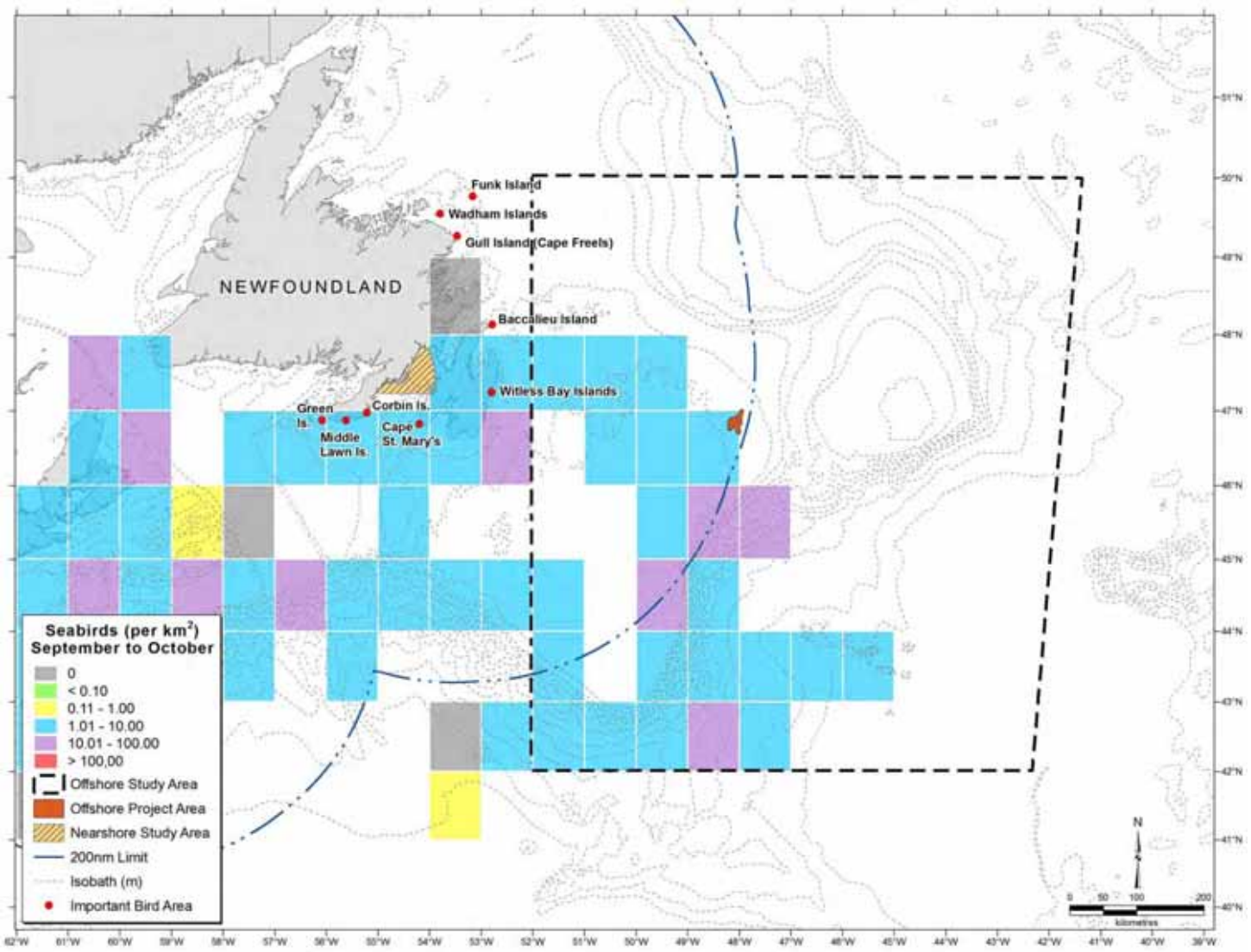

Source: Fifield et al. 2009.

**Figure 10-3 Eastern Canadian Seabirds at Sea Survey Effort and Seabird Densities in and around the Nearshore and Offshore Study Areas: March to April**



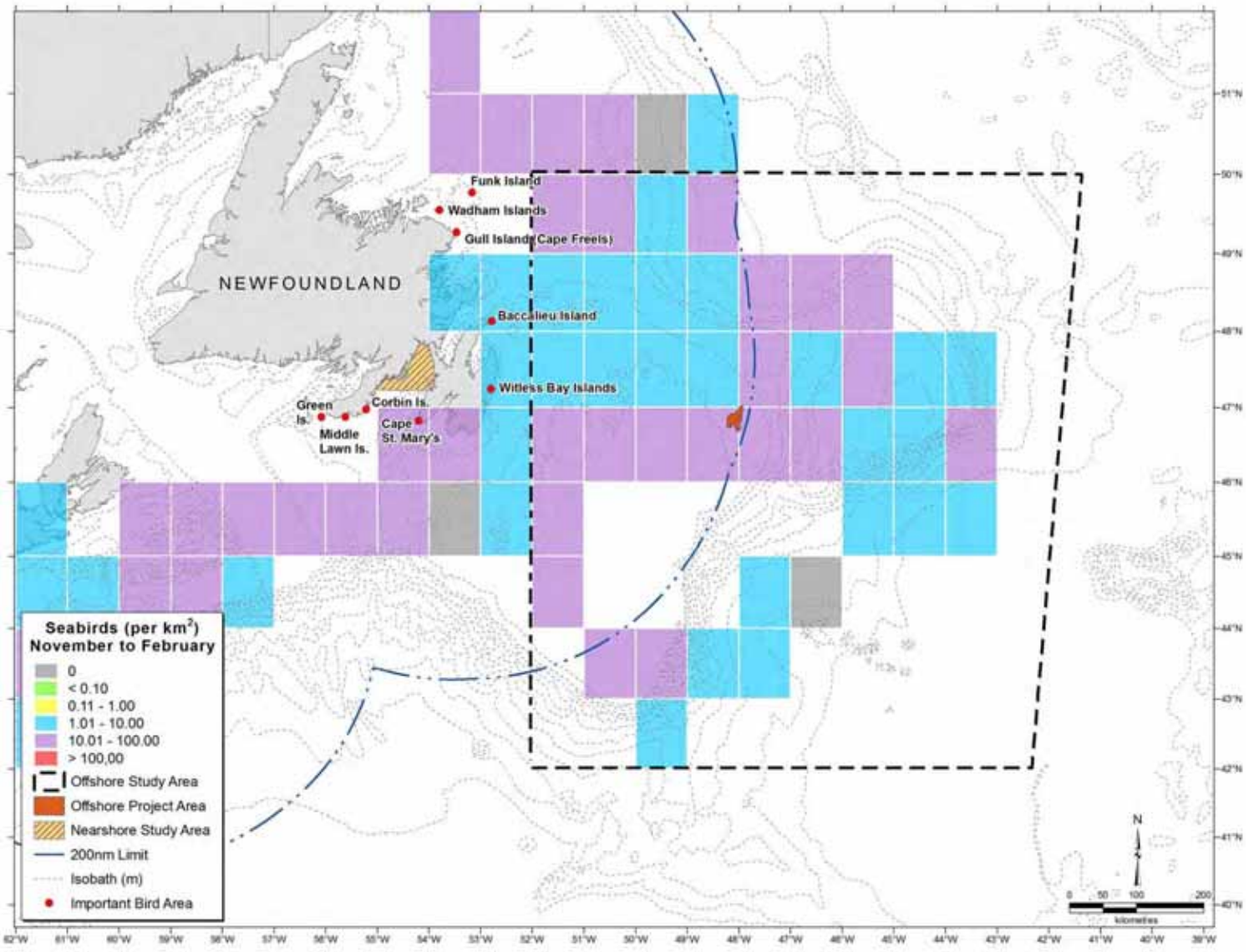

Source: Fifield et al. 2009.

**Figure 10-4 Eastern Canadian Seabirds at Sea Survey Effort and Seabird Densities in and around the Nearshore and Offshore Study Areas: May to August**




Source: Fifield et al. 2009.

**Figure 10-5 Eastern Canadian Seabirds at Sea Survey Effort and Seabird Densities in and around the Nearshore and Offshore Study Areas: September to October**




Source: Fifield et al. 2009.

**Figure 10-6 Eastern Canadian Seabirds at Sea Survey Effort and Seabird Densities in and around the Nearshore and Offshore Study Areas: November to February**

**Table 10-4 Predicted Monthly Abundances of Seabird Species Occurring in the Offshore Study Area (Orphan Basin, Flemish Cap, Grand Banks)**

| 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 | -- |
| **Oceanitidae** | | | | | | | | | | | | | |
| 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 | -- | -- | -- |
| **Laridae** | | | | | | | | | | | | | |
| 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 |
| 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 | C | C | C | C | 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 | -- | -- | -- |

| Common Name | Scientific Name | Monthly Abundance | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec |
| **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 | C | C | C | C | C | C | C | C | C |
| Thick-billed Murre | *Uria lomvia* | C | C | C | C | C | S-U | S-U | S-U | U-C | C | C | C |
| Razorbill | *Alca torda* | -- | -- | -- | S | S | S | S | S | S | S | S | -- |
| Atlantic Puffin | *Fratercula arctica* | -- | -- | -- | S | S | S | S | S | U | U | U | U |

Sources: Brown 1986; Lock et al. 1994; Baillie et al. 2005; Moulton et al. 2005a, 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. Double hyphen indicates 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).

The highest densities and diversity are found from July to September (Brown 1986; Lock et al. 1994). During this period non-breeding, summering species (e.g., Great Shearwater) are joined by post-breeding, local nesters and their fledglings that have moved offshore from nesting colonies (e.g., Leach's Storm-petrel, Black-legged Kittiwake). The lowest densities are found during the winter months (December through March): however, the Grand Banks and its shelf slope continue to support hundreds of thousands of birds during these months. Large numbers of Arctic-breeding Thick-billed Murre, Dovekie, Northern Fulmar and Black-legged Kittiwake migrate to eastern Newfoundland, including the Grand Banks, for the winter. During migration periods, other marine birds (e.g., jaegers, terns, phalaropes) migrate north in spring (April to May) and south in autumn (September to November) over the Grand Banks between breeding sites in the Arctic (Canada and Greenland) and wintering areas in southern latitudes.

The only species of Atlantic offshore marine bird that is listed under SARA is the Ivory Gull. This species is currently listed as Endangered on Schedule 1. It is likely rare and of less than annual occurrence in the Offshore Study Area (see Section 12.3.3.4 for more details).

### 10.3.5 Marine Bird Nesting Colonies Along Southeastern Newfoundland

Millions of marine birds nest on headlands, cliffs and islands along the coastline of the Avalon Peninsula. The marine bird nesting 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 10-2; Figure 10-1). This number 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 (272,729 pairs on Witless Bay Islands) (Cairns et al. 1989; Rodway et al. 2003; Robertson et al. 2004). No major marine bird nesting colonies are located within either the Nearshore or Offshore Study Areas, so these sites are not discussed within the Sensitive or Special Areas VEC, with the exception of Cape St. Mary's. All of these colonies are included here as part of the profiles of the species within the Nearshore and Offshore Study Areas.

All these birds feed on the Grand Banks, Orphan Basin and adjacent areas during the nesting or post-nesting seasons (May to September). In addition, Funk Island, located 150 km northwest of the Grand Banks, supports the largest Common Murre colony in Atlantic Canada. Many of these birds would reach the Offshore Study Area during the breeding season.

There are nine major marine bird nesting sites on the southeast coast of Newfoundland from Cape Freels to the Burin Peninsula which meet the criteria for an IBA (Figure 10-1). In addition, Grates Point, Mistaken Point and Placentia Bay qualify as IBAs because of important wintering populations of Common Eider. A total of 5.2 million pairs of birds breed at these sites. The Offshore Study Area is well beyond the foraging range of breeding birds during the breeding season (approximately May to August). At Witless Bay, Common Murres have been known to forage up to 200 km from the breeding site, but usually do not exceed 50 to 100 km (Cairns et al. 1990, in Gaston and Jones 1998). During post-breeding dispersal, the Offshore Study Area is within range of all marine birds breeding in eastern Newfoundland and Labrador.

### 10.3.6 Species Profiles

The following is a summary of the spatial and temporal distribution of the marine birds in the Nearshore Study Area and the Offshore Study Area. Where data for the Nearshore Study Area are lacking, data from other parts of Placentia Bay are used. Occurrence in Placentia Bay does not necessarily indicate occurrence within the Nearshore Study Area. A summary of the predicted occurrence and relative abundance of birds in the Offshore Study Area is found in Table 10-3. Information was derived primarily from Brown (1986), Lock et al. (1994), Baillie et al. (2005) and Abgrall et al. (2008a, 2008b, 2009).

#### 10.3.6.1 Anatidae (Sea Ducks)

Sea ducks are species that spend most of the non-breeding season on saltwater. This includes eiders (*Somateria* spp.), scoters (*Melanitta* spp.), Long-tailed Duck (*Clangula hyemalis*), Harlequin Duck (*Histrionicus histrionicus*) and mergansers (*Mergus* spp.). Most species feed on bivalves, crustaceans and other invertebrates, but the mergansers feed primarily on fish. They forage by diving from a resting position on the surface to depths of up to 160 m.

**Common Eider**

The Common Eider is the most abundant species of sea duck wintering in Placentia Bay. Common Eiders wintering in Placentia Bay are mostly of the northern subspecies, *Somateria mollissima borealis*, which breeds in the eastern Arctic south to the mid-Labrador coast (Goudie et al. 2000). Large numbers winter at Cape St. Mary's. A winter study of sea ducks at Cape St. Mary's in 1978-79 showed a mean peak of 4,593 during the 4 to 24 January period (Goudie 1981). Christmas Bird Count totals for the period 1997 to 2009 ranged from 1,999 to 3,198, with an average of 2,613 Common Eiders (National Audubon Society 2012). One to two thousand Common Eiders winter in Placentia Bay 1 km offshore at the Virgin Rocks and along the 10 km stretch of east coast of Placentia Bay from Great Barasway to Gooseberry Cove. During 2006/2007 pelagic seabird surveys, scattered groups of Common Eiders were observed over offshore shoals south of Red Island in December 2006 and March 2007 (Goudie et al. 2007). Several thousand (3,990 on 20 April 2007) eiders were observed during aerial surveys in "The "Breadbox", adjacent to Morgan's Island (St. Lawrence to Point May area) during the winter of 2007. King Eider (*S. spectabilis*) is a scarce wintering species in eastern Newfoundland. Small numbers are found with wintering flocks of Common Eider in Placentia Bay.

**Other Sea Duck Species**

The three species of scoter, White-winged (*Melanitta fusca*), Surf (*M. perspicillata*) and Black (*M. americana*), migrate through eastern Newfoundland coastal waters. Small numbers overwinter in Placentia Bay. A local overwintering population of Black Scoter at Cape St. Mary's averaged approximately 60 individuals during the period 1997 to 2006 (National Audubon Society 2012). Long-tailed Duck is a ubiquitous sea duck over-wintering in ice-free coastal waters of Newfoundland. The Cape St. Mary's Christmas Bird Count totals in the ten-year period from 1997-2009 ranged from 116 to 365 individuals with an average of 227 (National Audubon Society 2012). Other species of duck that occur in small numbers around the coast of Placentia Bay are Common

Goldeneye (*Bucephala clangula*), Common Merganser (*Mergus merganser*) and Red-breasted Merganser (*M. serrator*).

### 10.3.6.2 Procellariidae (Fulmars and Shearwater)

Northern Fulmar and the three species of shearwaters that are expected to occur in the area feed on a variety of invertebrates, fish and zooplankton at or very near the surface. Capelin is an important food source for shearwaters. Fulmars and shearwaters secure their prey by swimming on the surface and picking at items on the surface, or dipping their heads under the water. They are also capable of diving a short distance under the surface, to a depth of a few metres at most. They may do this by 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 resting position on the surface.

#### Northern Fulmar

The Northern Fulmar has a circumpolar distribution, breeding in the north Pacific, Arctic and the North Atlantic Ocean. The centre of breeding abundance in the North Atlantic is the Canadian Arctic, Greenland, Iceland and northeast Europe and Scandinavia. It is a common year-round resident in eastern Newfoundland waters south of the pack ice. Only approximately 100 pairs breed in eastern Newfoundland (Lock et al. 1994; Stenhouse and Montevecchi 1999). The summer populations off eastern Newfoundland are thought to be composed of sub-adults from northern breeding colonies. Banding records show that Northern Fulmars from breeding colonies in the Canadian Arctic, Greenland and the British Isles regularly occur in Newfoundland waters (Brown 1986; Lock et al.1994).

Twelve pairs held nest sites at Cape St. Mary's in 1999 (Stenhouse and Montevecchi 1999). The Northern Fulmar is probably scarce to common in the outer reaches of Placentia Bay throughout the year. Winter storms are known to shift hundreds of individuals temporarily into Placentia Bay. Counts of 1,619 and 330 Northern Fulmar were observed flying south past Cross Point, St. Brides, the morning after southeast gales during annual Christmas bird counts in December 1999 and 2006, respectively (National Audubon Society 2012). During the monthly pelagic bird survey program in Placentia Bay from August 2006 to April 2007, only four Northern Fulmars were observed, including three in September and one in December (Goudie et al. 2007).

Results from monitoring programs on the Orphan Basin 2004 to 2007 show Northern Fulmar among the top four most numerous species from mid-May to September (Moulton et al. 2006a; Abgrall et al. 2008b). Monthly average densities during June, July and August ranged from 1.7 to 4.8 birds/km$^2$. Higher densities were recorded in May and September, with 30.1 birds/km$^2$ in May 2005 and 16.1 birds/km$^2$ in September 2005 and 5.8 birds/km$^2$ in September 2006. Results from the Jeanne d'Arc Basin in 2005, 2006 and 2008 show an average of 5.1 birds/km$^2$ for July and August 2006, an average of 1.2 birds/km$^2$ late May to September 2008 and 14.7 birds/km$^2$ in October and early November in 2005 (Abgrall 2008a, Abgrall et al. 2009).

The ECSAS survey data from 2006 to 2009 in the Offshore Study Area show Northern Fulmar was present during all seasons (spring, summer and winter) surveyed (Fifield et al. 2009). Densities within the Offshore Study Area (considering 1°N by 1°W survey blocks) ranged from 1.0 to 22.4 birds/km$^2$ in spring to 0 to 10.7 birds/km$^2$ in summer, and

0 to 33.7 birds/km$^2$ in winter. High densities were observed along the southern edge of Orphan Basin at the Sackville Spur in winter.

**Great Shearwater**

Great Shearwaters migrate north from breeding islands in the South 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).

Concentrations of 100,000 shearwaters, mostly Greater with some Sooty Shearwaters, have been observed on the east side of Placentia Bay in June. Such observations serve as the basis for the IBA in eastern Placentia Bay (www.ibacanada.com). Large numbers of shearwaters are attracted to the southern Avalon Peninsula during the early summer season from mid-June to late July when capelin spawn. The numbers of Greater and Sooty Shearwaters using Placentia Bay during the summer is not accurately known, but is probably in the hundreds of thousands.

Great Shearwater was among the top four most numerous species observed on the Orphan Basin during seismic monitoring 2004 to 2007 from June to September, with monthly density averages ranged from 2.4 to 35.4 birds/km$^2$ (Moulton et al. 2006a; Abgrall et al. 2008b). Seismic monitoring on the Jeanne d'Arc Basin showed Greater Shearwater were common in summer with a mean weekly density of 5.1 birds/km$^2$ from 9 July to 16 August 2006 (Abgrall et al. 2008a) and 11.9 birds/km$^2$ from 21 May to 29 September 2008 (Abgrall et al. 2009). ECSAS survey data from 2006 to 2009 lumps all shearwater species within the Offshore Study Area shows densities per 1º survey blocks ranging from 0 to 14.1 birds/km$^2$ during the summer period May to August (Fifield et al. 2009).

**Sooty Shearwater**

The Sooty Shearwater breeds in the Southern Hemisphere from November to March. A large percentage of the population migrates to the Northern Hemisphere and is present from May through October. It is a common bird during the summer months off Atlantic Canada north to Labrador, but it usually outnumbered by the Greater Shearwater, with which it often associates.

During the monthly pelagic bird survey program in Placentia Bay from August 2006 to April 2007, only three Sooty Shearwaters were recorded and these birds were seen in August (Goudie et. al. 2007).

Seismic monitoring programs in the Orphan Basin in late spring to early fall 2005 to 2008 showed Sooty Shearwater was greatly outnumbered by Great Shearwater (Moulton et al. 2006a; Abgrall et al. 2008b). Sooty Shearwater was the second most abundant seabird species over the course of the 2008 seismic monitoring program in the Jeanne d'Arc Basin; increased densities in September may reflect staging prior to southward migration (Lang 2007; Abgrall et al. 2008a, 2009).

**Manx Shearwater**

Most of the world population of Manx Shearwater breeds on islands in northwest Europe (Iceland, Scotland, Ireland, England and France) and The Azores and Canary Islands. It winters in the southwest Atlantic off eastern South America (Lee and Haney 1996). It is an uncommon species in Atlantic Canada from May through October, with most of the birds thought to be sub-adults from European breeding colonies. The only known established breeding colony in the northwest Atlantic is at Middle Lawn Island, Burin Peninsula.

The first breeding record of Manx Shearwater for Newfoundland and North America was Middle Lawn Island, Burin Peninsula Newfoundland. Breeding was first confirmed in 1977. The breeding population has been estimated as high as 100 pairs based on the number of burrows and adults present. However, it was later determined that most of the birds appeared to be prospecting nesting sites without actually laying eggs. In 1981, 13 burrows contained eggs, with an estimated 360 birds attending the colony (Storey and Lien 1985). The low rate of breeding indicates the colony was in the early stages of development. In 2000, a thorough survey of nesting burrows revealed only two burrows with an egg; nine other burrows were deemed active (Robertson 2002). In 2001, an estimated 100 Manx Shearwaters were present at Middle Lawn Island (Robertson 2002). The consistent low rate of breeding relative to the number of birds in attendance from 1981 to 2001, the decline in numbers of eggs in burrows from 1981 to 2000, and fewer birds attending the colony indicates the breeding colony is struggling to maintain an existence. The number of birds and active burrows appears to have further declined since 2000 (Roul 2011). During the monthly pelagic bird survey program in Placentia Bay, a single Manx Shearwater was observed in August (Goudie et al. 2007).

This species is expected to be scarce in the Offshore Study Area during May to October. A total of 39 were observed on drill platforms on the northeast Grand Banks 1999 to 2002 (Baillie et al. 2005). This represents less than 0.1 percent of all the birds recorded. Manx Shearwater densities averaged less than 0.1 birds/km$^2$ per month from May to October during seismic monitoring programs on the Jeanne d'Arc Basin in 2005, 2006 and 2008 (Lang 2007; Abgrall et al. 2008a, 2009). In the Orphan Basin, densities averaged less than 0.1 birds/km$^2$ per month from May to September during seismic and CSEM monitoring programs 2005, 2006 and 2007 (Moulton et al. 2006a; Abgrall et al. 2008b).

### 10.3.6.3 Oceanitidae (Southern Storm-Petrels) and Hydrobatidae (Northern Storm-Petrels)

There are two species of storm-petrel occurring in Newfoundland and Labrador waters, the Wilson's Storm-Petrel and Leach's Storm-Petrel. They feed on mysid fish, small decapod crustaceans and other invertebrates. These storm-petrels usually feed while on the wing, picking small food items from the surface.

**Wilson's Storm-Petrel**

The Wilson's Storm-Petrel breeds on islands from December to March in the South Atlantic Ocean, including the Antarctic and sub-Antarctic. In the non-breeding season, the population that breeds in the South Atlantic migrates to the Northern Hemisphere. It reaches the northern limits of the range in southern Newfoundland.

Small numbers probably occur in Placentia Bay during the summer months June to September. However, it was not recorded during the monthly pelagic bird survey program in Placentia Bay from August 2006 to April 2007 (Goudie et al. 2007).

Wilson's Storm-Petrels occur in such low densities on the Jeanne d'Arc Basin and Orphan Basin that very few are recorded on systematic surveys. The same is probably true for the entire Offshore Study Area.

**Leach's Storm-Petrel**

Leach's Storm-Petrel is a widespread and abundant species occurring in both the Atlantic and Pacific oceans. In the Atlantic, it breeds in northwest Europe (Iceland, Scotland and Norway) and in North America, from southeast Labrador to Massachusetts (Huntington et al. 1996). The centre of breeding abundance in the North Atlantic is Newfoundland.

There are several large colonies on the east coast of Newfoundland, including the largest colony in the world at Baccalieu Island at the western mouth of Conception Bay (3.3 million pairs). Three important breeding colonies of Leach's Storm-Petrels are located on the southern Burin Peninsula: Middle Lawn Island, with 13,879 pairs; Corbin Island, with 100,000 pairs; and Green Island, with 103,833 pairs (Figure 10-1; Table 10-2). Leach's Storm-Petrels are common and widespread at sea. They probably occur regularly in moderate numbers in the outer parts of Placentia Bay from April through at least the end of October. During the monthly pelagic bird survey program in Placentia Bay from August 2006 to April 2007, a single Leach's Storm-Petrel was observed on 20 October 2006 (Goudie et al. 2007).

Leach's Storm-Petrel is common in most of the Offshore Study Area between April and early November. During seismic monitoring programs on the Jeanne d'Arc Basin in 2005, 2006 and 2008 between May and October, weekly and biweekly densities ranged from 0.1 to 1.1 birds/km$^2$ (Lang 2007; Abgrall et al. 2008a, 2009). Monthly densities ranged from 4.3 to 10.2 birds/km$^2$ during seismic and CSEM monitoring programs on the Orphan Basin in 2005, 2006 and 2007 (Moulton et al. 2006a; Abgrall et al. 2008b). CWS surveys show that Leach's Storm-Petrel occurs on the Flemish Cap from March to August in densities of 0 to 3.5 birds/km² (Fifield et al. 2009).

**10.3.6.4 Sulidae (Gannets)**

**Northern Gannet**

The Northern Gannet is the only species of the Sulidae that occurs in the North Atlantic. Northern Gannets breed in the north Atlantic in eastern Canada, Iceland, Faeroe Islands and British Isles. This species winters along the coast from New Jersey to Florida and from the British Isles to the Azores. Three of the five major Northern Gannet colonies in North America are located in Newfoundland at Cape St. Mary's, Baccalieu Island and Funk Island (Figure 10-1; Table 10-2).

Cape St. Mary's at the mouth of Placentia Bay is the largest Northern Gannet breeding colony in Newfoundland, with 14,696 pairs in 2011 (S. Wilhelm, CWS, unpublished data). Northern Gannets are common in Placentia Bay from late March to November. They feed extensively on spawning herring and capelin schools, often following them

right to the head of the bay at Arnold's Cove and to the entrance to Long Harbour (Goudie et al. 2007). During the monthly pelagic bird survey program in Placentia Bay, Northern Gannets were observed in low-to-moderate numbers in August, September and October, with a few late individuals observed on 4 December in the southeast portion of the bay (Goudie et al. 2007).

Northern Gannets were rarely recorded on systematic seabird surveys during seismic monitoring programs in the Orphan Basin and Jeanne d'Arc Basin (Moulton et al. 2006a; Lang 2007; Abgrall et al., 2008a, 2008b, 2009). The CWS surveys in 2006 to 2009 showed gannets present in the western edge of the Offshore Study Area from April to August, with densities of 0 to 0.9 birds/km² (Fifield et al. 2009). Northern Gannets are expected to occur in Offshore Study Area from April to early November in very low densities, with increasing numbers in the western portion.

#### 10.3.6.5 Phalaropodinae (Red and Red-necked Phalaropes)

Phalaropes are the only group of shorebirds considered pelagic because they spend most of the non-breeding season at sea. Red-necked Phalaropes and Red Phalaropes regularly occur in the Atlantic Ocean migrating between Arctic breeding grounds and wintering areas at sea south mostly south of the equator.

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. These phalarope species are scarce in the Offshore Study Area during the May to October period and generally absent outside that period.

Both these phalarope species have been recorded in the Placentia Bay, but there are few data on their abundance. During fall migration, Red-necked Phalaropes generally migrate earlier than Red Phalaropes, with peak fall migration occurring in August and September, while the Red Phalarope migration extends into October with stragglers into November. The only phalaropes observed during the monthly pelagic bird survey program in Placentia Bay were two Red Phalaropes sighted on 26 September 2006 and two unidentified phalaropes sighted on 18 October 2006 (Goudie et al. 2007). On 4 December 2006, three Red Phalaropes were observed from boat by LGL biologists while in transit to Southern Head from Northern Harbour (Goudie et al. 2007).

Red-necked and Red Phalaropes both migrate at sea from south of the equator to Arctic breeding grounds. Phalaropes are rarely recorded during systematic seabird surveys because of their relatively low densities. However, small numbers have been observed incidentally on the Jeanne d'Arc Basin and Orphan Basin during seismic monitoring programs from mid-May to October (Moulton et al. 2006a; Lang 2007; Abgrall et al. 2008a, 2008b, 2009). There were no concentrations of phalaropes observed during these surveys. Phalaropes are expected to occur in the Offshore Study Area in small numbers between mid-May and early November.

#### 10.3.6.6 Laridae (Gulls and Terns)

Gulls feed on a variety of fish and invertebrate species and carrion. They feed by picking items from the surface while on the wing or while resting on the surface, and by plunge diving. Terns feed on fish exclusively by plunge diving. They rarely alight on the surface.

At least 13 species of gulls are likely to occur annually in eastern Newfoundland. Five of these, Laughing Gull (*Leucophaeus atricilla*), Black-headed (*Chroicocephalus ridibundus*), Bonaparte's Gull (*Chroicocephalus philadelphia*), Mew Gull (*Larus canus*) and Sabine's Gull (*Xema sabini*) are rare and occur in very small numbers.

Ivory Gull is associated with sea ice and may occur rarely in the Nearshore and Offshore Study Areas. It is listed as Endangered on Schedule 1 of *SARA* and assessed the same by COSEWIC (COSEWIC 2011a) and under Newfoundland and Labrador's *Endangered Species Act*. It is discussed in detail in Section 12.3.3.4.

**Herring, Great Black-backed, Glaucous, Iceland, Lesser Black-backed and Ring-billed Gulls**

Great Black-backed and Herring gulls are common breeding birds in Newfoundland and Labrador. They winter along the coast from insular Newfoundland and south into the United States. A portion of Great Black-backed Gull population winters at sea. Ring-billed Gull (*Larus delawarensis*) is a common breeding bird on insular Newfoundland. It winters south of the province and rarely occurs far from shore. Glaucous and Iceland Gulls are northern gulls. Glaucous Gulls breed in the Arctic south to the mid-Labrador coast. They winter as far north as there is open water south to the New England States. Iceland Gulls breed in the Arctic and winter from Labrador south to the northern United States. The Lesser Black-backed Gull is a European gull. Some of the breeding population migrates to North America for the winter. It is observed duration migration seasons, but some sub-adults birds are present through the summer in Newfoundland waters.

Herring Gull and Great Black-backed Gull were the most numerous gulls recorded during the monthly pelagic bird survey program in Placentia Bay from August 2006 to April 2007 (Goudie et al. 2007). They commonly nest on islands around the coast of Placentia Bay (Cairns et al. 1989). They are a year-round resident of Placentia Bay. Glaucous and Iceland gulls are present in small numbers during the winter months in Placentia Bay. Ring-billed Gull stay near shore but breed on islands in Placentia Bay. For example, large breeding colonies are known from Crawley Island in Long Harbour and Goose Island, 2 km southeast of Arnold's Cove. The Crawley Island colony contained 992 active nests in 2005, whereas Goose Island contained 304 active nests in 2005 (G. Robertson, CWS, unpublished data).

The Sackville Spur has been identified as an area with a high concentration of large gulls, particularly in late winter and early spring (Fifield et al. 2009). During the surveys in the period November to February, densities of large gulls per 1° blocks ranged from 0.5 to 20.8 birds/km². Great Black-backed Gull are usually the most numerous of the large gulls found in the offshore regions of Newfoundland. On drilling platforms on the northeast Grand Banks during 1999 to 2002, Great Black-backed Gull were 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, unpublished data). Herring Gull were present in consistent numbers throughout the year, but in lower numbers than Great Black-backed Gull. Results from seismic monitoring programs in Jeanne d'Arc Basin in 2005, 2006 and 2008 indicate that large gulls were most numerous from mid-August to October (Lang 2007; Abgrall et al. 2008a, 2009). In the Orphan Basin, highest densities of Great Black-backed Gull occurred in September, with

averages of 12.1 birds/km² in 2005 and 2.4 birds/km² in 2006 (Moulton et al. 2006a; Abgrall et al. 2008b). Other species of large gulls, Glaucous, Iceland and Lesser Black-backed, occur in small numbers often in association with the other large gulls.

**Black-legged Kittiwake**

Black-legged Kittiwake are potentially a year-round resident in Placentia Bay. Numbers in winter are expected to be low. During the breeding season of April to early August, approximately 10,000 breeding pairs are present at the Cape St. Mary's Ecological Reserve (Figure 10-1; Table 10-2). They are expected to be common in Placentia Bay during the breeding season. The Black-legged Kittiwake were observed on 12 of the 15 pelagic boat surveys from August 2006 to April 2007 (Goudie et al. 2007). They were generally less numerous than Herring and Great Black-backed gulls, but sometimes occurred in small flocks.

Black-legged Kittiwake are present in all months of the year on the Grand Banks. Observations from the drill platforms on the northeast Grand Banks during 1999 to 2002 showed Black-legged Kittiwake were present in October to May, but were most prevalent during November to December (Baillie et al. 2005). They were among the most numerous species observed by environmental observers on offshore installations on the Terra Nova oil field during the winter months (Suncor, unpublished data).

Results from monitoring programs in the Orphan Basin from 2005 to 2007 show Black-legged Kittiwake as uncommon from mid-May to September (Moulton et al. 2006a; Abgrall et al. 2008b). Monthly average densities during surveys from 14 May to 24 September 2005 were 0.3 birds/km². Higher densities were recorded in August and September 2006, with an average of 3.9 birds/km². Results from monitoring programs in the Jeanne d'Arc Basin in 2005, 2006 and 2008 show an average of 0.01 birds/km² for July and August 2006, an average of 0.02 birds/km² late May to September 2008 and 6.6 birds/km² in October and early November in 2005 (Lang 2007; Abgrall et al. 2008a, 2009). Based on ECSAS survey data collected on the Orphan Basin and the shelf areas from 2006 to 2009, densities of Black-legged Kittiwake ranged from 0 to 10.2 birds/km² during the winter period (November to February), 0 to 5.8 birds/km² during the spring period (March and April) and 0 to 2.1 birds/km² during the summer period May to August (Fifield et al. 2009). Information for the deep water areas in the southeast quadrant of the Offshore Study Area is lacking.

**Common and Arctic Tern**

Common Tern (*Sterna hirundo*) and Arctic Tern are present in Newfoundland waters from late May to early September. They often nest in mixed colonies. Aerial surveys of colonial nesting birds in Placentia Bay by CWS in 2005 located 22 tern colonies, ranging in size from 10 to 350 individuals, with six colonies consisting of greater than 100 individuals (P. Thomas, CWS, unpublished data). A few individual Arctic Tern and Common Tern were recorded in August during the monthly pelagic bird survey program in Placentia Bay (Goudie et al. 2007).

Arctic Tern migrate through the Offshore Study Area from May to September. A small number of sub-adult birds may spend part of the summer in the area. Like the skuas and jaegers, densities are so low that they are rarely recorded on systematic seabird

surveys. Common Tern are common near shore, but rarely venture beyond the sight of land. They are very rare in the Offshore Study Area.

#### 10.3.6.7 Stercorariidae (Skuas and Jaegers)

When at sea, skuas and jaegers feed by chasing other species of birds until they either drop food or disgorge the contents of their stomachs (kleptoparasitism). As with predators, their numbers are relatively low compared to the seabirds that they kleptoparasitize. The Long-tailed Jaeger, the smallest member of this group, also feeds on small invertebrates and fish that it catches by dipping to the surface of the water while remaining on the wing.

The Great Skua and South Polar Skua are uncommon seabirds in eastern Canadian waters. The Great Skua breed in the northeast Atlantic Ocean, in the Faeroes and Iceland, and winter farther south, but remain north of the equator. In Atlantic Canada, they are a summer visitor and spring and fall migrant. The South Polar Skua breed in the Southern Hemisphere, on Antarctic islands, from December to March. Part of the population migrates to the North Atlantic during May to October.

Pomarine, Parasitic and Long-tailed jaegers all have circumpolar breeding distributions. They winter at sea in the mid-to-southern Atlantic Ocean. The three species of jaegers migrate through Newfoundland waters during spring and fall. Sub-adult birds spend the summer south of the breeding range, including Newfoundland pelagic waters.

**Great and South Polar Skua**

Both species of skua have been recorded in Placentia Bay in the summer. They are likely regular visitors in small numbers in the outer reaches of Placentia Bay from May through October

Both species of skua occur regularly in low densities in the Offshore Study Area. Numbers are so low that they are rarely recorded on systematic seabird surveys. South Polar Skua are expected within the Offshore Study Area from late May to October and the Great Skua from April to November.

**Pomarine, Parasitic and Long-tailed Jaeger**

Jaegers are expected to be scarce to uncommon in the middle and outer portions of the Placentia Bay between May and October. During the monthly pelagic bird survey program in Placentia Bay from August 2006 to April 2007, only three Parasitic and five Pomarine jaegers were observed in August, September and October (Goudie et al. 2007).

Like the skuas, the three species of jaegers are widespread in the Offshore Study Area, but occur in such low densities that they are rarely recorded on systematic seabird surveys. Pomarine Jaeger is the largest and usually the most numerous of the three species off Newfoundland. They are expected to be present from April to November. Long-tailed and Parasitic Jaegers are less numerous and arrive a month earlier and depart a month later then Pomarine Jaegers.

### 10.3.6.8 Alcidae (Murres, Razorbill, Puffins, Guillemots and Dovekie)

Alcids feed on eat fish, copepods, amphipods, cephalopods, molluscs, crustaceans and other invertebrates that they obtain by pursuit diving. They spend most of their time on or under the sea surface.

There are six species of alcids occurring in Newfoundland and Labrador. All but the Dovekie breed in the province. There is a concentration of breeding alcids at several important mixed seabird colonies in eastern Newfoundland (Figure 10-1; Table 10-2). In general, alcids are common at sea off eastern Newfoundland year-round, but species composition and abundance change between winter and summer.

#### Dovekie

The Dovekie breeds in the North Atlantic, mainly in Greenland and east to Novaya Zemlya, Jan Mayen and Franz Josef Land north of Russia; they winter at sea south to 35°N. The Dovekie is an abundant species, with a world population estimated at 30 million individuals. A large percentage of the Dovekie that breed in Greenland winter in the western Atlantic, mainly off Newfoundland (Brown 1986).

Dovekie are probably common at times during the winter in Placentia Bay. During the monthly transects from August 2006 to April 2007, Dovekie were recorded in low numbers, mainly in October, December and March (Goudie et al. 2007). Highest numbers occurred in December, with average densities of 0.54 birds/km² in the southeast part of the bay and 0.41 birds/km² in the central area of the bay (Goudie et al. 2007).

During seismic monitoring programs on the Orphan Basin in the last two weeks of May 2005, there was an average density of 1.3 birds/km$^2$ (Moulton et al. 2005). These were mostly birds flying north in the latter part of the spring migration. Sightings were rare on the Orphan Basin monitoring programs between mid-June and mid-September (Moulton et al. 2006a; Abgrall et al. 2008b). During seismic monitoring programs on the Jeanne d'Arc Basin in 2005, 2006 and 2008, Dovekie were most numerous in October, with an average density of 6.6 birds/km$^2$ during the period of 1 October to 8 November 2005 (Abgrall et al. 2008a). Incidental observations of Dovekie during this monitoring program include daily totals of 500 on 3 October, 2,000 on 13 October, and 2,500 on 4 November (Abgrall et al. 2008a.).

The ECSAS survey data from 2006 to 2009 for Dovekie within the Offshore Study Area show densities in 1° survey blocks ranging from 0 to 22.59 birds/km$^2$ during spring migration (March and April). The highest densities occurred on the northeast Grand Banks and Flemish Cap (Fifield et al. 2009). On the Tail of the Grand Bank, densities in various 1° survey blocks in March and April ranged from 0 to 0.9 birds/km².

#### Common Murre

The Common Murre breed in the North Pacific and North Atlantic. In the Atlantic, they breed in northern Europe including Iceland and Greenland and in the western Atlantic from Labrador to Nova Scotia. It is an abundant breeder in eastern Newfoundland with nearly 500,000 pairs, with 80 percent of those on Funk Island.

The Cape St. Mary's seabird nesting colony contained 14,789 pairs of breeding Common Murre in 2009 (CWS, unpublished data). Common Murre include capelin as part of their diet and will follow spawning schools far into Placentia Bay during the summer, but typically feed offshore. In the spring and summer (March to July), Common Murre can be common in Placentia Bay, depending in part on food availability. In fall and winter, they are expected to be scarce in Placentia Bay. Common Murre were recorded in low numbers during the monthly pelagic bird survey program in Placentia Bay from August 2006 to April 2007 (Goudie et al. 2007).

During the breeding season, the nearly 500,000 pairs of Common Murre nesting on Funk Island, Baccalieu Island and Witless Bay Island are within foraging range of the western parts of the Offshore Study Area. Seismic monitoring efforts on the Orphan Basin and Jeanne d'Arc Basin record very low densities of Common Murre during the breeding season. However, eastern Newfoundland breeding birds move offshore as soon as the young are fledged in August. During the 2008 seismic monitoring program in Jeanne d'Arc Basin, Common Murre were seen in small numbers almost daily through May to September, except during the first half of August (Abgrall et al. 2009). The first adult-chick pair was seen on 29 August and these pairs were common after 13 September, with up to 75 individuals (adults and flightless chicks) per day. In October and November 2005, an average density of 0.81 birds/km$^2$ was observed for Common Murre in Jeanne d'Arc Basin (Abgrall et al. 2008a). Weekly densities derived from systematic 10-minute counts peaked at 7.5 birds/km² in the third week of October.

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. This indicates the source of some of the murres on the northern Grand Banks.

Both murre species are lumped together on the ECSAS survey data from 2006 to 2009. Generally, all 1° survey blocks within the Offshore Study Area recorded murres throughout the year. Densities per survey block generally ranged from 1 to 5 birds/km² on the Orphan Basin, Grand Banks and Flemish Cap (Fifield et al. 2009). The few survey blocks in the deep-water south and southeast of the Grand Banks generally contained no murres.

**Thick-billed Murre**

The Thick-billed Murre breeds in the Subarctic to Arctic in North America and Eurasia. In Atlantic Canada, they breed in small numbers as far south as Newfoundland. They winter in open water within their breeding range and in the western Atlantic south to New Jersey. The Thick-billed Murre are the "winter turr" in eastern Newfoundland. Newfoundland waters are an important wintering area for many of the two million pairs breeding in Arctic Canada and Greenland. The Grand Banks is recognized as being a key area for wintering Thick-billed Murre (Brown 1986; Lock et al. 1994).

The Thick-billed Murre is expected to be scarce to common in Placentia Bay throughout the year, but most numerous during winter. During the monthly pelagic bird survey program in Placentia Bay from August 2006 to April 2007, they were found in low numbers in October, December, March and April (Goudie et al. 2007). Approximately 1,000 pairs breed at Cape St. Mary's (Table 10-2).

During the seismic monitoring program on the Jeanne d'Arc Basin from 1 October to 8 November 2005, there was an average density of 4.1 Thick-billed Murre/km$^2$ over the survey period (Abgrall et al. 2008a). Extensive seabird surveys have not been conducted on the Orphan Basin during the wintering season, but during the 14 May to 24 September 2005 seismic monitoring surveys, there were average monthly densities for Thick-billed Murre of 0.6 birds/km$^2$ in May and 0.7 birds/km$^2$ in June but none in July to September (Moulton et al. 2006a). Both murre species are lumped together on the ECSAS survey data from 2006 to 2009 (see the Common Murre discussion above).

**Razorbill**

The Razorbill breeds in the North Atlantic Ocean from Maine, eastern Canada, Greenland and Iceland to Great Britain. They winter south to North Carolina and France. Razorbill are relatively scarce compared to Common and Thick-billed murres. More than 1,300 pairs breed in eastern Newfoundland (Chapdelaine et al. 2001) (Table 10-2).

Approximately 100 pairs breed at Cape St. Mary's (Cairns et al. 1989). The Razorbill is expected to be scarce in Placentia Bay throughout the year, but least numerous in winter. During the monthly pelagic bird survey program in Placentia Bay from August 2006 to April 2007, the Razorbill was observed only once during October and March (Goudie et al. 2007).

Razorbill are rarely recorded on systematic seabird surveys in the offshore regions of Newfoundland. They feed closer to shore than the murres. Razorbill occur in small numbers on the Grand Banks, especially near shore and probably within the western edge of the Offshore Study Area.

**Black Guillemot**

The Black Guillemot is ubiquitous along ice-free coastlines of Newfoundland. Newfoundland breeders are augmented by migrants from the Arctic in fall and winter. Guillemots usually feed within 2 km of shore. Breeding numbers are difficult to determine because their breeding sites in crevices and under rocks are difficult to detect.

Black Guillemot are expected to be fairly common year-round near shore around the entire coastline of Placentia Bay, including the islands. During the monthly pelagic bird survey program in Placentia Bay, this species was observed along all pelagic survey routes, but was most numerous at the head of Placentia Bay, particularly in August and March (Goudie et al. 2007).

Black Guillemot are expected to be rare in the Offshore Study Area.

**Atlantic Puffin**

Atlantic Puffin breed in the North Atlantic in Maine, Nova Scotia, Newfoundland and Labrador, Greenland, Iceland and northwest Europe. Approximately 320,000 pairs nest in Atlantic Canada, most of them in southeast Newfoundland. In North America, they winter at sea from southern Newfoundland to southern Nova Scotia.

Atlantic Puffin occur in Placentia Bay during migration and in small numbers in summer and winter. Grand Colombier in St. Pierre et Miquelon is the only breeding colony near Placentia Bay; approximately 400 pairs nest there. During the monthly pelagic bird survey program in Placentia Bay from August 2006 to April 2007, Atlantic Puffin were observed in low numbers in all months surveyed, suggesting that the species overwinters in that bay (Goudie et al. 2007).

The Atlantic Puffin nesting in eastern Newfoundland are within foraging range of the western edge of the Offshore Study Area. The Grand Banks is also an important feeding area for newly fledged puffins in September and October. During monitoring of the seismic survey of Jeanne d'Arc Basin from 1 October to 8 November 2005, there was an average density of 1.46 birds/km$^2$ (Abgrall et al. 2008a). Non-breeding sub-adults occur offshore in low numbers throughout the summer. Seabird surveys during monitoring operations 2004 to 2008, conducted within the period mid-May to September in the Orphan Basin and Jeanne d'Arc Basin, recorded low densities of Atlantic Puffins (Moulton et al. 2006a; Lang 2007; Abgrall et al. 2008a, 2008b, 2009).

## 10.4 Project-Valued Environmental Component Interactions and Existing Knowledge of Environmental Effects

WREP activities with similar potential effects on Marine Birds have been grouped into three categories rather than assessing each WREP activity separately: Change in Habitat Quantity, Change in Habitat Quality and Potential Mortality. This permits a complete and comprehensive environmental effect analysis including a cumulative environmental effects assessment of within-WREP activities.

### 10.4.1 Nearshore

Nearshore WREP activities have the potential to have effects on habitat quantity and habitat quality for marine birds. Habitat quality can be reduced by noise and lights emanating from project activities. Lighting during periods of darkness may attract marine birds, particularly Leach's Storm-Petrels, which may strike vessels or infrastructure leading to injury or strandings. Activities with the greatest potential for disturbance (i.e., change in habitat use) include pile driving, vessel traffic and dredging. Mortality of marine birds is not expected to be an environmental effect of most routine activities in the Nearshore Study Area, except perhaps from night-time collisions with vessels/infrastructure.

#### 10.4.1.1 Graving Dock Construction

**Lighting**

Safety/security lighting at the construction site may attract nocturnally-active marine birds in the Nearshore Study Area. Leach's Storm-Petrels are especially attracted to artificial lighting, particularly in offshore areas. The existing knowledge of the effects of light attraction is therefore described in detail for the Offshore Study Area in Section 10.4.2.1.

### Air Emissions

Although air emissions could, in theory, affect the health of some resident marine birds, the effects would likely be minimal because emissions of potentially harmful materials will be small and rapidly disperse to undetectable levels.

### Construction Noise

Temporary and localized noise disturbances are the most likely effects of WREP construction activities on marine birds. In coastal regions, varying levels of human disturbance (from human presence to physical substrate disturbance and construction activities) are known to cause minor disturbance of several species. Such disturbance could have important environmental effects on birds if opportunities to forage or breed become limited as a result of the activities.

Burger et al. (2007) described the effects of human presence, cars or planes and dog presence on the average number of Herring Gulls, Laughing Gulls (*Leucophaeus atricilla*) and shorebirds that included Red Knot (*Calidris canutus*). The responses of gulls and shorebirds differed considerably, with gulls generally returning to pre-disturbance levels within five minutes of a disturbance. All shorebirds responded most strongly to the presence of dogs and did not return to the beach within the 10 minute post-disturbance monitoring period. Red Knots also appeared to be more responsive to humans than to cars or planes, showing moderate signs of recovery to pre-disturbance within 30 seconds of car or plane disturbance relative to periods greater than 10 minutes for human disturbance.

Burger (1988) monitored the abundance of shorebirds (species not provided), Laughing Gulls and Herring Gulls during pre- and post-activities associated with demolition, beach clean-up and construction for development on a coastal mudflat in New Jersey. Activities included the use of chainsaws, humans picking up and/or piling debris from the mudflat and crane loading from the beach. The overall number of birds using the mudflat was higher during the period prior to coastal activities. Birds also moved away when activity began and returned when activity ceased. Gulls that moved farther out on the mudflat had measurably lower foraging efficiencies, and foraging efficiencies of gulls did not return to previous levels until 60 to 90 minutes after work began. Mitigation measures that restricted human activity to a 100 m stretch of beach at a time succeeded in substantially reducing adverse environmental effects and in allowing birds to rest and feed.

## 10.4.1.2 Concrete Gravity Structure Construction

### Lighting

Artificial lighting on coastal structures at the construction site may attract nocturnally-active marine birds in the Nearshore Study Area. The existing knowledge of the effects of light attraction is discussed in Section 10.4.2.1 under the discussion on artificial lighting.

**Air Emissions**

Although air emissions could, in theory, affect the health of some resident marine birds, the effects would likely be minimal because emissions of potentially harmful materials will be small and rapidly disperse to undetectable levels.

**Construction Noise**

As discussed in Section 10.4.1.1, temporary and localized disturbances to marine birds are possible with construction activities generating noise.

### 10.4.1.3 Tow-out and Offshore Installation

**Lighting**

Artificial lighting on project vessels, the CGS and topsides may attract nocturnally-active marine birds at the deepwater mating site. Leach's Storm-Petrels are especially attracted to artificial lighting, particularly in offshore areas. The existing knowledge of the effects of light attraction is therefore described in detail for the Offshore Study Area in Section 10.4.2.1 under the discussion on artificial lighting.

**Air Emissions**

Although air emissions could, in theory, affect the health of some resident marine birds, the effects would likely be minimal because emissions of potentially harmful materials will be small and rapidly disperse to undetectable levels.

**Operation of Helicopters and Vessels**

As discussed in Section 10.4.1.1, temporary and localized disturbances to marine birds are possible with human disturbance. Activities such as the operation of helicopters and vessels could cause disturbance. Disturbance from dredging vessels is likely to have a similar effect as that from other vessels. Helicopter disturbance will be limited to a few trips per week to the deepwater site.

Most marine birds flush or dive in response to low-flying aircraft (e.g., Polar Gas Project 1977; Husky Oil 2000; LGL Ltd. unpublished data). The magnitude of these disturbances is likely low, given infrequent flights at low levels. Of greater concern are flights over large colonies of nesting marine birds (for locations see Table 10-2, Figure 10-1). An aircraft flying low near a marine bird colony is capable of causing a panic response by the birds, which can result in eggs and flightless young being accidentally pushed off cliff ledges when the adults suddenly flush, or being unguarded and thus exposed to harsh weather and predators.

## 10.4.2 Offshore

### 10.4.2.1 Wellhead Platform or Subsea Drill Centre Installation/Commissioning

Offshore WHP installation/commissioning activities have the potential to result in effects on habitat quality and habitat quantity. For example, placement of the WHP will obstruct use of a limited area of habitat. In contrast, a subsea drill centre with attendant MODU

would not, except temporarily. Activities with the greatest potential for disturbance (e.g., effects on habitat quality) include the operation of helicopters, the operation of vessels (including dredging activities), and well site and VSP surveys. Lighting at night throughout the WREP installation and commissioning phase may attract marine birds, particularly Leach's Storm-Petrels, which may be attracted to and strike vessels or platform infrastructure leading to injury, strandings and mortality. It is not known if there is hearing impairment to marine birds spending considerable amounts of time below the surface of the water and in close proximity to airgun pulses during wellsite surveys and VSPs. Of the marine bird species in the Offshore Study Area only the alcids (murres, Razorbill, Dovekie, puffin) spend time below the surface of the water.

In addition, several activities may also lead to temporary disturbance of marine birds in a localized area. With the exception of collisions with infrastructure, mortality of marine birds is not expected to be an environmental effect of activities in the Offshore Study Area during the construction/installation phase.

Installation of a subsea drill centre would have similar potential environmental effects on marine birds as the installation of the WHP.

**Wellsite and Vertical Seismic Profile Surveys**

A key potential WREP activity during construction in the offshore that is predicted to have an effect on habitat quality is well site and VSP surveys. Diving birds are expected to hear a sound pulse if the birds are underwater at the time the pulse arrives. However, the distance at which a bird under water could hear sound from a well site survey or VSP is unknown because so little is known about underwater hearing sensitivity in birds. Potentially, marine birds that are diving in close proximity to a loud underwater sound could be injured. Although no 2-D or 3-D seismic surveys are associated with the WREP, most existing knowledge is based on the effects of seismic surveys, and that information is summarized below. However, the sound pressure levels produced by well site and VSP surveys are much lower than those of 2-D or 3-D seismic surveys and the duration is much shorter.

Seismic sound energy is predominantly directed downward and below the surface of the water. Received sound above the water is substantially reduced from that underwater and is likely to have little or no effect on birds that have their heads above water or are in flight. It is possible that birds on the water at close range would be startled by the sound; however, the presence of the ship and associated gear should have already warned any birds of unnatural visual and auditory stimuli. Received sound levels of airgun pulses in the upper few metres of the water column are also considerably diminished from those at depth due to pressure-release effects and interference phenomena that occur at and near the surface (Richardson et al. 1995).

Most species of marine birds that are expected to occur in the Offshore Study Area (see Table 10-4) feed at less than 1 m below the surface of the ocean. This includes members of Procellariidae, Oceanitidae, Hydrobatidae, Phalaropodinae and Laridae. Northern Gannets plunge dive to a depth of 10 m, but the birds remain submerged for only a few seconds in total, so would have minimal chance to receive underwater seismic sound. Gannets are scarce in the Offshore Study Area from spring to fall but are absent during winter (Table 10-4). The only group of marine birds in the Offshore Study Area that spends considerable time submerged under water is the Alcidae (Dovekie,

Common Murre, Thick-billed Murre, Razorbill and Atlantic Puffin). Alcids secure food by diving under the water and propelling their bodies rapidly through the water with their wings. All are capable of reaching considerable depths and spending prolonged periods of time submerged (Gaston and Jones 1998). Murres regularly dive to a maximum depth of 100 m and have been recorded underwater for up to 202 seconds (Gaston and Jones 1998).

Seismic surveys have the potential to affect the habitat quality of marine birds, particularly members of the Alcidae, but seismic surveys also have the potential to disturb marine birds. The main environmental effect of seismic surveys on habitat use by marine birds is that of the operation of vessels, as described above. Limited information is available on the behavioural effects of seismic surveys on marine birds.

A study on the effects of underwater seismic surveys on moulting Long-tailed Ducks in the Beaufort Sea showed no effects on movement or diving behaviour (Lacroix et al. 2003). The authors suggested caution in interpretation of these data, however, because they were limited in their ability to detect subtle disturbance effects and recommended studies on other species to fully understand the effects of seismic sounds.

The potential physical and physiological effects of seismic noise on marine birds have recently been reviewed for StatoilHydro's 3-D program in Jeanne d'Arc Basin (LGL 2008), Petro-Canada's 3-D program in Jeanne d'Arc Basin (LGL 2007e) and for Husky's program in northern Jeanne d'Arc Basin (LGL 2005b; Moulton et al. 2006b). Geohazard surveys are less likely to affect marine birds as reviewed in several environmental assessments for Jeanne d'Arc Basin (LGL 2005a, 2005b, 2005c, 2005d, 2008).

### Lighting

Artificial lighting on offshore oil/gas drilling or production structures, ships at sea, coastal communities and oceanic island communities regularly attracts nocturnally-active seabirds and nocturnally-migrating land- and water-birds, sometimes in large numbers (Montevecchi et al. 1999; Gauthreaux and Belser 2006; Montevecchi 2006). This often results in bird mortality, occasionally due to collisions with non-illuminated structures near the lights that the birds cannot see, or more rarely, with the lights themselves (Dick and Donaldson 1978; Telfer et al. 1987; Black 2005; Russell 2005; Poot et al. 2008; Rodríguez and Rodríguez 2009; Bocetti 2011). However, most mortality occurs because these birds mill about near the lights and eventually land on the deck or ground, after which many seabird species in this situation typically are unable to take off and eventually succumb to dehydration, starvation, exhaustion, or hypothermia or drowning in water-filled cavities on deck. Birds may be attracted to artificial lighting from a distance of up to 5 km in the case of offshore oil/gas installations with 30 kW of lighting (Poot et al. 2008).

Attraction to artificial lighting and attendant grounding appears to be widespread among procellariiform seabird species (i.e., petrels, shearwaters, prions, storm-petrels, and diving-petrels (Pelecanoididae), but not albatrosses (Diomedeidae)), having been observed in more than 20 species (Imber 1975; Reed et al. 1985; Telfer et al. 1987; Le Corre et al. 2002; Black 2005; Montevecchi 2006; Abgrall et al. 2008b; Rodríguez and Rodríguez 2009; Miles et al. 2010; Howell 2012). Light attraction has also been noted in Atlantic Puffin (Miles et al. 2010), Crested Auklet (Dick and Donaldson 1978), Xantu's Murrelet (Carter et al. 2000 and Pacific Seabird Group 2002, in Montevecchi 2006), and

Common Eider (Merkel 2010). Attraction of migrating land-birds to artificial lighting at sea is found in a large diversity of orders and families, although the majority of species landing on deck are readily able to take off again if uninjured (Russell 2005; Gauthreaux and Belser 2006).

The attraction of seabirds to artificial lighting occurs at all times of the year, but tends to be more common at the end of the nesting season (Telfer et al. 1987; Le Corre et al. 2002; Miles et al. 2010). In studies in which the age of the grounded seabirds has been determined, the majority of individuals have been newly fledged young, particularly near seabird nesting colonies (Imber 1975; Telfer et al. 1987; Rodríguez and Rodríguez 2009; Miles et al. 2010).

The greatest numbers of individual birds attracted to artificial lighting tend to be found when there is a low cloud cover, particularly when accompanied by fog or rain (Hope-Jones 1980 and Wallis 1981, in Montevecchi 2006; Telfer et al. 1987; Black 2005; Russell 2005; Abgrall et al. 2008a, 2008b; Poot et al. 2008). Light attraction among seabirds also seems to peak when moonlight levels are lowest (i.e., around the time of the new moon) (Telfer et al. 1987; Rodríguez and Rodríguez 2009; Miles et al. 2010). The reason for peaks in activity during overcast or new moon lighting conditions may be a lack of ambient light for navigation (Reed et al. 1985). Alternatively, because aerial activity at seabird nesting colonies is lowest around the time of the full moon (Imber 1975; Bretagnolle 1990), a preference among seabirds for dark nights may be a mechanism for avoiding predators (Watanuki 1986; Mougeot and Bretagnolle 2000; Oro et al. 2005).

The reason for the attraction of birds to artificial lighting is not clear. One hypothesis is that because of the low level of ambient light under overcast or new moon lighting conditions, artificial lighting becomes a strong visual orientation cue (Reed et al. 1985). Once attracted to artificial lighting, birds may be reluctant to leave because they have lost their visual orientation to the horizon (Russell 2005). Alternatively, nocturnally-active seabirds and migrating birds may be disorientated by the effect of artificial lighting on their ability to navigate via cues from the Earth's magnetic field (Poot et al. 2008). In the laboratory, long-wavelength visible light (i.e., red light or the red component of white light) disrupts magnetic orientation in birds (Wiltschko et al. 1993). Another potential reason for light attraction may be birds foraging for bioluminescent prey (Imber 1975).

To date, the bird strandings in the Newfoundland offshore have been almost entirely Leach's Storm-Petrels. The remaining species were Wilson's Storm-Petrel, Great Shearwater and Sooty Shearwater. Leach's Storm-Petrels breed in large numbers in eastern Newfoundland, with Baccalieu Island at the northeastern tip of Trinity Bay representing the largest breeding colony in the world. Lighting is potentially an issue during WREP activities that provide continuous use of lights during darkness or periods of poor visibility.

Monitoring of pelagic storm-petrels stranded (presumably due to light attraction) on board seismic vessels off Newfoundland and Labrador has been conducted by biologists during 14 seismic programs from 2004 to 2010. Seismic programs were initiated as early as 7 May and terminated as late as 8 November; however, most were conducted during some portion of the months of June to September. In total, 758 nights were monitored during these seismic programs. Numbers of strandings per-day on seismic vessels have ranged from zero early in the season to tens of birds, mostly late in the season after

fledging. The largest single stranding event observed by biologists on seismic vessels was 46 birds, all of which were released alive (LGL Limited, unpublished data). The number of nights per week with strandings, and the number of individuals stranded per night, was greatest from late August to mid-October. This period coincides with the fledging of Leach's Storm-Petrels from Newfoundland colonies. Young of this species fledge from Great Island (Witless Bay), Newfoundland, as early as 10 September, but the majority fledges from mid-September to late October (Huntington et al. 1996). The mean fledging date is 25 September.

In other areas of the North Atlantic, juveniles also account for most strandings of Leach's Storm-Petrels. For example, near a Leach's Storm-Petrel colony off Scotland, juveniles make up the large majority of birds stranded due to light attraction (Miles et al. 2010). However, in wintering areas adults also strand, probably due to light attraction (Rodríguez and Rodríguez 2009). Visibility during nights when storm-petrels stranded on seismic vessels off Newfoundland and Labrador was usually reduced due to fog, rain or overcast conditions.

On one occasion, Dovekies were observed to circle the lighted Hibernia platform for hours (in Wiese et al. (2001)), but Husky is not aware of any large-scale strandings or mortalities related to such events on the Grand Banks. There have been reports in other regions of strandings involving related species. For example, Dick and Donaldson (1978) interviewed the crew of an Alaskan crab fishing vessel that experienced collisions with Crested Auklets (*Aethia cristatella*), a related species. It was estimated that about 1.5 tons of birds collided and landed on the brightly lit boat. The birds appeared to be disoriented by the bright overhead work deck lights although they only ran into the lower running lights because the birds were all flying close to the water.

Bird attraction to artificial lighting at sea may be mitigated in a variety of ways. Recovering grounded seabirds and returning them to sea when their plumage has dried greatly reduces mortality (Telfer et al. 1987; Le Corre et al. 2002; Abgrall et al. 2008b; Rodríguez and Rodríguez 2009; Williams and Chardine No Date). In offshore Newfoundland, the mitigation of releasing birds by experienced environmental observers, according to CWS protocols established by CWS and offshore operators, appears to reduce mortality to a few birds per seismic vessel per season. Reducing, shielding or eliminating skyward radiation from artificial lighting also achieves great reductions in the numbers of birds grounded (Reed et al. 1985; Rodríguez and Rodríguez 2009; Miles et al. 2010). A preliminary study of the effect of replacing white and red lights on an offshore natural gas production platform with green lights showed large reductions in the number of birds attracted to artificial lighting (Poot et al. 2008).

#### 10.4.2.2 Operation and Maintenance

Operations/maintenance activities have the potential to result in changes to habitat quality and habitat use. Interactions are summarized here:

- Lighting and flaring at night and periods of low visibility for the duration of the Project may attract marine birds, particularly Leach's Storm-Petrels, which may strike vessels or platform infrastructure leading to injury, strandings, and mortality.

- The operation of helicopters, the operation of vessels, and seismic surveys have potential for disturbance.

- The discharges of fluids or solids have the potential to foul the plumage of marine birds and possibly lead to ingestion of non-biological substances, which may lead to mortality.

- Hearing impairment to marine birds spending considerable amounts of time below the surface of the water and in close proximity to airgun pulses during well site or VSP surveys may be a possibility. However, as mentioned above, there is no evidence to support this.

**Lighting**

Artificial lighting on the installed WHP, MODUs and support and supply vessels may attract nocturnally-active marine birds in the Offshore Study Area. Leach's Storm-Petrels are especially attracted to artificial lighting, particularly in offshore areas. The existing knowledge of the effects of attraction to artificial lighting has been described in more detail in Section 10.4.2.1.

**Flaring**

Gas flares are bright sources of light. Flares may therefore attract nocturnally-active birds, as discussed above for artificial lighting in Section 10.4.2.1. It is possible that birds attracted by gas flaring at night might become incinerated, collide with platform structures, or strand on the platform, thereby causing mortality (Russell 2005; Montevecchi 2006). Systematic visual monitoring of North Sea gas flares has detected no such mortality (Hope-Jones 1980; Wallis 1981). Such monitoring has not been conducted in the Gulf of Mexico, but two burned songbirds were found in the Russell (2005) study. Circling of the platforms by birds for minutes to hours was observed both in the North Sea and the Gulf of Mexico on overcast nights (Hope-Jones 1980; Wallis 1981; Russell 2005). This occurred both at platforms with flares and those with electric lighting alone. Some of the songbirds involved in such a nocturnal circulation around a flare in the North Sea eventually descended into the sea around the platform, presumably exhausted (Hope-Jones 1980). Examination of dead birds found on the platform after the event revealed the birds to be underweight, compared with birds weighed on shore, and lacking visible subcutaneous fat (Hope-Jones 1980). Bird mortality at an onshore flare stack in Alberta has been documented (Bjorge 1987). However, necropsies of 56 of the birds revealed equivocal evidence of collisions and no evidence of burning. The injuries observed were instead consistent with hydrogen sulfide poisoning.

**Operational Discharges**

Activities that involve the storage and discharge of fluids and solids that occur during the operations and maintenance phase in the Offshore Study Area have the potential to foul marine birds. Fouling the feathers of marine birds may affect their ability to fly and possibly lead to ingestion of toxic substances. The treated discharge of some fluids like drilling muds and cuttings from MODUs could potentially leave a sheen on the water surface, however, SBM mud and cuttings will be re-injected from the WHP.

The discharge of any blowout preventer fluid is likely to have minimal environmental effects on marine birds because low-toxicity glycol-water mixes will be used; these fluids are also typically released on a periodic basis near the seafloor. Black water (treated

sewage) and grey water (kitchen and sink) generated by the platform and support vessels will be treated and discharged according to the OWTG. Cooling water will be chlorinated and discharged overboard at an approximate temperature of 30°C, with a residual chlorine level <0.5 ppm. Thus, the volume of entrainment will be low and the area of thermal effects will be small. O'Hara and Morandin (2010) demonstrated that it only requires a small amount of oil (e.g., 10 ml) to affect the feather structure of Common Murre and Dovekie. Such modifications to feather structure cause a loss of insulation, which in turn can result in mortality in the cold Northwest Atlantic environment.

Some marine birds, such as the Leach's Storm-Petrel, are known to feed on naturally-produced oily slicks (of biological origin) on the water and could possibly be attracted to a slick. However, Leach's Storm-Petrels do not spend much time on the water and would remain on the wing during an investigation of a slick, reducing the chances that feathers will contact the fluid. Some species such as shearwaters, Northern Fulmars and gulls may be attracted to vessels and the WHP; these birds may rest on the water, making them more likely to come in contact with discharges. Some marine birds, particularly gulls, may be attracted to sewage particles, but the small amount discharged below the surface is unlikely to increase the abundance of marine birds in the Offshore Project Area.

#### 10.4.2.3 Decommissioning and Abandonment

Effects of WREP decommissioning/abandonment activities have the potential to affect habitat use by marine birds similarly to those effects experienced during the construction and operations phases. Lighting during darkness periods may attract marine birds, particularly Leach's Storm-Petrels, which may strike vessels or WHP infrastructure, leading to injury, strandings, or mortality. In addition, the operation of helicopters and vessels may also lead to temporary disturbance of marine birds in a localized area.

#### 10.4.2.4 Potential Future Activities

Future activities in the Offshore Project Area may include, but are not limited to, geophysical surveys, drilling from a MODU, dredging and dredge spoils disposal, vessel traffic and helicopter overflights. Most of these activities involve artificial lighting, and noise. These activities, as well as operational discharges, could affect habitat quality. There is also some potential for direct mortality as a result of collisions with, or strandings on, artificially lit structures. The potential effects of geophysical surveys, drilling, vessel traffic and helicopter overflights have been discussed previously within Section 10.4.

### 10.4.3 Accidental Events

The primary accidental event associated with the proposed WREP that could have environmental consequences of concern is the unintentional release of hydrocarbons during CGS construction, development drilling or operations. The hydrocarbon products subject to accidental release include crude oil, diesel oil, synthetic drilling muds and/or fluids, synthetic drill (base) fluid, lubricating oils and hydraulic oils. The main event of concern that can result in a hydrocarbon spill in the offshore is a loss of well control (blowout). Nearshore, the concern is related to vessel accidents. Hydrocarbon spills may also occur as a result of human error or equipment failure, hydraulic system failures,

drains system failures and others. An oil spill could potentially occur during the construction, operation and maintenance and/or decommissioning phases of the WREP (see Section 3.6 for a summary of blowout and spill frequencies). Several accidental events could result in mortality for marine birds within the Nearshore (see Section 3.7) and Offshore (see Section 3.8) Study Areas. Other effects include a change in habitat quality (i.e., effects on habitat that could result in physical and/or physiological effects on marine birds).

Marine birds are the most visible and among the first species impacted by oil spills. Bird species at risk of the effects of oil include not only pelagic species that come inshore only to nest, but also shorebirds (plovers (Charadriidae)) and sandpipers (Scolopacidae)), sea ducks and other coastal water birds (e.g., loons (Gaviidae), grebes (Podicipedidae) and cormorants), as they use the marine environment to varying degrees. Reported effects vary with species, type of oil, weather conditions, time of year and duration of the spill (Gorsline et al. 1981). Natural inter-annual variation in other factors that affect populations (e.g., prey availability and weather) reduces the ability of scientists to assess the full effect of oil spills on bird populations (Eppley 1992; White et al. 1995; Votier et al. 2005).

Nesting birds exposed to oil in either the Nearshore or Offshore Study Areas may return to nests. Nesting marine birds that have survived oil contamination generally exhibit decreased reproductive success. Nesting marine birds transfer oil from their plumage and feet to their eggs (Albers and Szaro 1978). Very small quantities (1 to 20 µL) of oil on eggs have produced developmental defects and mortality in avian embryos of many species (Albers 1977; Albers and Szaro 1978; Hoffmann 1978, 1979a; Macko and King 1980; Parnell et al. 1984; Harfenist et al. 1990). The resultant hatching and fledging success of young appears to be related to the type of oil (Hoffman 1979b; Albers and Gay 1982; Stubblefield et al. 1995) and the timing of exposure during incubation. Embryos are most sensitive to oil during the first half of incubation (Albers 1978; Leighton et al. 1985). Breeding birds that ingest oil generally exhibit a decrease in fertilization (Holmes et al. 1978), egg laying and hatching (Hartung 1965; Ainley et al. 1981), chick growth (Szaro et al. 1978) and survival (Vangilder and Peterle 1980; Trivelpiece et al. 1984), as well as a reduction in mean eggshell thickness and strength (Stubblefield et al. 1995). Growth was retarded in Herring Gull chicks, Black Guillemot chicks, and Mallard (*Anas platyrhynchos*) ducklings after they ingested oil directly (Peakall et al. 1981; Szaro et al. 1981).

Oil spills that affect prey availability of a species with low seasonal dietary variation could have a greater effect on that species through an indirect reduction in reproduction and poorer chick condition (Velando et al. 2005a). Eppley and Rubega (1990) suggested that exposure to an Antarctic oil spill causes changes in the normal parental behaviour of South Polar Skua, thus exposing young to increased predation and contributing to reproductive failure in that population. In another case, abandonment of nesting burrows by oiled adult Leach's Storm-Petrels may contribute to reproductive failure in that population (Butler et al. 1988). Therefore, a spill that occurs during the reproductive period could cause mortality of young even if the adults survived the exposure to oil. Decreased breeding success at oiled colonies of European Shag (*Phalacrocorax aristotelis*) was reported by Velando et al. (2005b). Fewer European Storm-Petrels (*Hydrobates pelagicus*) attempted breeding in the two years following the *Prestige* oil spill of September 2002 in northwest Spain (Zabala et al. 2011). Those that did breed

suffered greater breeding failure and poorer body condition in the three years after the spill (Azkona et al. 2006, in Zabala et al. 2011).

There are possible changes in habitat use of oiled areas by both oiled and un-oiled birds. After a large oil spill off the coast of Washington by the *Nestucca* in December 1988, a study of oiled shorebirds suggested that within 10 days of the oil spill they could be found at beach roosting sites, but that after 10 days they tended to remain in the harbour rather than complete their usual return flight to beach roosting sites at high tide (Larsen and Richardson 1990). In June 1979, an oil blow-out occurred from the *Ixtoc I* in the Gulf of Mexico off Mexico, causing shorebirds there to avoid oil-affected foreshores and instead use poorer backshore feeding habitats and freshwater pools (Chapman 1981). Three months after the oil spill, storms cleaned the beaches, but shorebirds failed to return to the foreshore feeding habitats at their pre-spill levels (Chapman 1981).

The greatest decrease in use of contaminated habitats immediately following a spill occurs in species that feed on or close to shore and either breed along the coast or are full-year residents (Wiens et al. 1996). Day et al. (1995) showed that species lacking clear evidence of recovery tended to be intertidal feeders and residents. However, they also found that other ecologically-similar species did not show signs of initial effects or showed rapid recovery.

Exposure to oil causes thermal and buoyancy deficiencies that typically lead to the deaths of affected marine birds. Although some may survive these immediate effects, long-term physiological changes may eventually result in death (Ainley et al. 1981; Williams 1985; Frink and White 1990; Fry 1990). Reported effects vary with bird species, type of oil (Gorsline et al. 1981), weather conditions, time of year and duration of the spill or blowout. Although oil spills at sea have the potential to kill tens of thousands of marine birds (Clark 1984; Piatt et al. 1990), some studies suggest that even very large spills may not have long-term effects on marine bird populations (Clark 1984; Wiens 1995).

External exposure to oil occurs when flying birds land in oil slicks, diving birds surface from beneath oil slicks and swimming birds swim into slicks. The external exposure results in matting of the feathers, which effectively destroys the thermal insulation and buoyancy provided by the air trapped by the feathers. Consequently, oiled birds may suffer from hypothermia and/or drown (Clark 1984; Hartung 1995). Birds living in coldwater environments, such as the Nearshore and Offshore Study Areas, are most likely to succumb to hypothermia (Hartung 1995; Wiese and Ryan 2003). Most mortalities occur during the initial phase of oil spills, when large numbers of birds are exposed to floating oil (Hartung 1995).

It is difficult to estimate how many marine birds are oiled during any particular oil spill, because some birds may not reach shore (dead or alive), and beached carcasses may be scavenged or washed out to sea before being counted (Ford et al. 1987). There is also no clear correlation between the size of an oil spill and numbers of marine birds killed, because the density of birds in a spill area, wind velocity and direction, wave action and distance to shore can have a greater bearing on mortality than the size of the spill (Burger 1993). Accordingly, even small spills can cause cumulative mass mortality of marine birds (Joensen 1972; Carter et al. 2003; Hampton et al. 2003). In contrast, relatively low mortalities have been recorded from some huge spills. For example, the *Amoco Cadiz* spilled 230,000 tonnes of crude oil along the French coast, causing the

recorded deaths of 4,572 birds (Clark 1984). A major spill that persists for several days near a nesting colony could kill a high proportion of pursuit-diving birds (e.g., murres) within the colony (Cairns and Elliot 1987). Tan et al. (2010) found no correlation between seabird mortality and spill size, except for spills less than 7 tonnes in size.

Most oil spills occur over a period of a few hours or days. In contrast, underwater blowouts may occur over a much longer time period, potentially causing marine bird mortality over a longer time period. Antonio et al. (2011) examined patterns in tetrapod (marine birds, sea turtles, marine mammals) morality rates during the *Deepwater Horizon* blowout in the Gulf of Mexico. This blowout took place over 90+ days, during which the total volume of oil accumulated at a constant rate. Marine birds were the first group to display mortality, beginning after the 38$^{th}$ day. The number of carcasses recorded per day increased exponentially, with the marine bird mortality rate increasing fastest. Marine birds were also the first group in which the morality rates decreased, in the case of marine birds after the 97$^{th}$ day.

Oiled birds that escape death from hypothermia and/or drowning often seek refuge ashore, where they engage in abnormally excessive preening in an attempt to remove the oil (Hunt 1957, in Hartung 1995). The preening leads to the ingestion of substantial quantities of oil that, although apparently only partially absorbed (McEwan and Whitehead 1980) can still cause lethal effects. Noted effects on Common Murres and Thick-billed Murres oiled off Newfoundland's south coast include emaciation, renal tubular degeneration, necrosis of the duodenum and liver, anemia and electrolytic imbalance (Khan and Ryan 1991). Glaucous-winged Gulls (*Larus glaucescens*) experienced similar effects after they ingested bunker fuel oil during preening (Hughes et al. 1990).

Another commonly observed effect is adrenal hypertrophy. This condition tends to make birds more vulnerable to adrenocortical exhaustion (e.g., Mallards (Hartung and Hunt 1966; Holmes et al. 1979), Black Guillemots (Peakall et al. 1980) and Herring Gulls (Peakall et al. 1982)). The adrenal gland maintains water and electrolyte balance that is essential for the survival of birds living in the marine environment. Hartung and Hunt (1966) found that ingested oils can cause lipid pneumonia, gastrointestinal irritation and fatty livers in several species of ducks. Aromatic hydrocarbons have been detected in the brains of Mallards (Lawler et al. 1978) and are probably associated with observed symptoms (e.g., lack of coordination, ataxia, tremors and constricted pupils) of nervous disorders (Hartung and Hunt 1966). Polycyclic aromatic hydrocarbons (PAH) can also be detected in plasma samples of oiled Common Murres (Troisi and Borjesson 2005). The availability of an immunoassay for the determination of PAH concentrations in plasma samples of oiled birds potentially can serve in the exposure assessment during oil spill response and rehabilitation (Troisi and Borjesson 2005).

Some reported sublethal effects of *Prestige* oil on birds included potential liver and kidney damage to Yellow-legged Gulls (*Larus cachinnans*) 17 months after the spill (Alonzo-Alvarez et al. 2007). Common Murres and Razorbills (but not Atlantic Puffins) displayed brain acetylcholinesterase inhibition (Oropesa et al. 2007). Other sublethal effects of oil contamination include reduced feeding rates (Sanderling (*Calidris alba*); Burger and Tsipoura 1998).

Elevated hydrocarbon-inducible cytochrome P4501A in Harlequin Duck livers up to 20 years after the *Exxon Valdez* spill was reported by Esler et al. (2010). It should be noted

that this measurement is a biomarker for exposure and not necessarily a deleterious effect per se. A similar effect in the same region was documented in Barrow's Goldeneye (*Bucephala islandica*) (Esler et al. 2011).

Other toxicological effects, however, do not appear to differ between oiled and unoiled birds (Kammerer et al. 2004; Pérez-López et al. 2006). Levels of zinc, copper, arsenic, chromium, lead and cadmium were all similar in the liver of three species (Common Murre, Atlantic Puffin and Razorbill Murre) affected by the *Prestige* oil spill; only mercury showed increased levels in the liver of oiled birds (Pérez-López et al. 2006). Vanadium hepatic and renal concentrations did not prove to be appropriate biomarkers for recent exposure to oil spills following analyses of samples from Common Murres, Common Scoters (*Melanitta nigra*), and Common Eiders exposed to the *Erika* wreck off coastal France (Kammerer et al. 2004).

The extensive use of dispersants during the *Deepwater Horizon* blowout held the potential for nesting marine birds to transfer mixtures of crude oil and dispersant from their breast feathers to their eggs. To investigate the potential effects of such mixtures on marine bird embryos Finch et al. (2012) applied mixtures of weathered Gulf of Mexico crude oil and Corexit 9500 to Mallard eggs in ratios of oil to Corexit of 50:1 and 10:1. The median lethal application of the 50:1 mixture to eggs was 321.8 µg/g egg. In contrast, the median lethal application of the 10:1 mixture was 517.0 µg/g egg.

Birds exposed to oil are also at risk of starvation (Hartung 1995). For example, oiled Common Eiders generally deplete all of their fat reserves and much of their muscle protein (Gorman and Milne 1970). In addition, energy demands are higher because the metabolic rate of oiled birds increases to compensate for the heat loss caused by the reduced insulating capacity of their plumage. This can expedite starvation (Hartung 1967; McEwan and Koelink 1973). For birds living under harsh environmental conditions (e.g., winters in colder climates), even a seemingly insubstantial amount of oiling can have fatal consequences (Levy 1980).

Oiled birds that are cleaned and released might not have high survival rates. Pooling across the three species with the most band recovery data between 1969 and 1994 (Western Grebe, White-winged Scoter and Common Murre), the median days that cleaned birds survived were 4 to 11 days, or a mean of four days (Sharp 1996). Birds that survived longer were those that typically had a low degree of oiling and spent less time in captivity; initial or release weights did not seem to matter (Sharp 1996). Birds cleaned after 1990 using more modern methods do not have a higher survival rate than those cleaned before 1990 (Sharp 1996). In contrast, cleaned Cape Gannets (*Morus capensis*) following the *Castillo de Bellver* oil spill of 1983 had only a slightly lower survival rate, which was similar to the difference in survival rate between colonies (Altwegg et al. 2008).

Focusing bird cleaning efforts soon after a spill may achieve greater reductions in mortality. During the *Deepwater Horizon* blowout, the number of oiled birds recovered daily that were alive sharply decreased following the 110$^{th}$ day of the blowout while the number of dead birds recovered sharply increased (Belanger et al. 2010).

A more subtle effect of oiling was shown by the reduction in carotenoid-based colouration of soft parts used in sexual signaling of Yellow-legged Gulls following the *Prestige* spill (Perez et al. 2011).

For some individual birds, oiling has not had lethal or marked sublethal effects. Among oiled, colour-banded Herring Gulls and Lesser Black-backed Gulls (*Larus fuscus*), most survived and cleaned themselves with a few weeks of oiling, some bred successfully and survived up to 20 years after oiling (Camphuysen 2011).

Birds are particularly vulnerable to oil spills during nesting, moulting and the period of time before young marine birds gain the ability to fly. Because newly fledged murres and Northern Gannets are unable to fly for the first two to three weeks at sea, they are less likely to be able to avoid contact with oil during that time (Lock et al. 1994). Before and during moult, the risks of hypothermia and drowning are increased (Erasmus and Wessels 1985), because feather wear and loss reduce the ability to repel water by approximately 50 percent (Stephenson 1997).

It is clear that truly aquatic and marine species of birds are most vulnerable and most often affected by exposure to marine oil spills. Diving species such as Black Guillemot, murres, Atlantic Puffin, Dovekie, eiders, Long-tailed Duck, scoters, Red-breasted Merganser (*Mergus serrator*) and loons are considered to be the most susceptible to the immediate effects of surface slicks (Leighton et al. 1985; Chardine 1995; Wiese and Ryan 1999; Irons et al. 2000). Alcids, especially Common and Thick-billed Murres, often have the highest oiling rate of marine birds recovered from beaches along the south and east coasts of the Avalon Peninsula, Newfoundland and Labrador (Wiese and Ryan 2003). Those were the only group of marine birds to show an annual increase over a 13-year period (2.7 percent) in the proportion of oiled to stranded birds (Wiese and Ryan 1999). There also appears to be a strong seasonal effect, as statistically significantly higher proportions of alcids (along with other marine bird groups) are oiled in winter versus summer (Wiese and Ryan 1999).

Other species such as Northern Fulmar, shearwaters, storm-petrels, gulls and terns are vulnerable to contact with oil because they feed over wide areas and make frequent contact with the water's surface. They are also vulnerable to the disturbance and habitat damage associated with oil spill cleanup (Lock et al. 1994).

Shorebirds may be more affected by oil spills than has been suggested by carcass counts. A total of 7,800 collected bird carcasses were identified after the *Nestucca* oil spill, but only six shorebird carcasses were present out of 3,574 oiled shorebirds observed by Larsen and Richardson (1990). The authors suggested that this reveals a historic difficulty in finding shorebird carcasses, which may be explained by the higher mobility of oiled shorebirds (Larsen and Richardson 1990).

The extent of bioaccumulation of the chemical components of oil in birds is limited because vertebrate species are capable of metabolizing them at rates that minimize bioaccumulation (Neff 1985, in Hartung 1995). Birds generally excrete much of the hydrocarbons within a short time period (McEwan and Whitehead 1980).

Some studies have suggested that oil pollution is unlikely to have major long-term effects on bird productivity or population dynamics (Clark 1984; Butler et al. 1988; Boersma et al. 1995; Erikson 1995; Stubblefield et al. 1995; White et al. 1995; Wiens 1995, 1996; Seiser et al. 2000), while others suggest the opposite (Piatt et al. 1990; Walton et al. 1997; Votier et al. 2005). Natural inter-annual variation in other factors that affect populations (e.g., prey availability and weather) reduces the ability of scientists to

assess the full effect of oil spills on bird populations (Eppley 1992; White et al. 1995; Votier et al. 2005).

Studies conducted following the *Exxon Valdez* oil spill in 1989 have tried to ascertain whether marine bird populations have recovered in the Prince William Sound area in Alaska. Esler et al. (2002) noted that as of 1998, the Harlequin Duck population that winters in Prince William Sound had not yet recovered, based on initial high mortalities, the decrease in population size only in oiled areas during 1995 to 1997, and the fact that fewer female adults survived winters in oiled areas possibly because of continued oil exposure. Continued exposure was found up to 20 years after the spill (Esler et al. 2010). However, concentrations of PAHs in nearshore waters off oiled shores and in five intertidal prey species returned to background levels 22 years after the spill (Neff et al. 2011). Female winter survival improved 21 years after the spill (Esler and Iverson 2010). Based on modelling, Iverson and Esler (2010) suggested a population recovery time of 24 years for Harlequin Duck after the *Exxon Valdez* spill.

For other populations in Prince William Sound, it is not as clear whether they have or have not yet recovered. Irons et al. (2000) conducted a study of marine bird densities and found that as of 1998, five taxa (mostly those that dive for their food) were still negatively affected by the oil spill, including cormorants, goldeneyes (*Bucephala* spp.), mergansers (*Mergus* spp.), Pigeon Guillemot (*Cepphus columba*) and murres. Furthermore, as of July 2000, goldeneyes, mergansers, Pigeon Guillemot and Black-legged Kittiwake had decreased statistically significantly in oiled areas, and only one species, the Black Oystercatcher (*Haematopus bachmani*), had shown signs of recovery (Irons et al. 2001). Wiens et al. (2001) disagreed with the study design and interpretation of data by Irons et al. (2000), maintaining that most populations are no longer affected by the oil spill. However, Esler et al. (2002) pointed out that the studies that have found rapid recovery of bird populations are either based on presence/absence data (Wiens et al. 1996), which are not informative about the status of populations, on a short time period and inappropriate geographic scale for some species (Day et al. 1997), or on summer data (Murphy et al. 1997) when some populations mainly overwinter in Prince William Sound. However, all authors do agree that different bird populations responded differently to the *Exxon Valdez* oil spill. Some populations showed little signs of being affected, other populations recovered quickly, and some populations took as much as a decade to fully recover (e.g., Pigeon Guillemot; Golet et al. 2002, in Esler et al. 2002). Populations of bird species with little genetic differentiation among breeding colonies are less likely to be affected severely by an oil spill because they have a greater potential for population recovery (Riffaut et al. 2005).

Several small spills have occurred in or near the Nearshore and Offshore Study Areas, and “small” oil releases (most likely from bilge pumping and de-ballasting by trans-Atlantic vessel traffic) occur frequently, killing thousands of marine birds (Brown et al. 1973; Brander-Smith et al. 1990; Chardine and Pelly 1994; Wiese and Ryan 2003). These discharges total more metric tons of oil on a world-wide basis than the total spillage from more well-known catastrophic spills, such as the *Exxon Valdez* and others (Brander-Smith et al. 1990, in Wiese and Ryan 2003). Between 1984 and 1999, the southeast coast of the island of Newfoundland had the highest recorded rates in the world of oiled dead birds per kilometre of beach (0.77 versus 0.02 to 0.33 elsewhere; Wiese and Ryan 2003). Some researchers suggest that chronic oil pollution, acting in combination with other mortality factors, may affect seabirds at the population level (Piatt et al. 1990).

In February 1970, the *Irving Whale* spilled between 11,356 to 26,497 L (3,000 and 7,000 gallons) of Bunker C oil near St. Pierre and Miquelon, which subsequently spread along insular Newfoundland's southeast coast. It was estimated that 7,000 birds, primarily Common Eiders, were killed (Brown et al. 1973). During the same month, the *Arrow* ran aground in Chedabucto Bay, Nova Scotia. Approximately 9,463,265 L (2,500,000 gallons) of Bunker C fuel oil were spilled, and at least 2,300 birds were killed in the bay itself (Brown et al. 1973). Primarily diving birds were affected, most notably Long-tailed Duck, Red-breasted Merganser, murres, Dovekie and grebes (Brown et al. 1973). The spill spread offshore to Sable Island, where mostly murres, Dovekie, and Northern Fulmar were killed. The lowest estimate of marine bird mortality from that part of the slick was 4,800 birds (Brown et al. 1973).

In November 2004, a spill of crude oil occurred from the FPSO in the Terra Nova oil field. Based on the total area of the spill and on marine bird densities derived from marine bird surveys conducted in the spill area after the release, CWS has estimated that mortality to marine birds in the area may have been in the order of 10,000 (Wilhelm et al. 2007). This estimate depends on a number of assumptions being met, including: the marine bird surveys conducted seven and eight days following the incident were representative; the proportion of those birds flying during those surveys that made contact with the oil is known; and that the oil covered the entire surface area within the slick's perimeter. In fact, the high sea state during and after the spill resulted in areas of slick-free water within the slick (Wilhelm et al. 2007). Using a different method, a Memorial University scientist arrived at a mortality estimate for the *Terra Nova FPSO* spill that was of similar order of magnitude as the CWS estimate. He did this by inserting the *Terra Nova FPSO* spill volume into Burger's (1993) regression of mortality estimates on spill volumes, which was derived from data from historical spills occurring in a wide range of locations (Wilhelm et al. 2007). The mortality estimates from those historical spills were themselves extrapolations from the numbers of birds found dead after those spills.

On a broader geographical scale, estimates of the number of birds that die annually from spills range from 21,000 on the Atlantic coast of Canada, and 72,000 in all of Canada (Thomson et al. 1991), to 315,000 ±65,000 Common Murres, Thick-billed Murres and Dovekies annually in southeastern insular Newfoundland alone due to illegal oil discharges from ships (Wiese and Robertson 2004). Clark (1984) estimated that 150,000 to 450,000 birds die annually in the North Sea and North Atlantic from oil pollution from all sources.

As top level predators and scavengers, Bald Eagles can be excellent bio-monitors of the health of the environment. Bald Eagles forage extensively by scavenging, thereby increasing potential contact with contaminated wildlife prey, notably oiled seabirds (Dominguez et al. 2002; Wiese and Ryan 2003). After the *Exxon Valdez* oil spill of 1989 in Valdez, Alaska, Bald Eagle were observed scavenging dead and dying oiled birds and most of the 32 eagle carcasses found were oiled (Piatt et al. 1990). Bald eagles would therefore be at risk if oiled birds were washed up on the shores of Placentia Bay.

### 10.4.4 Summary

WREP-VEC interactions potentially resulting in changes in habitat quality for marine birds are likely to arise from a variety of WREP activities. There are potential interactions with artificial lighting, flaring, air emissions, well site and VSP surveys, waste management with potential effects on habitat quality and mortality. Changes in habitat quality are possible as a result of localized and temporary disturbance from potential interactions with construction noise, operation of helicopters and vessels (including dredging), ballasting, clearance surveys, presence of structures and maintenance activities. Limited potential effects on habitat quantity are possible from interactions with the installation of the WHP or subsea drill centre.

A summary of the potential environmental effects resulting from WREP-VEC interactions, including those of past, present and likely future projects and accidental events, is provided in Table 10-5.

**Table 10-5 Potential White Rose Extension Project-related Interactions: Marine Birds**

| Potential Project WREP Activities, Physical Works, Discharges and Emissions | Change in Habitat Quality | Change in Habitat Quantity | Potential Mortality |
|---|---|---|---|
| **Nearshore** | | | |
| ***Pre-construction and Installation*** | | | |
| Lighting | x | | x |
| Construction of Graving Dock (include sheet pile/driving, potential grouting) | x | | |
| Dewater Graving Dock | x | | |
| Air Emissions | x | | |
| ***CGS Construction and Installation*** | | | |
| *Onshore (Argentia Construction Site)* | | | |
| Lighting | x | | x |
| Air Emissions | x | | |
| *Marine (Argentia and Deep-water Mating Site)* | | | |
| Additional Nearshore Surveys (e.g., geotechnical, geophysical, environmental) | x | | |
| Dredging | x | | x |
| CGS Solid Ballasting (which may include disposal of water containing fine material) | x | | |
| CGS Water Ballasting and De-ballasting (noise) | x | | |
| CGS Towing to Deep-water mating site | x | | |
| Noise from Topsides Mating | x | | |
| Lighting | x | | x |
| Air Emissions | x | | |
| Additional Hook-up and Commissioning of Topsides | x | | |
| Operation of helicopters supply, support, standby, mooring and tow vessels/ barges/ROVs) | x | | |
| **Offshore** | | | |
| ***Wellhead Platform Installation/Commissioning*** | | | |
| Clearance Surveys (e.g., sidescan sonar) prior to installation of WHP or pipelines/flowlines | x | | |
| Tow-out/offshore Installation | x | x | |
| Operation of Helicopters and Vessels/Barges | x | | |
| Potential Rock Berms for Flowline Protection | x | | |
| Additional Hook-up, Production Testing and Commissioning | x | | |
| Lighting | x | | x |
| Air Emissions | x | | |
| Hydrostatic Test Fluid (flowlines) | x | | |

| Potential Project WREP Activities, Physical Works, Discharges and Emissions | Change in Habitat Quality | Change in Habitat Quantity | Potential Mortality |
|---|---|---|---|
| Waste Generated (domestic waste, construction waste, hazardous waste, sanitary waste) | x | | |
| Drilling-associated Seismic (VSPs and wellsite surveys) | x | | x |
| ***Subsea Drill Centre Excavation/Installation* (previously assessed; LGL 2007a)** | | | |
| Operation Of Helicopters (supply, support, standby and tow vessels/barges) | x | | |
| Lighting | x | | x |
| Air Emissions | x | | |
| Waste Generated (domestic waste, construction waste, hazardous waste, sanitary waste) | x | | |
| Drilling-associated Seismic (VSPs and wellsite surveys) | x | | x |
| ***Production/Operation and Maintenance*** | | | |
| Presence of Structure | x | | |
| WBM (from either WHP or MODU) and SBM (from MODU only) cuttings [(C)] | x | | |
| Maintenance Activities | x | | |
| Lighting | x | | x |
| Air Emissions | x | | |
| Power Generation and Flaring | x | | x |
| Chemical Use and Management (e.g. BOP fluids, fuel, well treatment fluids, corrosion inhibitors [(A)]) | x | | |
| Waste Generated (domestic waste, construction waste, hazardous, sanitary waste) | x | | |
| Operation of Helicopters (supply, support, standby and tow vessels/barges/ROVs) | x | | |
| Surveys (geotechnical, geophysical and environmental) | x | | x |
| ***Decommissioning and Abandonment*** | | | |
| Removal of WHP | x | | |
| Plugging and Abandoning Wells | x | | |
| Operation of Helicopters | x | | |
| Operation of Vessels (supply/support/standby/tow vessels/barges/diving/ROVs) | x | | x |
| Lighting | x | | |
| Air Emissions | x | | |
| Surveys (geotechnical, geophysical and environmental) | x | | x |
| **Potential Future Activities** | | | |
| Surveys (e.g., geophysical, geological, geotechnical, environmental, ROV, diving) | x | | x |
| WBM and SBM Cuttings [(B)] | x | | |
| Chemical Use and Management (e.g., BOP fluids, fuel, well treatment fluids, corrosion inhibitors [(A)]) | x | | |
| **Accidental Events** | | | |
| Marine Diesel Fuel Spill from Support Vessel | x | | x |
| Graving Dock Breach | x | | |
| SBM Whole Mud Spill | x | | x |
| Subsea Hydrocarbon Blowout | x | | x |
| Hydrocarbon Surface Spill | x | | x |
| Other Spills (e.g., fuel, waste materials) | x | | x |
| Marine Vessel Incident (including collisions) (i.e., marine diesel fuel spill) | x | | x |
| **Cumulative Environmental Effects** | | | |
| Commercial Fisheries (nearshore and offshore) | x | | x |
| Marine Traffic (nearshore and offshore) | x | | x |
| White Rose Oilfield Development (including North Amethyst and South White Rose extension drill centre) | x | x | x |
| Terra Nova Development | x | x | x |
| Hibernia Oil Development | x | x | x |
| Hibernia Southern Extension Project | x | x | x |
| Hebron Oil Development | x | x | x |

| Potential Project WREP Activities, Physical Works, Discharges and Emissions | Change in Habitat Quality | Change in Habitat Quantity | Potential Mortality |
|---|---|---|---|
| Offshore Exploration Seismic Activity | x | | x |
| Offshore Exploration Drilling Activity | x | x | x |

Notes:
(A) Husky will evaluate the use of biocides other than chlorine. The discharge from the hypochlorite system will be treated to meet a limit approved by the C-NLOPB's Chief Conservation Officer.
(B) Water-based drilling fluids and cuttings will be discharged overboard. Husky will evaluate best available cuttings management technology and practices to identify a waste management strategy for spent non-aqueous fluid and non-aqueous fluid cuttings from the MODU. Synthetic-based mud cuttings will be re-injected into a dedicated well from the WHP, pending confirmation of a suitable disposal formation.

## 10.5 Environmental Effects Analysis, Monitoring, and Mitigation Measures

As shown in Table 10-5, WREP activities can interact with marine birds to create the following potential environmental effects:

- Change in Habitat Quantity: includes interactions that limit habitat availability to marine birds.
- Change in Habitat Quality: includes interactions that may result in physical/ physiological/behavioural effects that occur as a result of a change in habitat quality for marine birds.
- Potential Mortality: includes interactions that may cause the mortality of marine birds.

As discussed in Section 10.4, the WREP construction and offshore industrial activities with the greatest potential to affect the habitat quality of marine birds are noise, artificial lighting, vessel traffic and helicopter overflights. Habitat quantity has the potential to be affected by nearshore dredging and the presence of a WHP or subsea drill centre in the offshore. Flaring, as well as collisions with infrastructure, have the greatest potential for mortality of marine birds.

### 10.5.1 Nearshore

#### 10.5.1.1 Pre-construction and Installation

**Change in Habitat Quantity**

The use of The Pond for the disposal of dredging material may remove potential habitat if marine birds use this area. Although, very small numbers of shorebirds occasionally use The Pond during fall migration, marine bird concentrations are not known to occur at The Pond (B. Mactavish, pers. comm.) and no IBAs overlap the site. As a result, no changes in habitat quantity from the WREP are expected in the Nearshore Study Area.

### Change in Habitat Quality

#### *Lighting*

Artificial lighting on coastal structures and vessels has the potential to attract nocturnally-active marine birds, resulting in stranding. Leach's Storm-Petrels are particularly susceptible when present. However, effects on this species are less likely in the Nearshore Study Area, because storm-petrels nesting off the south coast of Newfoundland near Placentia Bay feed on small, deep-water fish off the continental shelf (Steele and Montevecchi 1994).

Recovered birds will be released in accordance with standard protocols (Williams and Chardine No Date; Husky 2008). A marine bird salvage and release permit under the authority of the Federal Migratory Bird Permit must be applied for and obtained from the CWS. Husky will evaluate use of shielding and deflectors with directional lighting to minimize attraction by lighting, and may incorporate such features where safety of operations and navigation are not affected.

#### *Air Emissions*

The effects of air emissions on marine birds would likely be minimal, because emissions of potentially harmful materials will be small and rapidly disperse to undetectable levels. Air emissions are expected to have a negligible effect on the habitat quality of the Marine Bird VEC.

### Potential Mortality

Collision with infrastructure is another potential source of mortality, primarily via attraction to artificial lighting. As discussed above, this is more likely to be an issue during offshore operations and is assessed in Section 10.5.2.1.

### Summary

The environmental effects of WREP pre-construction and installation activities on marine birds are summarized in Table 10-6.

Given that WREP activities are mostly localized, of low magnitude, and reversible, there are not likely to be significant adverse environmental effects on Marine Birds from pre-construction and installation activities associated with the WREP in the Nearshore Study Area.

**Table 10-6 Environmental Effects Assessment: Construction and Installation**

| WREP Activity | Potential Positive (P) or Negative (N) Environmental Effect | Mitigation Measure | Evaluation Criteria for Assessing Environmental Effects [A] | | | | | | Significance Rating | Level of Confidence |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | Magnitude | Geographic Extent | Frequency | Duration | Reversibility | Ecological / Socio-cultural / Economic Significance | | |
| **Nearshore** | | | | | | | | | | |
| Infilling of The Pond | | | L | 1 | 1 | 3 | R | 2 | NS | H |
| Bund Wall Construction (e.g., sheet/pile driving) | Change in habitat quality (N) | • Equipment design | L | 1 | 1 | 3 | R | 2 | NS | H |
| Dredging of Tow-out Route | Change in habitat quality (N) | • Planning<br>• Equipment design | L | 2 | 1 | 2 | R | 2 | NS | H |
| Lighting | Change in habitat quality (N)<br>Potential mortality (N) | • Adhere to CWS recovery and release protocol for stranded bird<br>• Evaluate use of shielding and deflectors with directional lighting and incorporate where safe | L | 2 | 6 | 3 | R[B] | 2 | NS | H |
| Air Emissions | Change in habitat quality (N) | • Adhere to NL *Air Pollution Control Regulations, 2004* and CEPA *National Ambient Air Quality Objectives* | L | 3 | 6 | 3 | R | 2 | NS | H |
| CGS Solid and/or Water Ballasting/Deballasting | Change in habitat quality (N) | | L | 1 | 1 | 1 | R | 2 | NS | H |
| Nearshore Geophysical Surveys | Change in habitat quality (N) | • Avoid animal concentration when possible<br>• Maintain steady course and safe speed when possible | L | 1 | 1 | 2 | R | 2 | NS | H |
| CGS Tow-out | Change in habitat quality (N) | | L | 1 | 1 | 1 | R | 2 | NS | H |
| Noise from Topside Mating | Change in habitat quality (N) | | L | 1 | 6 | 5 | I | 2 | NS | H |
| Additional hook-up and commissioning of topsides | Change in habitat quality (N) | | L | 1 | 2 | 2 | R | 2 | NS | H |

| WREP Activity | Potential Positive (P) or Negative (N) Environmental Effect | Mitigation Measure | Evaluation Criteria for Assessing Environmental Effects [A] | | | | | | Significance Rating | Level of Confidence |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | Magnitude | Geographic Extent | Frequency | Duration | Reversibility | Ecological / Socio-cultural / Economic Significance | | |
| Operation of Helicopters and Vessels (e.g., supply, tug, barge) | Change in habitat quality (N) | • Avoid marine bird concentrations when possible<br>• Maintain steady course and safe speed when possible<br>• Deviate course to avoid animals<br>• Minimum altitude of 300 m and lateral distance of 2 km over active colonies, including Cape St. Mary's Ecological Reserve and elsewhere when possible | L | 2 | 6 | 3 | R | 2 | NS | H |
| **Offshore** | | | | | | | | | | |
| WHP Tow-out and Installation | Change in habitat quantity (P)<br>Change in habitat quality (N) | | L | 1 | 6 | 2 | R | 2 | NS | H |
| Potential rock berms for flowline protection (light attraction, disturbance from noise and visible movement) | Change in habitat quality (N) | | L | 2 | 1 | 6 | R | 2 | NS | H |
| Additional hook-up, production testing and commissioning (light attraction, disturbance from noise and visible movement) | Change in habitat quality (N) | | L | 1 | 1 | 2 | R | 2 | NS | H |
| Geophysical Surveys (e.g., VPS, geohazard, sidescan sonar) | Change in habitat quality (N) | • Adherence to the *Geophysical, Geological, Environmental and Geotechnical Program Guidelines* (C-NLOPB 2012d) | L | 1 | 1 | 2 | R | 2 | NS | H |

| WREP Activity | Potential Positive (P) or Negative (N) Environmental Effect | Mitigation Measure | Evaluation Criteria for Assessing Environmental Effects [(A)] | | | | | | Significance Rating | Level of Confidence |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | Magnitude | Geographic Extent | Frequency | Duration | Reversibility | Ecological / Socio-cultural / Economic Significance | | |
| Operation of Helicopters and Vessels (e.g., supply, tug, barge) | Change in habitat quality (N) | • Avoid marine bird concentrations when possible<br>• Maintain steady course and safe speed when possible<br>Deviate course to avoid animals<br>• Minimum altitude of 300 m and lateral distance of 2 km over active colonies, including Cape St. Mary's Ecological Reserve and elsewhere when possible | L | 2 | 6 | 3 | R | 2 | NS | H |
| Lighting | Change in habitat quality (N)<br>Potential mortality (N) | • Adhere to CWS recovery and release protocol for stranded bird<br>• Evaluate use of shielding and deflectors with directional lighting and incorporate where safe | L | 2 | 6 | 3 | R | 2 | NS | H |
| Air Emissions | Change in habitat quality (N) | • Adhere to NL *Air Pollution Control Regulations, 2004* and CEPA *National Ambient Air Quality Objectives* | N | 3 | 6 | 3 | R | 2 | NS | H |
| Hydrostatic test fluid | Change in habitat quality (N) | • Adhere to OWTG | L | 1 | 1 | 2 | R | 2 | NS | H |
| Waste generated (domestic, construction, hazardous, sanitary, hydrostatic testing, cooling, firewater) | Change in habitat quality (N) | • Adhere to OWTG | L | 1 | 1 | 2 | R | 2 | NS | H |

| WREP Activity | Potential Positive (P) or Negative (N) Environmental Effect | Mitigation Measure | Evaluation Criteria for Assessing Environmental Effects (A) | | | | | | Significance Rating | Level of Confidence |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | Magnitude | Geographic Extent | Frequency | Duration | Reversibility | Ecological / Socio-cultural / Economic Significance | | |

Key:
Magnitude:
N = Negligible (essentially no effect)
L = Low: <10 percent of the population or habitat in the Study Area will be affected
M = Medium: 11 to 25 percent of the population or habitat in the Study Area will be affected
H = High: >25 percent of the population or habitat in the Study Area will be affected

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

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

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

Reversibility (population level):
R = Reversible
I = Irreversible

Ecological / Socio-cultural / Economic Significance:
1 = Relatively pristine area not affected by human activity
2 = Evidence of existing adverse activity
3 = High level of existing adverse activity

Significance Rating:
S = Significant
NS = Not Significant
P = Positive

Level of Confidence:
L = Low level of confidence
M = Medium level of confidence
H = High level of confidence

(A) Where there is more than one potential environmental effect, the evaluation criteria rating is assigned to the environmental effect with the greatest potential for harm
(B) Reversible at the population level but irreversible at the individual level

### 10.5.1.2 Concrete Gravity Structure Construction

#### Change in Habitat Quantity

Construction of the CGS is not expected to overlap the marine environment, thus will not have an effect on habitat quantity for marine birds.

#### Change in Habitat Quality

##### *Lighting*

As discussed above, artificial lighting on coastal structures and vessels has the potential to attract nocturnally-active marine birds. Husky will implement the mitigation by recovery and release according to CWS protocols established by CWS and offshore operators as discussed above in section 10.4.2.1.

##### *Air Emissions*

As discussed above, air emissions are expected to have a negligible effect on the habitat quality of marine birds.

##### *Operation of Helicopters and Vessels*

As discussed above, marine birds may be temporarily disturbed by passing vessels or helicopters associated with WREP activities. No known concentrations are likely to occur in the Nearshore Study Area that potentially may be affected. Whenever possible, vessels associated with the WREP should maintain a steady course and safe speed (the vessel will be operated in a safe manner in accordance with applicable vessel operating regulations). Concentrations of marine birds, if any occur, will be avoided.

#### Potential Mortality

As discussed above, collision with infrastructure is a potential source of mortality and is discussed in the context of offshore operations in Section 10.5.2.1.

#### Summary

The environmental effects of WREP concrete gravity structure construction activities on marine birds are summarized in Table 10-6.

Given that WREP activities are mostly localized, of low magnitude, and reversible, there are not likely to be significant adverse environmental effects on Marine Birds from CGS construction activities associated with the WREP in the Nearshore Study Area.

#### 10.5.1.3 Concrete Gravity Structure Tow-out and Installation

**Change in Habitat Quantity**

Modelling for the WREP dredging along the tow-out route shows that dredging will have a limited geographic extent (AMEC 2012a). Total particulate matter will be well below the thresholds set in *Canadian Water Quality Guidelines for the Protection of Aquatic Life* (CCME 2002). The Nearshore Project overlaps the northern edge of the Placentia Bay Important Bird Area (see Section 13.3.1.5), designated for the large numbers of Great Shearwaters and seabirds nesting outside the IBA that feed there on capelin during the summer. Food sources for marine birds are patchy and ephemeral and there is no known permanent important marine bird habitat along the tow-out route (see the Sensitive Areas chapter). Bald Eagles may nest in the Nearshore Project Area along shorelines (see the Sensitive Areas chapter). Dredging will likely take place too far offshore to cause disturbance to nesting Bald Eagles. Consequently, any dredging taking place along the tow-out route is not expected to have an effect on habitat quantity for the Marine Bird VEC.

**Change in Habitat Quality**

***Lighting***

As discussed above, artificial lighting on coastal structures and vessels has the potential to attract nocturnally-active marine birds, particularly Leach's Storm-Petrel during the nesting season. Husky will implement the mitigation by recovery and release according to CWS protocols established by CWS and offshore operators as discussed in Section 10.4.2.1 above.

***Air Emissions***

As discussed above, air emissions are expected to have a negligible effect on the habitat quality of marine birds.

***Operation of Helicopters and Vessels***

As discussed above, marine birds may be temporarily disturbed by passing vessels or helicopters associated with WREP activities. No known concentrations are likely to occur in the Nearshore Study Area that potentially may be affected. Whenever possible, vessels associated with the WREP should maintain a steady course and safe speed. Concentrations of marine birds, if any occur, will be avoided.

**Potential Mortality**

As discussed above, collision with infrastructure is a potential source of mortality and is discussed in the context of offshore operations in Section 10.5.2.1.

**Summary**

The environmental effects of WREP concrete gravity structure tow-out and installation activities on marine birds are summarized in Table 10-6.

Given that WREP activities are mostly localized, of low magnitude, and reversible, there are not likely to be significant adverse environmental effects on Marine Birds from concrete gravity structure tow-out and installation activities associated with the WREP in the Nearshore Study Area.

### 10.5.1.4 Accidental Events in the Nearshore

The following sections assess the effect of an accidental release of hydrocarbons in the nearshore. Spills in the nearshore could result from vessel malfunctions or collision. The results of each of the nearshore spill modelling scenarios are summarized in Section 3.7. A detailed analysis is provided in SL Ross (2012).

Spill modelling of the accidental release of marine fuel in Placentia Bay predicts that 100 $m^3$ and 350 $m^3$ spills not reaching shore would evaporate from the surface within approximately 52 and 67 hours, respectively (SL Ross 2012). Slick width was estimated to be up to 440 m, with the loss of the slick at distances of up to 53 km. However, under certain wind conditions and currents, a spill in Placentia Bay could reach shore prior to evaporation (SL Ross 2012). When wind conditions were included in the model, a 350 $m^3$ slick during March-July reached the shore within 2 to 159 hr, but was most likely to do so within 6 to 48 hr (SL Ross 2012). The maximum slick life for a spill that did not reach shore was eight days. Weathering processes (photolysis and biodegradation) would reduce the amount of oil potentially reaching shorelines.

Hydrocarbon spill response is included as part of the emergency response preparedness undertaken for the WREP (Section 16.7.1), and additional information regarding spill response can be found in Section 16.9. Chapter 16 describes the WREP overall environmental management process. A graving dock breach would increase suspended sediment and sedimentation in the nearshore and potentially affect seabirds through localized effects on their food (e.g., benthic invertebrates and fish) and/or their foraging ability (e.g., reduced visibility).

**Change in Habitat Quantity**

Hydrocarbon spills are not likely to permanently alter marine bird habitat. Spill cleanup, weathering and biodegradation would result in eventual recovery of such habitat.

**Change in Habitat Quality**

The presence of hydrocarbons may temporarily affect habitat quality of oiled areas for both oiled and un-oiled birds. Prey availability may be reduced or marine birds may react by avoidance of affected habitat. Sublethal effects of hydrocarbons ingested by marine birds may affect their reproductive rates or survival rates. Sublethal effects may persist for a number of years, depending upon generation times of affected species and the persistence of any spilled hydrocarbons.

### Potential Mortality

Exposure to hydrocarbons has effects on thermal regulation and buoyancy that typically lead to mortality of affected marine birds. Although some may survive these immediate effects, long-term physiological changes may eventually result in death. Most seabirds are relatively long-lived. Hydrocarbons may be transferred to eggs or nestlings, causing embryo or nestling mortality.

### Summary

The environmental effects of WREP accidental events on marine birds are summarized in Table 10-7.

Adverse environmental effects of accidental events (hydrocarbon spills due to collisions, graving dock breach) in the Nearshore Study Area are predicted to be low to high in magnitude, low to moderate in geographic extent, low to moderate in duration and low in frequency. Although significant at the individual level in most cases (Camphuysen 2011), these environmental effects are predicted to be reversible at the population level. These environmental effects could be significant if carried over more than one generation. The effect of spills on marine birds may be mitigated via oil spill response measures and marine bird rehabilitation. There will be an emphasis on accident prevention at all phases of the WREP.

**Table 10-7 Environmental Effects Assessment: Accidental Events in the Nearshore**

| WREP Activity | Potential Positive (P) or Negative (N) Environmental Effect | Mitigation Measure | Evaluation Criteria for Assessing Environmental Effects [A] | | | | | | Significance Rating | Level of Confidence |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | Magnitude | Geographic Extent | Frequency | Duration | Reversibility | Ecological / Socio-cultural / Economic Significance | | |
| Marine Diesel Fuel Spill from Support Vessel | Change in habitat quality (N)<br>Potential mortality (N) | • Training, Preparation, Equipment Inventory, Prevention and Emergency Response Drills<br>• Oil Spill Response Plan | H | 3 | 1 | 2 | R/I [B] | 2 | S | H |
| Graving Dock Breach | Change in habitat quality (N) | • Prevention through Design Standards and Maintenance<br>• Emergency Response Contingency Plan | L | 1 | 1 | 1 | R | 3 | NS | H |

Key:
Magnitude:
N = Negligible (essentially no effect)
L = Low: <10 percent of the population or habitat in the Study Area will be affected
M = Medium: 11 to 25 percent of the population or habitat in the Study Area will be affected
H = High: >25 percent of the population or habitat in the Study Area will be affected

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

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

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

Reversibility (population level):
R = Reversible
I = Irreversible

Ecological / Socio-cultural / Economic Significance:
1 = Relatively pristine area not affected by human activity
2 = Evidence of existing adverse activity
3 = High level of existing adverse activity

Significance Rating:
S = Significant
NS = Not Significant
P = Positive

Level of Confidence:
L = Low level of confidence
M = Medium level of confidence
H = High level of confidence

(A) Where there is more than one potential environmental effect, the evaluation criteria rating is assigned to the environmental effect with the greatest potential for harm
(B) Reversible at the population level but irreversible at the individual level

### 10.5.2 Offshore

#### 10.5.2.1 Wellhead Platform or Subsea Drill Centre Installation/Commissioning

**Change in Habitat Quantity**

The WHP or subsea drill centre in the Offshore Project Area would occupy a small area that may reduce the habitat quantity for marine birds. However, this reduction in habitat quantity is expected to result in minimal habitat loss for this VEC.

**Change in Habitat Quality**

Temporary and localized disturbances to marine birds in the Offshore Study Area may affect bird habitat quality resulting in behavioural changes. WREP activities creating noise, such as wellsite and VSP surveys, light emissions, vessel traffic and helicopter operations are most likely to potentially result in a change in habitat quality.

***Wellsite and Vertical Seismic Profiling Surveys***

Wellsite and VSP surveys have the potential to affect habitat quality for marine birds, especially diving species such as the Alcidae, through disturbance from airgun noise. However, sound levels used in these surveys are unlikely to have more than a very localized, reversible effect.

***Lighting***

Lighting on vessels and WHPs in the Offshore Study Area at night has the potential to attract nocturnally-active marine birds. Leach's Storm-Petrels are likely to be attracted, with the potential for stranding onboard the vessels and the WHP or mortality from collisions with infrastructure. The mitigations by recovery and release according to CWS protocols established by CWS and offshore operators as discussed in Section 10.4.2.1 above are effective to recover and release stranded birds unharmed.

***Operation of Helicopters and Vessels***

As discussed above, marine birds may be temporarily disturbed by passing vessels, vessels engaged in dredging or helicopters associated with offshore construction/installation activities. No known concentrations are likely to occur in the Offshore Study Area that potentially may be affected. Whenever possible, vessels associated with the WREP should maintain a steady course and safe speed.

**Potential Mortality**

Collision with infrastructure resulting from attraction to artificial lighting is a potential source of mortality. However, mortality from collisions is not likely to affect the population of the most commonly attracted species (i.e., Leach's Storm-Petrel). If strandings occur, the potential mortality from subsequent dehydration and starvation is readily mitigated, by recovery and release according to CWS protocols established by CWS and offshore operators as discussed in Section 10.4.2.1.

The effects of wellsite and VSP survey airgun sound are unlikely to result in marine bird mortality because of the relatively small sound sources and limited duration used in these kinds of surveys. Also, in rare instances when disturbance from the source vessel does not cause the dispersal of diving marine birds, such birds would be unlikely to be within the few metres of the sound source necessary to cause mortality.

**Summary**

The environmental effects of WREP wellhead platform or subsea drill centre installation/ commissioning activities on marine birds are summarized in Table 10-5.

Given that WREP activities are mostly localized, of negligible to low magnitude, and reversible, there are not likely to be significant adverse environmental effects on Marine Birds from installation/commissioning activities associated with the WREP in the Offshore Study Area.

### 10.5.2.2 Production/Operations and Maintenance

**Change in Habitat Quantity**

None of the WREP activities in the Offshore Study Area during the operation and maintenance phase are predicted to result in changes in habitat quantity for marine birds.

**Change in Habitat Quality**

Primary WREP activities that could potentially result in changes in habitat quality for marine birds include wellsite and VSP surveys, artificial lighting, flaring, operational discharges and operation of helicopters and vessels.

***Wellsite and Vertical Seismic Profiling Surveys***

As discussed above, wellsite and VSP surveys have the potential to affect habitat quality for marine birds, especially diving species such as the Alcidae, through disturbance from airgun noise. However, sound levels used in these surveys are unlikely to have more than a very localized, reversible effect. Surveys should be planned, to the extent possible, to avoid periods of known concentration in the Offshore Study Area for members of the alcids.

***Lighting***

As discussed above, artificial lighting on vessels, MODUS or a WHP at night has the potential to attract nocturnally-active marine birds. In the Offshore Study Area, Leach's Storm-Petrels are likely to be attracted, with the potential for stranding onboard. Population level effects are unlikely given that the numbers stranding are negligible compared to the very large population of this species. Husky will investigate directional lighting via shielding and deflectors to mitigate attraction by lighting, and may incorporate such features where safety of operations and navigation are not affected. Release and recovery of stranded birds will contribute to minimizing effects on habitat quality.

### *Flaring*

As with artificial lighting discussed above, flaring on the WHP may attract nocturnally-active marine birds like Leach's Storm-Petrels. However, the noise and heat from the flare will likely repel nocturnal birds. Such birds may, however, strand on or collide with the platform superstructure. As described in this document, the need for flaring will be reduced compared with past oil developments in offshore Newfoundland. Release and recovery of stranded birds will contribute to minimizing effects on habitat quality. Consequently, there should be no significant residual effects.

### *Operational Discharges*

As discussed in Section 10.4.2.2, discharges from the WHP could potentially produce sheens. However, SBM mud and cuttings from the WHP will be re-injected, minimizing the possibility of sheens. Blowout preventer fluid contains low toxicity glycol and will be released near the seafloor, minimizing the possibility of toxic effects on marine birds. Cooling water will be chlorinated and discharged overboard at an approximate temperature of 30°C, with a residual chlorine level <0.5 ppm. This water will therefore be diluted, resulting in small thermal effects. Sewage will be macerated and discharged below the surface. As a result, sewage will be unlikely to attract birds. Consequently, operational discharges will be unlikely to have significant residual effects.

### *Operation of Helicopters and Vessels*

As discussed above, marine birds may be temporarily disturbed by passing vessels or helicopters such as those associated with offshore operation/maintenance activities. Seabirds are present in the Offshore Study Area throughout the year and concentrations occur on the continental shelf slope dozens of kilometres to the east of the Project Area during winter. However, as discussed in this document, the locations of any such concentrations are temporary because the locations of concentrations of seabird prey are themselves ephemeral. Consequently, there are no permanent concentrations that can be affected by routine helicopter and vessel movements. In addition, the effect of vessel traffic on marine birds is temporary and localized. As a result, there will be no residual effects of vessel traffic on marine birds. Whenever possible, vessels associated with the WREP should maintain a steady course and safe speed.

### Potential Mortality

Although the potential for flaring to cause marine bird mortality is poorly understood, the heat from noise flares should deter birds from close approach. Even those marine birds induced into circulating around the flare boom and becoming exhausted as a result would not suffer mortality by descending to rest on the sea surface. Those birds stranding on the WHP will be unlikely to suffer mortality because of the mitigation by recovery and release according to CWS protocols established by CWS and offshore operators as discussed in Section 10.4.2.1.

### Summary

The environmental effects of WREP production/operation and maintenance activities on Marine Birds are summarized in Table 10-8.

**Table 10-8 Environmental Effects Assessment: Production/Operation and Maintenance**

| WREP Activity | Potential Positive (P) or Negative (N) Environmental Effect | Mitigation Measure | Evaluation Criteria for Assessing Environmental Effects [A] | | | | | | Significance Rating | Level of Confidence |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | Magnitude | Geographic Extent | Frequency | Duration | Reversibility | Ecological / Socio-cultural / Economic Significance | | |
| Presence of Structure | Change in habitat quality (N) | | L | 1 | 6 | 5 | R | 2 | NS | H |
| WBM (from either WHP or MODU) and SBM (from MODU only) cuttings | Change in habitat quality (N) | • Subsurface discharge<br>• Compliance with OWTG | L | 1 | 2 | 5 | R | 2 | NS | H |
| Maintenance activities | Change in habitat quality (N) | • Use Best Practices | I | 1 | 3 | 5 | R | 2 | NS | H |
| Lighting | Change in habitat quality (N)<br>Potential mortality (N) | • Adhere to CWS recovery and release protocol for stranded birds<br>• Evaluate use of shielding and deflectors with directional lighting and incorporate where safe | L | 2 | 6 | 5 | R [B] | 2 | NS | H |
| Air Emissions | Change in habitat quality (N) | • Adhere to NL *Air Pollution Control Regulations, 2004* and CEPA *National Ambient Air Quality Objectives* | N | 3 | 6 | 5 | R | 2 | NS | H |
| Power Generation and Flaring | Change in habitat quality (N)<br>Potential mortality (N) | • Adhere to CWS recovery and release protocol for stranded birds | L | 1 | 6 | 5 | R [B] | 2 | NS | H |
| Chemical use and management (e.g. BOP fluids, fuel, well treatment fluids, corrosion inhibitors) | Change in habitat quality (N) | • Adhere to OWTG | L | 1 | 6 | 5 | R | 2 | NS | H |
| Waste generated (domestic, construction, hazardous, sanitary, hydrostatic testing, cooling, firewater) | Change in habitat quality (N) | • Subsurface Discharge<br>• Adhere to OWTG | L | 2 | 6 | 5 | R | 2 | NS | H |

| WREP Activity | Potential Positive (P) or Negative (N) Environmental Effect | Mitigation Measure | Evaluation Criteria for Assessing Environmental Effects [A] | | | | | | Significance Rating | Level of Confidence |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | Magnitude | Geographic Extent | Frequency | Duration | Reversibility | Ecological / Socio-cultural / Economic Significance | | |
| Operation of helicopters, supply, support, standby and tow vessels/ barges/ROVs | Change in habitat quality (N) | • Maintain steady course and safe speed when possible<br>• Minimum altitude of 300 m and lateral distance of 2 km over active colonies, including Cape St. Mary's Ecological Reserve and elsewhere when possible | L | 3 | 6 | 5 | R | 2 | NS | H |
| Wellsite and VSP Surveys | Change in habitat quality (N) | • Adherence to the *Geophysical, Geological, Environmental and Geotechnical Program Guidelines* (C-NLOPB 2012d) | L | 1 | 1 | 2 | R | 2 | NS | H |

Key:

Magnitude:
N = Negligible (essentially no effect)
L = Low: <10 percent of the population or habitat in the Study Area will be affected
M = Medium: 11 to 25 percent of the population or habitat in the Study Area will be affected
H = High: >25 percent of the population or habitat in the Study Area will be affected

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

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

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

Reversibility (population level):
R = Reversible
I = Irreversible

Ecological / Socio-cultural / Economic Significance:
1 = Relatively pristine area not affected by human activity
2 = Evidence of existing adverse activity
3 = High level of existing adverse activity

Significance Rating:
S = Significant
NS = Not Significant
P = Positive

Level of Confidence:
L = Low level of confidence
M = Medium level of confidence
H = High level of confidence

(A) Where there is more than one potential environmental effect, the evaluation criteria rating is assigned to the environmental effect with the greatest potential for harm
(B) Reversible at the population level but irreversible at the individual level

Given that WREP activities are mostly localized, of negligible to low magnitude, and reversible, there are not likely to be significant adverse environmental effects on Marine Birds from the production/operation and maintenance activities associated with the WREP.

#### 10.5.2.3 Offshore Decommissioning and Abandonment

**Habitat Quantity**

None of the WREP activities in the Offshore Study Area during the decommissioning and abandonment phase are predicted to result in changes in habitat quantity for marine birds.

**Habitat Quality**

Activities associated with the removal of the WHP may induce temporary and localized disturbance of marine birds. These activities are not expected to occur near any known nesting colonies, so will not affect that portion of marine bird life cycles. Disturbance is possible for small feeding concentrations of marine birds that are common in the Offshore Study Area. It is expected that bird behaviour would likely return to normal shortly after the completion of these activities (if disturbed at all).

Effects on habitat quality and mitigation associated with lighting, air emissions operation of helicopters and vessels, and wellsite and VSP surveys, have been discussed under the construction/installation and production/operations phases (Section 10.5.2.1 and 10.5.2.2, respectively) and are applicable to the decommissioning/abandonment phase.

**Potential Mortality**

The potential risk of mortality and mitigation associated with lighting have been discussed under the construction/installation and production/operations phases and are applicable to the decommissioning/abandonment phase, albeit at a much reduced level compared to previous phases due to the use of fewer lights and the relatively short duration of decommissioning activities. None of these activities are expected to result in potential mortality of marine birds.

**Summary**

The potential environmental effects of decommissioning activities are expected to be similar (or less than) those of construction or operation; therefore, no significant adverse environmental effects are predicted.

The environmental effects of WREP decommissioning/abandonment activities on Marine Birds are summarized in Table 10-9.

**Table 10-9 Environmental Effects Assessment: Decommissioning and Abandonment**

| WREP Activity | Potential Positive (P) or Negative (N) Environmental Effect | Mitigation Measure | Evaluation Criteria for Assessing Environmental Effects [A] | | | | | | Significance Rating | Level of Confidence |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | Magnitude | Geographic Extent | Frequency | Duration | Reversibility | Ecological / Socio-cultural / Economic Significance | | |
| Removal of WHP | Change in habitat quality (N) | | L | 2 | 1 | 1 | R | 2 | NS | H |
| Plugging and Abandoning Wells | Change in habitat quality (N) | | L | 1 | 3 | 2 | R | 2 | NS | H |
| Lighting | Change in habitat quality (N)<br>Potential mortality (N) | • Adhere to CWS recovery and release protocol for stranded birds<br>• Evaluate use of shielding and deflectors with directional lighting and incorporate where safe | L | 2 | 6 | 5 | R[B] | 2 | NS | H |
| Air Emissions | Change in habitat quality (N) | • Adhere to NL *Air Pollution Control Regulations, 2004* and CEPA *National Ambient Air Quality Objectives* | N | 3 | 6 | 5 | R | 2 | NS | H |
| Operation of helicopters, supply, support, standby and tow vessels/barges/ROVs | Change in habitat quality (N) | • Maintain steady course and safe speed when possible<br>• Minimum altitude of 300 m and lateral distance of 2 km over active colonies, including Cape St. Mary's Ecological Reserve and elsewhere when possible | L | 3 | 6 | 5 | R | 2 | NS | H |
| Wellsite and VSP Surveys | Change in habitat quality (N)<br>Potential mortality (N) | • Adherence to the *Geophysical, Geological, Environmental and Geotechnical Program Guidelines* (C-NLOPB 2012d) | L | 1 | 1 | 2 | R[B] | 2 | NS | H |

| WREP Activity | Potential Positive (P) or Negative (N) Environmental Effect | Mitigation Measure | Evaluation Criteria for Assessing Environmental Effects [A] | | | | | | Significance Rating | Level of Confidence |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | Magnitude | Geographic Extent | Frequency | Duration | Reversibility | Ecological / Socio-cultural / Economic Significance | | |

Key:
Magnitude:
N = Negligible (essentially no effect)
L = Low: <10 percent of the population or habitat in the Study Area will be affected
M = Medium: 11 to 25 percent of the population or habitat in the Study Area will be affected
H = High: >25 percent of the population or habitat in the Study Area will be affected

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

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

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

Reversibility (population level):
R = Reversible
I = Irreversible

Ecological / Socio-cultural / Economic Significance:
1 = Relatively pristine area not affected by human activity
2 = Evidence of existing adverse activity
3 = High level of existing adverse activity

Significance Rating:
S = Significant
NS = Not Significant
P = Positive

Level of Confidence:
L = Low level of confidence
M = Medium level of confidence
H = High level of confidence

(A) Where there is more than one potential environmental effect, the evaluation criteria rating is assigned to the environmental effect with the greatest potential for harm
(B) Reversible at the population level but irreversible at the individual level

### 10.5.2.4 Potential Future Activities

Future activities in the Offshore Project Area may include, but are not limited to, wellsite and VSP surveys, dredging and dredge spoils disposal, operation of a MODU, and operation of helicopters and vessels. These activities involve artificial lighting, noise and disturbance.

#### Change in Habitat Quantity

None of the potential future WREP activities are expected to cause changes in habitat quantity for marine birds, except the temporary placement of the MODU.

#### Change in Habitat Quality

Wellsite and VSP surveys, operation of a MODU, operation of helicopters and vessels activities, as well as chemical use and management ((an indirect effect if discharges affect seabird food resources (i.e., invertebrates and fish)), could affect habitat quality (see Section 8.5.2.4 on Fish and Fish Habitat). The potential environmental effects of all these activities have been discussed previously within Section 10.5.2, and are of similar magnitude, duration, frequency and extent as during potential future activities.

#### Potential Mortality

There is also some potential for direct mortality as a result of collisions with or strandings on artificially lit structures. As discussed above, the effects of artificial lighting on marine birds are not expected to cause changes in mortality after the application of mitigation.

#### Summary

The potential environmental effects of future activities are expected to be similar (or less than) those of construction or operation; therefore, no significant adverse environmental effects are predicted.

### 10.5.2.5 Accidental Events

Spills in the Offshore Study Area could be associated with a subsea hydrocarbon blowout, surface oil spills, or fuel spills from vessels. The environmental effects of an accidental release of oil from a blowout or surface spill are assessed below (summarized in Table 10-10). Oil spill modelling for the WREP in the Offshore Study Area indicates that a diesel fuel spill was estimated to have a slick survival time of 48 hr (SL Ross 2012) and would thus have reduced effects on marine birds compared to a large-scale crude oil spill. The different types and probability of spills are discussed in Section 3.6. A detailed analysis can be found in SL Ross (2012).

**Table 10-10 Environmental Effects Assessment: Accidental Events in the Offshore**

| WREP Activity | Potential Positive (P) or Negative (N) Environmental Effect | Mitigation Measure | Evaluation Criteria for Assessing Environmental Effects [A] | | | | | | Significance Rating | Level of Confidence |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | Magnitude | Geographic Extent | Frequency | Duration | Reversibility | Ecological / Socio-cultural / Economic Significance | | |
| SBM Whole Mud Spill | Change in habitat quality (N)<br>Potential mortality (N) | • Training, Preparation, Equipment Inventory, Prevention and Emergency Response Drills<br>• Oil Spill Response Plan | H | 1 | 1 | 2 | R/I [B] | 2 | NS | H |
| Subsea Blowout | Change in habitat quality (N)<br>Potential mortality (N) | • Oil Spill Response Plan<br>• Training, Preparation, Equipment Inventory, Prevention and Emergency Response Drills | H | 3 | 1 | 3 | R/I [B] | 2 | S[C] | H |
| Hydrocarbon Surface Spill | Change in habitat quality (N)<br>Potential mortality (N) | • Oil Spill Response Plan<br>• Training, Preparation, Equipment Inventory, Prevention and Emergency Response Drills | H | 3 | 1 | 2 | R/I [B] | 2 | S[C] | H |
| Other Spills (e.g., Fuel, Waste Materials | Change in habitat quality (N)<br>Potential mortality (N) | • Oil Spill Response Plan<br>• Training, Preparation, Equipment Inventory, Prevention and Emergency Response Drills | H | 1 | 1 | 2 | R/I [B] | 2 | NS | H |
| Marine Vessel Incident (including collisions) (i.e., marine diesel fuel spill) | Change in habitat quality (N)<br>Potential mortality (N) | • Oil Spill Response Plan<br>• Training, Preparation, Equipment Inventory, Prevention and Emergency Response Drills | M | 2 | 1 | 2 | R/I [B] | 2 | S[C] | H |

| WREP Activity | Potential Positive (P) or Negative (N) Environmental Effect | Mitigation Measure | Evaluation Criteria for Assessing Environmental Effects [A] | | | | | | Significance Rating | Level of Confidence |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | Magnitude | Geographic Extent | Frequency | Duration | Reversibility | Ecological / Socio-cultural / Economic Significance | | |

Key:

Magnitude:
N = Negligible (essentially no effect)
L = Low: <10 percent of the population or habitat in the Study Area will be affected
M = Medium: 11 to 25 percent of the population or habitat in the Study Area will be affected
H = High: >25 percent of the population or habitat in the Study Area will be affected

Geographic Extent:
1 = <1 km radius
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Frequency:
1 = <11 events/year
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R = Reversible
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Ecological / Socio-cultural / Economic Significance:
1 = Relatively pristine area not affected by human activity
2 = Evidence of existing adverse activity
3 = High level of existing adverse activity

Significance Rating:
S = Significant
NS = Not Significant
P = Positive

Level of Confidence:
L = Low level of confidence
M = Medium level of confidence
H = High level of confidence

(A) Where there is more than one potential environmental effect, the evaluation criteria rating is assigned to the environmental effect with the greatest potential for harm
(B) Reversible at the population level but irreversible at the individual level
(C) By definition used in this EA, a significant effect would only occur if carried past one generation

A crude oil blowout of 3,963 to 6,435 $m^3$/day over 120 days would have a slick survival time of more than 30 days; a subsea blowout would have a thinner, but wider slick (up to 2.8 km) than a surface blowout (up to 3.4 mm thick and 160 m wide) (SL Ross 2012). The spill would most likely be dispersed to a southeasterly direction, away from the shore. According to the spill modelling (SL Ross 2012), oil is highly unlikely to reach the shore if a spill occurs in the Offshore Study Area. The probability of a crude oil spill reaching shore was zero for December through February and April through September, and less than 1 percent for March, October and November (SL Ross 2012).

SBM whole mud spills, if they accidentally occur with the WREP, have some potential to form a sheen on the water's surface. However, the most likely scenario would be a release at depths greater than usually used by marine birds. The muds used are selected for their low toxicity to organisms. The density of SBMs would favour sinking to the sea bottom. Most spills modelled for the WREP were predicted to cover 1,800 $m^2$ or less (AMEC 2012b). The SBM will biodegrade within weeks to months depending upon water temperature and other physical factors.

Oil spill response is included as part of the emergency response preparedness undertaken for the WREP (Section 16.7.1), and additional information regarding spill response for the Offshore Study Area can be found in Section 16.9. Chapter 16 describes the WREP overall environmental management process.

**Change in Habitat Quantity**

As discussed above, hydrocarbon spills are not likely to permanently alter marine bird habitat quantity. Spill cleanup, weathering and biodegradation would result in eventual recovery of such habitat. SBM whole mud spills are likely to cover small areas and have small scale, reversible effects on benthos. Any sheen created from an SBM spill would be of short duration and cover a limited area of the sea surface.

**Change in Habitat Quality**

As discussed above, the presence of hydrocarbons may temporarily affect habitat quality of oiled areas for both oiled and un-oiled birds. Prey availability may be reduced or marine birds may react by avoidance of affected habitat. Sublethal effects of hydrocarbons ingested by marine birds may affect their reproductive rates or survival rates. Sublethal effects may persist for a number of years, depending upon generation times of affected species and the persistence of any spilled hydrocarbons.

Accidental release of SBM whole muds are likely to occur at depths below those used by marine birds, thus are unlikely to change habitat quality for marine birds unless a sheen forms at the sea surface.

**Potential Mortality**

As discussed above, exposure to hydrocarbons frequently leads to hypothermia and deaths of affected marine birds. Although some may survive these immediate effects, long-term physiological changes may eventually result in death. Most marine birds are relatively long-lived. Adult marine birds foraging offshore to provision their young may become oiled and bring hydrocarbons on their plumage back to the nest to contaminate their eggs or nestlings, causing embryo or nestling mortality. However, in the remote

possibility that hydrocarbons released at the WHP site reached the exposed coast, a slick would likely be rapidly weathered and dispersed on the high energy, rocky coastline.

SBM whole mud spills would not be toxic to marine birds and therefore would not have the potential for mortality except under very exceptional circumstances such as a large surface spill, flat calm conditions, presence of birds on the water, and presence of a thick enough sheen to affect insulation.

**Summary**

The environmental effects of WREP accidental events on marine birds are summarized in Table 10-10.

Adverse environmental effects of accidental events (i.e., hydrocarbon spills due to collisions, subsea blowouts, batch spills or marine vessel incidents, SBM whole mud spills) in the Offshore Study Area are predicted to be low to high in magnitude, low to high in geographic extent, low to moderate in duration and low in frequency. Although hydrocarbon spills could result in some mortality at the individual level (Camphuysen 2011), these environmental effects are predicted to be reversible at the population level within one generation. However, these environmental effects could be significant if carried over more than one generation according to the definition of significance used in this environmental assessment. Smaller scale spills in calm conditions may be mitigated via oil spill response measures and marine bird rehabilitation; however, these mitigations are recognized to be limited. Husky will practice spill prevention using safety and risk management systems, management of change procedures and global standards. There will be an emphasis on accident prevention at all phases of the WREP.

### 10.5.3 Cumulative Environmental Effects

Marine oil and gas exploration, commercial fishery activity, marine transportation and existing and future production activity (e.g., White Rose, Hibernia, Terra Nova and Hebron) all have the potential to interact with marine birds. Hunting of marine birds occurs in the Nearshore Study Area. It is unlikely that routine activities associated with other marine exploration, existing production areas, marine transportation and commercial fisheries have substantive environmental effects on marine birds. The one exception would be an accidental hydrocarbon spill or blowout in the Offshore Study Area.

#### 10.5.3.1 Nearshore

With the exception of marine bird hunting, cumulative environmental effects in the Nearshore Study Area are expected to be of a lower magnitude than those of the Offshore Study Area, as fewer activities have the potential to interact with the current WREP (see Section 10.5.3.2 for cumulative environmental effects assessment of the Offshore Study Area).

Most hunting of marine birds in Newfoundland and Labrador waters occurs inshore. The harvested populations are primarily sea ducks (especially Common Eider) and murres (mostly Thick-billed Murre). Sea ducks occur primarily inshore, but Thick-billed Murre occurs both inshore and offshore (autumn to spring). The last harvest survey was run in

2001 and estimated that approximately 300,000 murres were harvested in Newfoundland and Labrador (Wiese et al. 2004). Since then, based on permit purchases, there has been a general decline in hunter participation (CWS, unpublished data). Wiese et al. (2004) modelled the effects of hunting and oil pollution on the population growth of Thick-billed Murres and found that hunting decreased the population growth at the same rate as chronic oil pollution, arising primarily from illegal discharges of oily water from ships. Hunting of sea ducks and murres may therefore have a cumulative environmental effect with effects of accidental hydrocarbon spills and produced water (Wiese et al. 2004).

The bycatch of marine birds in commercial fisheries has historically been a known source of marine bird mortality. However, bycatch of marine birds in commercial fisheries (e.g., inshore gill netting) has declined sharply since 1992 (Benjamins et al. 2008). This has probably had a positive effect on marine bird populations nesting in Newfoundland and Labrador. Consequently, the environmental effects of commercial fisheries probably no longer pose any significant cumulative environmental effects on marine birds.

#### 10.5.3.2 Offshore

The effects of illumination on structures and vessels, air emissions, discharges, underwater sound, accidental hydrocarbon spills from exploration vessels, existing production drilling platforms and vessels, other exploratory drilling structures and platforms may have cumulative environmental effects with WREP activities and WREP accidental events.

Marine birds, particularly Leach's Storm-Petrels, may be attracted to the lights of offshore structures and vessels at night and during periods of poor visibility. As a result, Leach's Storm-Petrels may strand on offshore platforms, as discussed in Section 10.5.2.1. The stranding of birds at offshore platforms is largely mitigated by bird handling and release protocols so that any cumulative environmental effects, if they occur, would be low and not significant.

The WREP will create additional emissions to the atmosphere, but air emissions from one drilling operation will be relatively small in scale and within the range of other offshore marine activities such as marine shipping. Emissions will very rapidly dissipate in the windy offshore environment and will not endanger the health of marine birds since any exposures will be of very low concentrations and durations. Any cumulative environmental effects are considered negligible.

Drill mud and other discharges are regulated by the OWTG (NEB et al. 2010), and the quantities involved, geographic extents and magnitudes are small. There are few pathways for drill mud/cuttings discharges to affect marine birds, other than the potential exception of a sheen of SBM from accidental release of whole mud under flat calm conditions. As described for the effects of discharges on marine birds, any cumulative environmental effect is considered not significant.

As discussed above, bycatch of marine birds in commercial fisheries has declined sharply since 1992 (Benjamins et al. 2008). This has probably had a positive effect on marine bird populations, both those nesting in Newfoundland and those nesting in the

Arctic. Consequently, the environmental effects of commercial fisheries probably no longer pose any significant cumulative environmental effects on marine birds.

As described in the assessment above, underwater sound has the potential to disturb marine birds that spend prolonged periods submerged near a loud sound source. Alcids are the only family of marine birds found in Newfoundland and Labrador offshore waters that are known to dive underwater for extended periods and thus, are more likely to be affected by underwater sound than other species. Avoidance or behavioural disturbance is the most likely effect of underwater sound produced by offshore operations associated with the WREP or other nearby operations, but these effects are expected to be low in magnitude and only affect a small area. Thus, it is predicted that cumulative environmental effects of underwater sound on marine birds are not significant.

A major spill or blowout on the Grand Banks would affect marine birds, with the magnitude depending on the type, size, location, timing, species and life stages involved. A major spill is statistically very unlikely to coincide among various operations on the Grand Banks. Nevertheless, cumulative environmental effects could occur from chronic discharges of oil bilges at sea by ships transiting the area or from other activities that could affect marine birds. A major oil spill could significantly affect marine birds on the Grand Banks and thus result in a significant cumulative environmental effect when considered in addition to other stressors on bird populations (e.g., hunting, bycatch in commercial fishing, or oiling from bilge dumping). However, petroleum hydrocarbons from a deep-water blowout may be considerably reduced when it reaches the surface, and the wind and wave conditions typical of the Grand Banks will further aid in the dispersal of petroleum hydrocarbons. Spill countermeasures and marine bird rehabilitation would additionally reduce potential cumulative environmental effects.

### 10.5.4 Determination of Significance

The determination of significance is based on the definition provided in Section 10.2. It considers the magnitude, geographic extent, duration, frequency, reversibility and ecological context of each environmental effect with the Study Area, and their interactions, as presented in the preceding analysis. Significance is determined at the population level within the Study Area.

Adverse environmental effects of attraction to illumination on structures and vessels on marine birds during the construction/installation, operation and maintenance, and decommissioning and abandonment phases of the WREP are predicted to be low in magnitude, geographic extent, duration and frequency when mitigation measures are practiced. Although significant at the individual level, these environmental effects are predicted to be reversible at the population level. These environmental effects are therefore predicted to be not significant.

Adverse environmental effects of accidental events (i.e., hydrocarbon and other chemical spills due to collisions, subsea blowouts, batch spills, marine vessel incidents, graving dock breach, SBM whole mud spills) are predicted to be low to high in magnitude, low to high in geographic extent, low to moderate in duration and low in frequency. Although hydrocarbon spills would likely be significant at the individual level, these environmental effects are predicted to be reversible at the population level. The environmental effects of hydrocarbon spills could be significant if spills are large and persistent enough to affect more than one generation. Smaller scale spills in calm

conditions may be mitigated via oil spill response measures and marine bird rehabilitation; however, these mitigations are recognized to be limited. Husky will adhere to safety and risk management systems, management of change procedures and global standards. There will be an emphasis on accident prevention at all phases of the WREP.

The significance of potential residual environmental effects, including cumulative environmental effects, resulting from the interaction between WREP-related activities and marine birds, after taking into account any proposed mitigation, is summarized in Table 10-11.

**Table 10-11 Residual Environmental Effects Summary: Marine Birds**

| Phase | Residual Adverse Environmental Effect Rating (A) | Level of Confidence | Probability of Occurrence (Likelihood) |
|---|---|---|---|
| Construction (B) | NS | H | NA (C) |
| Installation of WHP or Subsea Drill Centre | NS | H | NA |
| Operation and Maintenance | NS | H | NA |
| Decommissioning and Abandonment (D) | NS | H | NA |
| Accidental Events | S | H | L |
| Cumulative Environmental Effects | NS | H | NA |

KEY

Residual Environmental Effects Rating:
S = Significant Adverse Environmental Effect
NS = Not Significant Adverse Environmental Effect
P = Positive Environmental Effect

Level of Confidence in the Effect Rating:
L = Low level of Confidence
M = Medium Level of Confidence
H = High level of Confidence

Probability of Occurrence of Significant Effect:
L = Low Probability of Occurrence
M = Medium Probability of Occurrence
H = High Probability of Occurrence

NA = Not Applicable
(A) As determined in consideration of established residual environmental effects rating criteria
(B) Includes all Argentia activities (engineering, construction, tow-out) of the WHP option only
(C) Effect is not predicted to be significant, therefore the probability of occurrence rating is not required under CEAA
(D) Includes decommissioning and abandonment of the WHP and offshore site

Because the adverse environmental effects of each WREP phase are predicted to be not significant, the adverse environmental effects of the WREP overall is predicted to be not significant.

### 10.5.5 Follow-up and Monitoring

The CEAA definition of "follow-up program" is "a program for (a) verifying the accuracy of the environmental assessment of a project, and (b) determining the effectiveness of any measures taken to mitigate the adverse environmental effects of the project". Follow-up programs serve as the primary means to determine and quantify change from routine operations on the receiving environment. Compliance monitoring on its own, does not satisfy the requirements for a follow-up program. Compliance monitoring is conducted to ensure that a project and its activities are meeting the relevant environmental standards, guidelines and regulations. Compliance monitoring will be conducted for the WREP in accordance with regulatory requirements.

A compliance monitoring program for the nearshore component of the WREP will be developed in consultation with regulators. The offshore EEM will be redesigned to incorporate the WREP activities into the existing EEM for the White Rose field.

In the event of a spill, and depending on the nature and size of the spill, marine bird monitoring will be implemented. The details regarding monitoring requirements and protocols are outlined in the oil spill response plan and will be determined in consultation with the C-NLOPB and Environment Canada.

Husky will continue the current seabird observation program for the White Rose field.

Husky supports initiatives such as the recent ESRF marine bird monitoring program. Marine bird monitoring protocols will be based on those provided by CWS (Gjerdrum et al. 2012), as per Appendix 2 in the C-NLOPB *Geophysical, Geological, Environmental and Geotechnical Program Guidelines* (C-NLOPB 2012d).

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# 11.0 MARINE MAMMALS AND SEA TURTLES

Marine Mammals and Sea Turtles have been selected as a VEC for the following reasons:

- Populations of marine mammals and some sea turtle species migrate to the Offshore Study Area primarily to forage for food
- The potential for interaction with WREP activities
- As high-level predators, marine mammals and sea turtles play an ecologically important role by serving as indicators of changes in the marine ecosystem
- They forage to some extent in the Nearshore Study Area
- They are a high profile group, important ecologically, culturally and economically

The Marine Mammal and Sea Turtle VEC includes cetaceans (whales, dolphins and porpoises), pinnipeds (seals) and sea turtles that are not considered at risk species by SARA or COSEWIC. Species at risk are assessed in Chapter 12.

## 11.1 Environmental Assessment Boundaries

### 11.1.1 Spatial Boundaries

The spatial boundaries of the Nearshore and Offshore Project and Study Areas are defined in the Effects Assessment Methods section (Chapter 5). The temporal boundaries are also defined in Chapter 5. The Study Areas are illustrated in Figures 5-2 and 5-4 for the Nearshore and Offshore, respectively. The Affected Areas for the WREP have been determined based on the results of modelling.

### 11.1.2 Temporal Boundaries

The temporal boundaries for the assessment are defined in Chapter 5 and outlined in Table 11-1.

### 11.1.3 Administrative Boundaries

Marine mammals and sea turtles are protected under the *Fisheries Act.* Marine mammal and sea turtle species at risk are protected under SARA (refer to Chapter 12).

**Table 11-1 Temporal Boundaries of Nearshore and Offshore Study Areas**

| Study Area | Temporal Boundary |
|---|---|
| Nearshore | • In the case of the WHP development option, site preparation, graving dock construction, construction of CGS, dredging, topsides mating and tow-out will occur over an estimated 30 to 38 months from 2013 to 2016. Various activities will occur at all times of year until completion.<br>• In the case of the subsea drill centre development option, no nearshore activities will occur |
| Offshore | • In the case of the WHP development option, site preparation, installation of the WHP, and initial production/maintenance will occur from 2016 to 2017. The WHP will be decommissioned and abandoned in accordance with standard practices at the end of its production life, which is anticipated to be 25 years.<br>• The subsea drill centre option is scheduled to begin construction in 2014, with first oil expected in 2015. Under this option, the wells will be plugged and abandoned at the end of its production life (anticipated to be 20 years), and the subsea infrastructure removed or abandoned in accordance with relevant regulations |

## 11.2 Definition of Significance

A significant adverse residual environmental effect is one that affects marine mammals and sea turtles resulting in a decrease in abundance or alteration in distribution of the population over more than one generation within the Nearshore and/or Offshore Study Area. Natural recruitment may not reestablish the populations(s) to baseline conditions within several generations, or avoidance of the area may become permanent.

An adverse environmental effect that does not meet above criteria is evaluated as not significant.

## 11.3 Existing Environment

Because of the overlap in offshore study areas and the migratory nature of marine mammals, much of the information contained in this section is similar to recent offshore environmental assessments (e.g., the Hebron Project Comprehensive Study Report (EMCP 2011), Environmental Assessment of Husky's Jeanne d'Arc Basin/Flemish Pass Regional Seismic Program, 2012-2020 (LGL 2012)). Updates from recent literature and sighting information have been included here.

### 11.3.1 Marine Mammals

A total of 21 species of marine mammals, including five species of baleen whale (mysticetes), 12 toothed whale species (odontocetes), and four true seal species (phocids), are known to occur in the Nearshore or Offshore Study Areas (Table 11-1). The temporal and spatial distribution, habitat, and relevant SARA listings and COSEWIC designations for each species are presented in Table 11-2. At-risk species are described in greater detail in Chapter 12. Most marine mammals are seasonal inhabitants of the Study Areas, with both regions representing important foraging grounds for many species. The best available abundance estimates for each of the marine mammal species in the Northwest Atlantic, as well as for eastern Newfoundland, are provided in Table 11-3.

**Table 11-2 Marine Mammals Known or Expected to Occur within the Nearshore and Offshore Study Areas**

| Species (Scientific Name) | Nearshore Study Area | | Offshore Study Area | | Habitat | SARA Status [A] | COSEWIC Status [B] |
|---|---|---|---|---|---|---|---|
| | Occurrence | Season | Occurrence | Season | | | |
| **Baleen Whales (Mysticetes)** | | | | | | | |
| Humpback Whale (*Megaptera novaeangliae*) | Common | Year-round, but mostly Jun-Sep | Common | Year-round, but mostly May-Oct | Coastal & Banks | NS | NAR |
| Blue Whale (*Balaenoptera musculus*) | Uncommon | Year-round, but mostly Jul-Sep | Uncommon | Year-round, but mostly June-Oct | Coastal & Pelagic | Schedule 1: Endangered | E |
| Fin Whale (*Balaenoptera physalus*) | Common | Jun-Oct | Common | Year-round, but mostly June-Oct | Slope & Pelagic | Schedule 1: Special Concern | SC |
| Sei Whale (*Balaenoptera borealis*) | Rare | Summer | Uncommon | May-Sept | Offshore & Pelagic | NS | DD |
| Minke Whale (*Balaenoptera acutorostrata*) | Common | Year-round, but mostly Jun-Oct | Common | Year-round, but mostly May-Oct | Shelf, Banks, & Coastal | NS | NAR |
| **Toothed Whales (Odontocetes)** | | | | | | | |
| Sperm Whale (*Physeter macrocephalus*) | Uncommon | Summer | Uncommon | Year-round, but mostly summer | Pelagic, Slope, Canyons | NS | NAR; LPC |
| Northern Bottlenose Whale (*Hyperoodon ampullatus*) [C] | Very Rare | Year-round? | Rare | Year-round? | Pelagic, Canyons, Slope | NS | SC |
| Sowerby's Beaked Whale (*Mesoplodon bidens*) | Very Rare | Year-round? | Rare | Year-round? | Pelagic, Deep, Slope, Canyon | Schedule 1: Special Concern | SC |
| Killer Whale (*Orcinus orca*) | Uncommon? | Year-round, but mostly Jun-Oct | Uncommon | Year-round, but mostly June-Oct | Widely Distributed | NS | SC |
| Long-finned Pilot Whale (*Globicephala melas*) | Uncommon | Year-round, but mostly Jul-Oct | Common | Year-round | Mostly Pelagic | NS | NAR |
| Risso's Dolphin (*Grampus griseus*) | Very Rare | Year-round? | Rare | Year-round? | Slope | NS | NAR |
| Common Bottlenose Dolphin (*Tursiops truncatus*) | Very Rare | Summer | Rare | Summer | Shelf & Pelagic | NS | NAR |

| Species (Scientific Name) | Nearshore Study Area | | Offshore Study Area | | Habitat | SARA Status (A) | COSEWIC Status (B) |
|---|---|---|---|---|---|---|---|
| | Occurrence | Season | Occurrence | Season | | | |
| Short-beaked Common Dolphin (*Delphinus delphis*) | Uncommon | Summer | Common | June-Oct | Shelf & Pelagic | NS | NAR |
| Striped Dolphin (*Stenella coeruleoalba*) | Rare | Summer | Uncommon | July-Oct | Slope & pelagic | NS | NAR |
| Atlantic White-sided Dolphin (*Lagenorhynchus acutus*) | Common | Year-round, but mostly Jun-Sept | Common | Year-round, but mostly June-Oct | Shelf & Slope | NS | NAR |
| White-beaked Dolphin (*Lagenorhynchus albirostris*) | Common | Year-round, but mostly spring & fall | Common | Year-round, but mostly June-Sept | Shelf | NS | NAR |
| Harbour Porpoise (*Phocoena phocoena*) | Common | Year-round?, but mostly summer | Uncommon | Year-round, but mostly May-Oct | Shelf | Schedule 2: Threatened | SC |
| **True Seals (Phocids)** | | | | | | | |
| Harbour Seal (*Phoca vitulina*) | Uncommon? | Year-round | Rare | Year-round | Coastal | NS | NAR |
| Harp Seal (*Phoca groenlandica*) | Uncommon? | Feb-May | Common | Dec-June | Ice & Pelagic | NS | NC; LPC |
| Hooded seal (*Cystophora cristata*) | Uncommon? | Mostly late winter | Uncommon | Mostly late winter | Ice & Pelagic | NS | NAR; LPC |
| Grey Seal (*Halichoerus grypus*) | Rare | Year-round | Uncommon | Year-round | Coastal | NS | NAR |
| **Otters (Mustelids)** | | | | | | | |
| Northern River Otter (*Lontra canadensis*) | Common | Year-round | - | - | Coastal | NS | NC |

Notes:
Note additional information on Species at Risk is provided in Chapter 12
? Indicates uncertainty
(A) Species designation under SARA (Government of Canada 2012); NS = No Status
(B) Species designation under COSEWIC (COSEWIC 2011a): E = Endangered, T = Threatened, SC = Special Concern, DD = Data Deficient, NAR = Not At Risk, NC = Not Considered, LPC = Low-priority Candidate, MPC = Mid-priority Candidate, HPC = High-priority Candidate
(C) Refers to the Davis Strait-Baffin Bay-Labrador Sea population; it is expected that most individuals observed in the Study Areas would belong to this population. The Scotian Shelf population is considered Endangered on Schedule 1 of SARA and Endangered by COSEWIC

**Table 11-3 Population Estimates of Marine Mammals that Occur off Eastern Newfoundland**

| Species | NW Atlantic | Population Occurring off Eastern Newfoundland | | |
|---|---|---|---|---|
| | Estimated Abundance [A] | Stock | Estimated Abundance | Source |
| **Baleen Whales** | | | | |
| Humpback whale | 11,570 [B] | NL | 1,700-3,200 | Whitehead (1982); Katona and Beard (1990); Baird (2003) |
| Sei whale | Unknown | Nova Scotia | 207 | Waring et al. (2009) |
| Minke whale | 188,000 [C] | Can. E. Coast | 3,312 | Dufault (2005); Waring et al. (2009) |
| **Toothed Whales** | | | | |
| Sperm whale | 4,804 [D] | NW Atlantic | Unknown | Reeves and Whitehead (1997); Waring et al. (2009) |
| Northern bottlenose whale | Unknown | North Atlantic | Unknown | Reeves et al. (1993) |
| Long-finned pilot whale | 31,139 [E] | NL | Tens of Thousands | Hay (1982); Nelson and Lien (1996) |
| Risso's dolphin | 20,479 | Can. E. Coast | Rare | Baird and Stacey (1991) |
| Common bottlenose dolphin | 81,588 [F] | Can. E. Coast | Unknown | Waring et al. (2009) |
| Short-beaked common dolphin | 120,743 | NL | Seasonally Abundant | Gaskin (1992) |
| Striped dolphin | 94,462 | Can. E. Coast | Unknown | Baird et al. (1993a) |
| Atlantic white-sided dolphin | 63,368 | Can. E. Coast | Unknown | Palka et al. (1997); Waring et al. (2009) |
| White-beaked dolphin | 2,003 | Can. E. Coast | Unknown | Waring et al. (2009) |
| **True Seals** | | | | |
| Harbour seal | 99,340 | NL | Thousands (at least 1,000) | Hammill and Stenson (2000); Sjare et al. (2005a); COSEWIC (2007a) |
| Harp seal | 8 million [G] | NL | Abundant | DFO (2011d) |
| Hooded seal | 593,500 [H] | NE NL | 535,800 | Hammill and Stenson (2006a) |
| Grey seal | 304,000 [I] | NL | Unknown | |

(A) "Best" estimates from the Northwest Atlantic (Waring et al. 2009), unless otherwise noted
(B) Estimate for North Atlantic (Stevick et al. 2003)
(C) Estimate for North Atlantic (IWC 2007; Waring et al. 2009)
(D) Estimate for North Atlantic (Waring et al. 2009)
(E) Estimate may include both long- and short-finned pilot whales (Waring et al. 2009)
(F) Estimate for the Northwest Atlantic offshore stock, but may include coastal forms (Waring et al. 2009)
(G) Estimate for the Northwest Atlantic (DFO 2011d)
(H) Estimate for the Canadian Northwest Atlantic (Hammill and Stenson 2006a)
(I) Estimate for Sable Island, eastern Nova Scotia, and the Gulf of St. Lawrence breeding populations (Thomas et al. 2007)

In addition to the species listed in Table 11-2 four species may be rare visitors in one or both of the Study Areas: the beluga whale (*Delphinapterus leucas*), North Atlantic right whale (*Eubalaena glacialis*), ringed seal (*Pusa hispida*), and bearded seal (*Erignathus barbatus*). However, these records are considered extralimital. The distributions of both ringed and bearded seals are centred in the Arctic and pack ice of the sub-Arctic (Jefferson et al. 2008). Occasionally, small numbers of either species may stray into the Offshore Study Area, particularly in heavy ice years. While it is possible that these four species could occur in the Study Areas, their presence is highly unlikely and they are not considered further in this document.

Marine mammal surveys of the Grand Banks, including the Offshore Study Area, were conducted over 25 years ago in support of the Hibernia EIS (Parsons and Brownlie 1981). These surveys represented the primary source of information on marine mammal distribution and abundance within the Jeanne d'Arc Basin for several years, but are not repeated for this report. However, marine mammal sightings from recent monitoring programs in and near the Offshore Study Area (including data from 2005 to 2008), as well as cetacean observations from Newfoundland and Labrador waters compiled by Fisheries and Oceans Canada (DFO) and the Whale Release and Stranding Group, are summarized and incorporated into the following species profiles, updating a previous summary in LGL (2006). Marine mammals were also recorded during supply vessel transits in August and early September 1999 from St. John's to oil platforms in the Jeanne d'Arc Basin (Wiese and Montevecchi 1999). Marine mammal observations are also available from the Terra Nova Floating, Production, Storage and Offloading (FPSO) monitoring facility for 2007 and 2008, but these are limited in terms of observational effort and detail. Waring et al. (2009) provide additional information on the distribution, abundance, seasonality and conservation status of marine mammals in the Northwest Atlantic. It should be noted that the "best estimates" of marine mammal population size in Waring et al. (2009) are largely based on aerial survey data that are typically uncorrected for dive times.

#### 11.3.1.1 Marine Mammal Monitoring in the Jeanne d'Arc and Orphan Basins in the Past Decade

Marine mammal monitoring programs conducted during seismic surveys in Jeanne d'Arc Basin and adjacent areas provide information on the spatial and temporal distribution of marine mammals in the area. Relevant programs include: Husky seismic programs during October and November 2005 (Lang et al. 2008) and July and August 2006 (Abgrall et al. 2008a); Petro-Canada's seismic survey during June and July 2007 (Lang and Moulton 2008); and StatoilHydro and Husky seismic program from June to September 2008 (Abgrall et al. 2009). However, the data represent only the late spring, summer and fall seasons (and typically only portions of the summer), and the number and types of marine mammals observed may be biased by potential responses to noise from the airgun arrays. Marine mammals were also recorded during a research expedition from the southern Grand Banks, along the eastern slope, through the Flemish Pass, around the Orphan Basin, and through the northern Grand Banks on a return to St. John's in June and July 2004 (Lang and Moulton 2004).

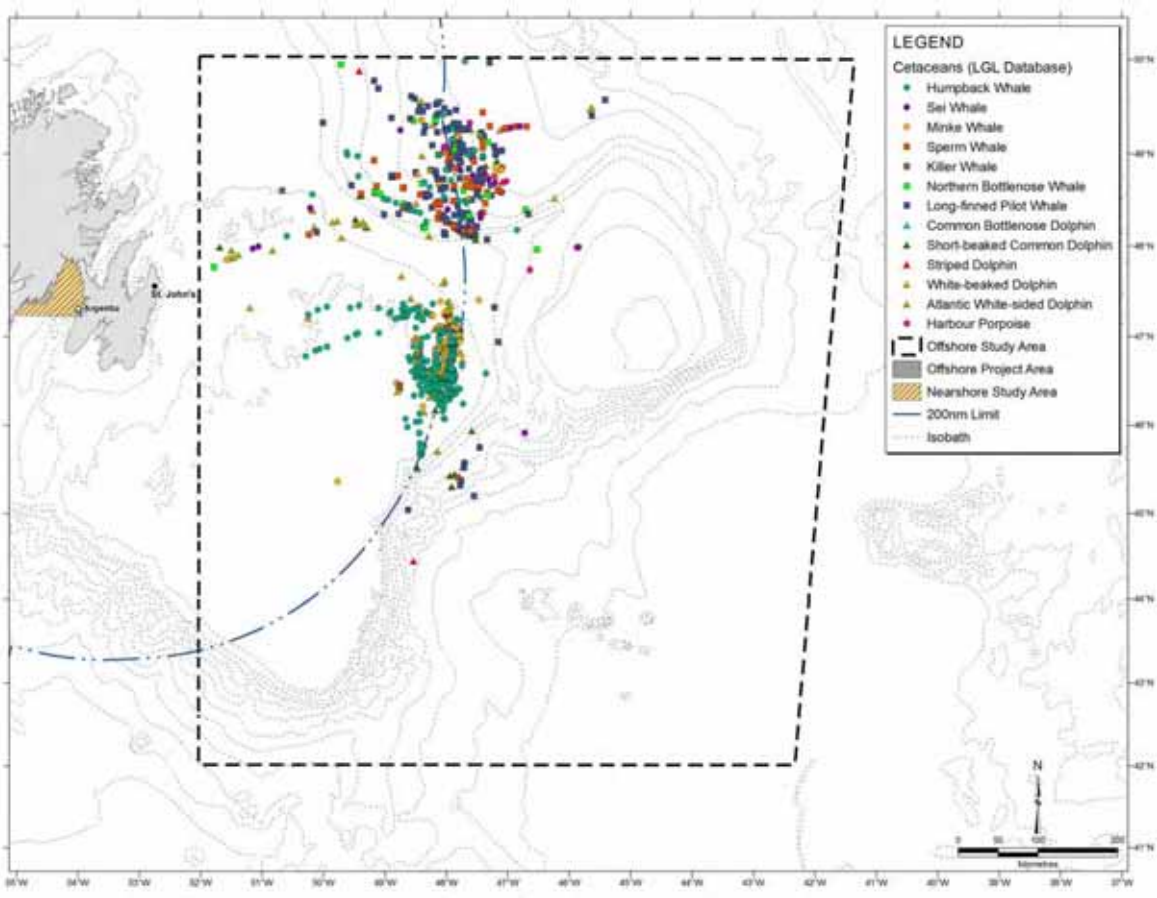
A summary of marine mammal sightings during the 2005 to 2008 seismic monitoring programs in the Jeanne d'Arc Basin is provided in Table 11-4.

**Table 11-4 Effort and Number of Marine Mammal Sightings in the Jeanne d'Arc and Orphan Basins during Monitoring Programs Conducted as a Component of Seismic Surveys, 2004 to 2008**

| Species | Jeanne d'Arc Basin | | | | Orphan Basin | | | | Total |
|---|---|---|---|---|---|---|---|---|---|
| | Oct-Nov 2005[A] | Jul-Aug 2006 [B] | Jun-Jul 2007 [C] | May-Sep 2008 [D] | Jun-Sep 2004[E] | May-Oct 2005[F] | Aug-Sep 2006[G] | Jul-Sep 2007[H] | |
| **Effort (km) [I]** | **1,895** | **2,731** | **2,511** | **6,734** | **10,894** | **3,874** | **3,145** | **3,851** | **35,634** |
| Humpback Whale | 27 | 178 | 5 | 138 | 13 | 36 | 1 | 9 | 407 |
| Blue Whale | -- | -- | -- | -- | -- | -- | -- | 2 | 2 |
| Sei Whale | 0 | 0 | 0 | 1 | 3 | 15 | 2 | -- | 21 |
| Fin or Sei Whale | 0 | 0 | 0 | 1 | 19 | 23 | 8 | 13 | 64 |
| Minke Whale | 4 | 12 | 1 | 31 | 6 | 8 | 1 | 2 | 65 |
| Unidentified Baleen Whale | 14 | 21 | 1 | 84 | 14 | 12 | 3 | 4 | 153 |
| **Total Baleen Whales** | **45** | **211** | **7** | **255** | **55** | **94** | **15** | **30** | **712** |
| Sperm Whale | -- | -- | -- | -- | 5 | 32 | 5 | 16 | 58 |
| Northern Bottlenose Whale | -- | -- | -- | -- | 3 | 7 | 2 | 4 | 16 |
| Sowerby's Beaked Whale | -- | -- | -- | -- | -- | 1 | -- | -- | 1 |
| Unidentified Beaked Whale | 1 | 0 | 0 | 1 | -- | -- | -- | -- | 2 |
| Unidentified Toothed Whale | 0 | 1 | 0 | 0 | 3 | 1 | -- | -- | 5 |
| **Total Large Toothed Whales** | **1** | **1** | **0** | **1** | **11** | **41** | **7** | **20** | **82** |
| Killer Whale | 1 | -- | -- | 21 | -- | -- | 1 | -- | 5 |
| Long-finned Pilot Whale | 0 | 2 | 1 | 2 | 45 | 101 | 14 | 9 | 174 |
| Common Dolphin | 1 | 7 | 0 | 0 | -- | 9 | 1 | 1 | 19 |
| Atlantic White-sided Dolphin | 2 | 7 | 0 | 24 | 5 | 17 | 6 | 10 | 71 |
| White-beaked Dolphin | 1 | 0 | 5 | 4 | -- | 6 | -- | 1 | 17 |
| Striped Dolphin | -- | -- | -- | -- | 1 | 2 | -- | -- | 3 |
| Bottlenose Dolphin | -- | -- | -- | -- | -- | 1 | -- | -- | 1 |
| Harbour Porpoise | -- | -- | -- | -- | 1 | 9 | -- | -- | 10 |
| Unidentified Dolphin | 2 | 28 | 5 | 41 | 10 | 53 | 4 | 22 | 165 |
| **Total Dolphins & Porpoises** | **7** | **44** | **11** | **71** | **62** | **198** | **25** | **44** | **461** |
| Unidentified Whale | 4 | 33 | 1 | 9 | 25 | 63 | 1 | 15 | 151 |
| **Total Cetaceans** | **56** | **289** | **19** | **336** | **153** | **396** | **48** | **109** | **1,406** |
| Harp Seal | 0 | 0 | 0 | 14 | 2 | 5 | -- | -- | 21 |
| Unidentified Seal | 0 | 2 | 0 | 22 | 2 | 5 | -- | -- | 31 |
| **Total Pinnipeds** | **0** | **2** | **0** | **36** | **4** | **10** | **--** | **--** | **52** |

(A) Husky seismic program from 1 October to 8 November 2005 (Lang et al. 2008)
(B) Husky seismic program from 9 July to 17 August 2006 (Abgrall et al. 2008a)
(C) Petro-Canada's seismic program from 18 June to 14 July 2007 (Lang and Moulton 2008)
(D) StatoilHydro and Husky's seismic program from 25 May to 28 September 2008 (Abgrall et al. 2009)
(E) Chevron Canada Resource's seismic program from 26 June to 18 September 2004 (Moulton et al. 2005) and Bedford Oceanographic Institute's research program from 21 June to 7 July 2004 (Lang and Moulton 2004)
(F) Chevron Canada Limited's seismic program from 12 May to 10 October 2005 (Moulton et al. 2006a)
(G) ExxonMobil Canada Ltd.'s seismic program from 11 August to 22 September 2006 (Abgrall et al. 2007)
(H) ExxonMobil Canada Ltd.'s seismic program from 20 July to 7 September 2007 (Abgrall et al. 2008a)
(I) Effort and sightings include those made in the designated "Seismic Analysis Area" or "Study Area" of each seismic program (i.e., the areas where seismic data were actually acquired plus a zone around this area where the seismic vessel made the majority of its turns at the end of seismic lines; effort and sightings during transit to and from the Jeanne d'Arc basin were excluded). See text of each report for specific coordinates, but all encompass Jeanne d'Arc and Orphan Basins and immediately adjacent areas

There were a total of 700 not at-risk cetacean sightings (including 518 baleen whale, three large toothed whale, 132 dolphin and porpoise, and 47 unidentified whale sightings) and 38 seal sightings within the Jeanne d'Arc Basin during seismic monitoring programs from 2005 to 2008. The majority of not at-risk baleen whale sightings identified to species consisted of humpback whales (91.3 percent of identified baleen whale sightings), followed by minke whales (12.6 percent). Most of the not at-risk dolphin and porpoise sightings in the Jeanne d'Arc Basin were of unidentified species (57.6 percent of dolphin and porpoise sightings), but Atlantic white-sided dolphins were the most frequently identified species (58.9 percent of identified dolphin and porpoise sightings). The harp seal was the only identified seal in Jeanne d'Arc Basin during these monitoring programs (14 of 38 seal sightings). The distribution of marine mammal sightings during these surveys, relative to the proposed Offshore Study Area, are shown in Figure 11-1.




Source: Lang and Moulton 2004, 2008; Moulton et al. 2005, 2006a; Lang 2007; Abgrall et al. 2008a, 2008b. 2009; Lang et al. 2008.

**Figure 11-1 Locations of Marine Mammal Sightings Observed during Jeanne d'Arc Basin and Orphan Basin Seismic Surveys (2004 to 2008), Relative to the Offshore Study Area**

Wiese and Montevecchi (1999) recorded 34 sightings of 282 individuals during the six round-trip surveys aboard a supply vessel travelling from St. John's to Jeanne d'Arc Basin. The majority of sightings were of humpback whales (11 sightings totalling 13 individuals). There were also sightings of minke and fin whales (eight and seven

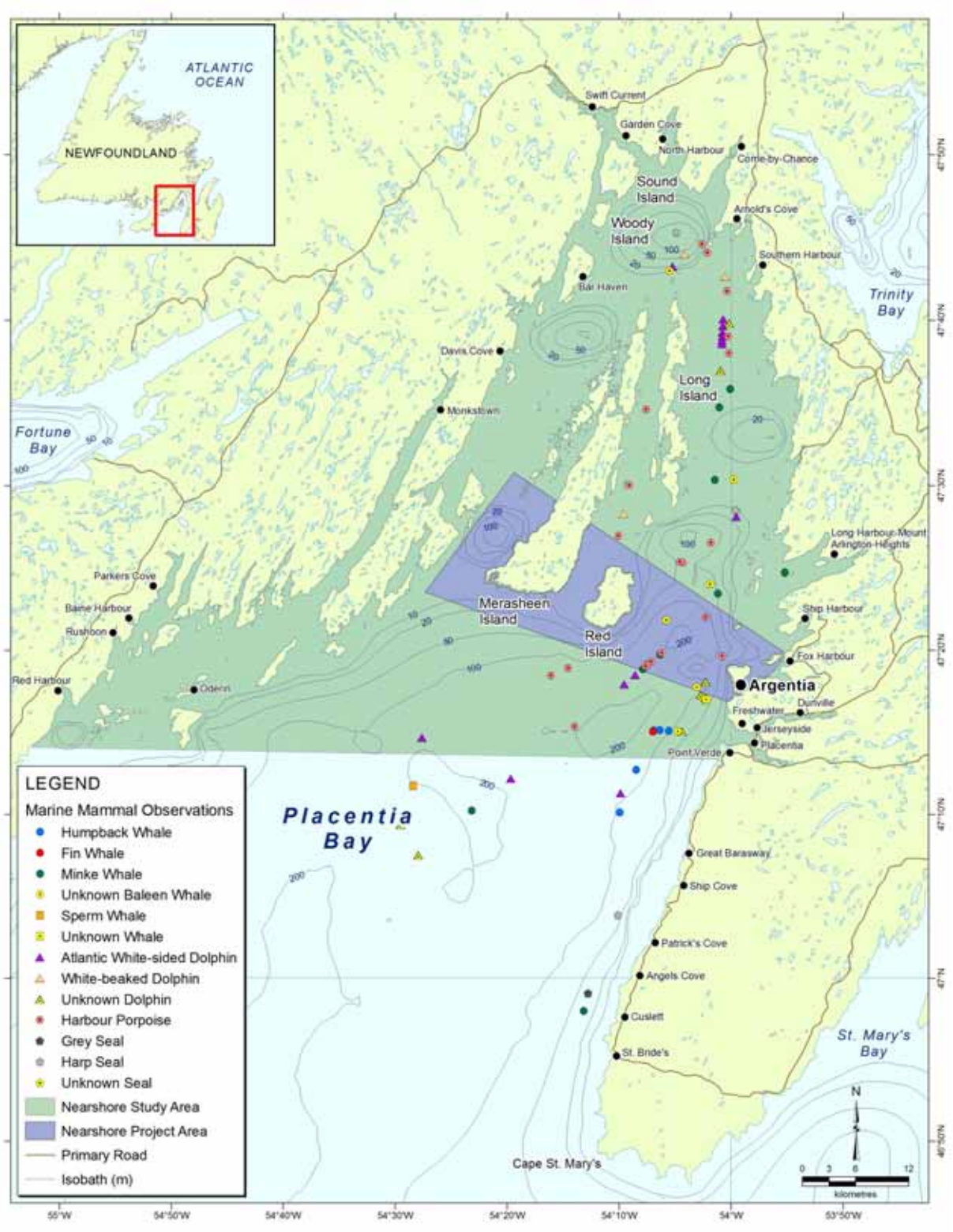
sightings, respectively). Most dolphin sightings were of Atlantic white-sided dolphins (seven sightings totaling 250 individuals). There was also a sighting of three killer whales recorded on August 24, 1999. Lang and Moulton (2004) reported 20 sightings of marine mammals during a June to July 2004 research cruise from the southern Grand Banks, around Orphan Basin, and across the northern Grand Banks; long-finned pilot whale was the most frequently sighted species (six sightings), although there were also several sightings of unidentified baleen whales and dolphins. Atlantic white-sided dolphin and fin whale were also identified. In the adjacent Orphan Basin, several years of monitoring during seismic and controlled source electromagnetic (CSEM) surveys during 2004 to 2008 have also yielded hundreds of sightings of marine mammals. Orphan Basin has much greater water depths than Jeanne d'Arc Basin and different species were more frequently encountered in the Orphan Basin (Table 11-3). For example, deep-diving sperm whale, northern bottlenose whale and Sowerby's beaked whale were identified on several occasions in the Orphan Basin, and there have also been sightings of blue whale, bottlenose dolphin and striped dolphin in the Orphan Basin (Moulton et al. 2005, 2006a; Abgrall et al. 2008b).

#### 11.3.1.2 Recent Marine Mammal Surveys in Placentia Bay

Surveys of eastern Placentia Bay for marine mammals and sea turtles were undertaken from August 2006 to April 2007 to provide baseline data for the environmental impact assessment of a proposed refinery (Abgrall and Moulton 2007). Three areas in the eastern portion of the bay were each sampled on a monthly basis, usually traversing a total of 291 to 312 km each month. A total of 1,548 km were surveyed on 15 days. Within the Nearshore Study Area, there were a total of 65 not at-risk species sightings (including 13 baleen whale, 23 dolphin, 21 porpoise, and one unidentified whale sightings) and seven seal sightings during the surveys (Table 11-5; Figure 11-2).

**Table 11-5 Number of Marine Mammal Sightings during Surveys in Placentia Bay in 2006 and 2006 within the Nearshore Study Area**

| Species | No. of Sightings | No. of Individuals | Month(s) Sighted |
|---|---|---|---|
| Fin Whale | 1 | 1 | Aug |
| Humpback Whale | 3 | 4 | Aug |
| Minke Whale | 7 | 7 | Mar-Apr, Aug |
| Unidentified Baleen Whale | 3 | 3 | Aug |
| Atlantic White-sided Dolphin | 14 | 144 | Mar, Aug-Oct |
| White-beaked Dolphin | 3 | 28 | Mar, Aug |
| Unknown Dolphin | 6 | 24 | Aug, Sep |
| Harbour Porpoise | 21 | 49 | Mar-Apr, Aug, Dec |
| Harp Seal | 2 | 4 | Mar |
| Unidentified Seal | 5 | 6 | Mar-Apr |
| Source: Abgrall and Moulton 2007. | | | |




Source: Abgrall and Moulton 2007.

**Figure 11-2 Locations of Marine Mammal Sightings Observed during Marine Mammal Surveys in Placentia Bay (2006 to 2007), Relative to the Nearshore Study Area**

### 11.3.1.3 Fisheries and Oceans Canada Cetacean Sighting Database

DFO in St. John's (J. Lawson 2009, pers. comm.) has compiled a database of cetacean sightings in waters around Newfoundland and Labrador. These data provide some indication of what species can be expected to occur in the area, but they cannot, at this point in the development of the database, provide any fine-scale quantitative information as the database typically does not include observation effort. The coarse summary data pertaining to sightings within the Nearshore and Offshore Study Areas are provided in Tables 11-6 and 11-7; caveats associated with the DFO data are also presented. The locations of the cetacean sightings in the Nearshore and Offshore Study Areas are depicted in Figures 11-3 and 11-4, respectively.

**Table 11-6 Fisheries and Oceans Canada Database Cetacean Sightings within the Nearshore Study Area, 1945 to 2007**

| Species | No. of Sightings | No. of Individuals | Month(s) Sighted |
|---|---|---|---|
| Sei Whale | 1 | 6 | Jul |
| North Atlantic Right Whale | 1 | 1 | Aug |
| Blue Whale | 1 | 5 | Aug |
| Fin Whale | 27 | 48 | Mar-Aug |
| Humpback Whale | 91 | 266 | Apr-Sep |
| Minke Whale | 12 | 23 | Apr-Jul, Nov |
| Sperm Whale | 2 | 2 | Sep |
| Narwhal | 1 | 1 | Jul |
| Killer Whale | 3 | 15 | Jul-Aug |
| Long-finned Pilot Whale | 17 | 646 | Jul-Oct |
| Atlantic White-sided Dolphin | 6 | 16 | Jun, Aug, Oct |
| Short-beaked Common Dolphin | 1 | 3 | Aug |
| White-beaked Dolphin | 16 | 200 | Apr-May, Jul-Sep |
| Unknown Dolphin | 11 | 130 | Apr, Jun-Oct |
| Harbour Porpoise | 16 | 17 | Jan, Mar, Jun-Sep, Nov-Dec |
| Other Unknown Cetacean | 21 | 34 | Jan, Mar, May-Aug, Nov |

Source: DFO cetacean sightings database (DFO 2007c); J. Lawson 2009, pers. comm.
Note the following caveats associated with the tabulated data:

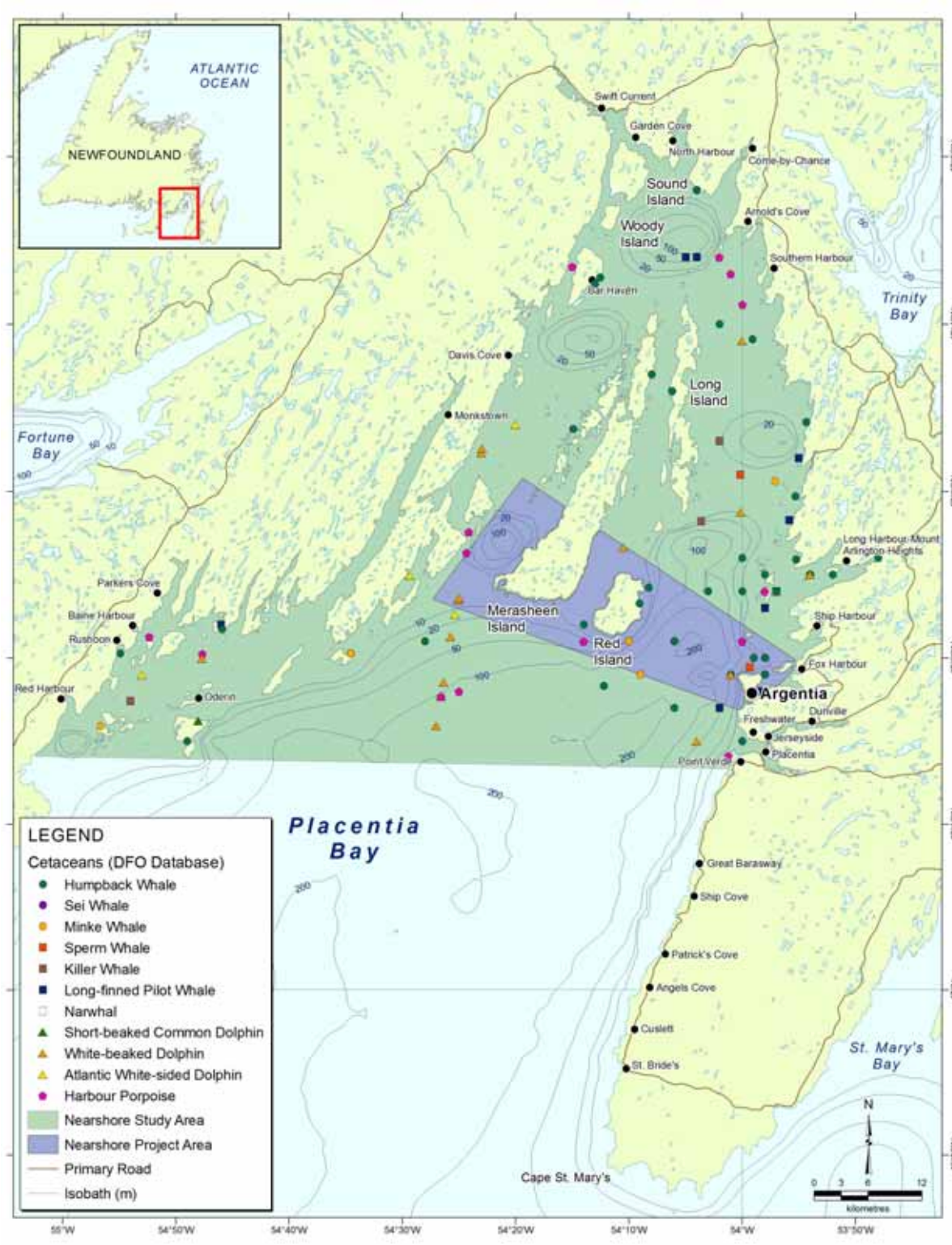
- The sighting data have not yet been completely error-checked.
- The quality of some of the sighting data is unknown.
- Most data have been gathered from platforms of opportunity that were vessel-based. The inherent problems with negative or positive reactions by cetaceans to the approach of such vessels have not yet been factored into the data.
- Sighting effort has not been quantified (i.e., the numbers cannot be used to estimate true species density or real abundance).
- 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.
- Numbers sighted have not been verified (especially in light of the significant differences in detectability among species).
- For completeness, these data represent an amalgamation of sightings from a variety of years (e.g., since 1945) and seasons. Hence, they may obscure temporal or real patterns in distribution (e.g., the number of pilot whales sighted in nearshore Newfoundland appears to have declined since the 1980s but the total number sighted in the database included here suggest they are relatively common).

**Table 11-7 Fisheries and Oceans Canada Cetacean Sightings Database within the Offshore Study Area, 1945 to 2007**

| Species | No. of Sightings | No. of Individuals | Month(s) Sighted |
|---|---|---|---|
| Sei Whale | 46 | 78 | May-Sep, Nov |
| Sei/Fin Whale | 16 | 23 | Jun-Sep |
| Fin Whale | 545 | 739 | Mar-Nov |
| North Atlantic Right Whale | 1 | 2 | Jun |
| Blue Whale | 7 | 11 | Apr-Aug |
| Humpback Whale | 921 | 2956 | Jan-Dec |
| Minke Whale | 217 | 413 | Jan, Mar-Dec |
| Unidentified Baleen Whale | 41 | 67 | May-Oct |
| Sperm Whale | 138 | 299 | Jan-Dec |
| Beluga Whale | 1 | 1 | Jul |
| Northern Bottlenose Whale | 19 | 87 | Mar, May-Sep |
| Sowerby's Beaked Whale | 1 | 4 | Sep |
| Killer Whale | 50 | 309 | Jan, Mar, May-Nov |
| False Killer Whale | 1 | 2 | Jun |
| Long-finned Pilot Whale | 350 | 5813 | Jan-Mar, May-Dec |
| Unknown Toothed Whale | 4 | 20 | Jul-Sep |
| Atlantic White-sided Dolphin | 79 | 1113 | Feb, Apr-Oct |
| Short-beaked Common Dolphin | 120 | 1954 | Jan, Mar, Apr, Jun-Dec |
| White-beaked Dolphin | 51 | 329 | Feb, Mar, May-Sep |
| Common Bottlenose Dolphin | 2 | 17 | Aug-Sep |
| Striped Dolphin | 4 | 19 | Aug, Sep |
| Unknown Dolphin | 347 | 7905 | Jan-Dec |
| Harbour Porpoise | 60 | 493 | Feb, Mar, May-Nov |
| Other Unknown Cetacean | 630 | 2456 | Jan-Dec |

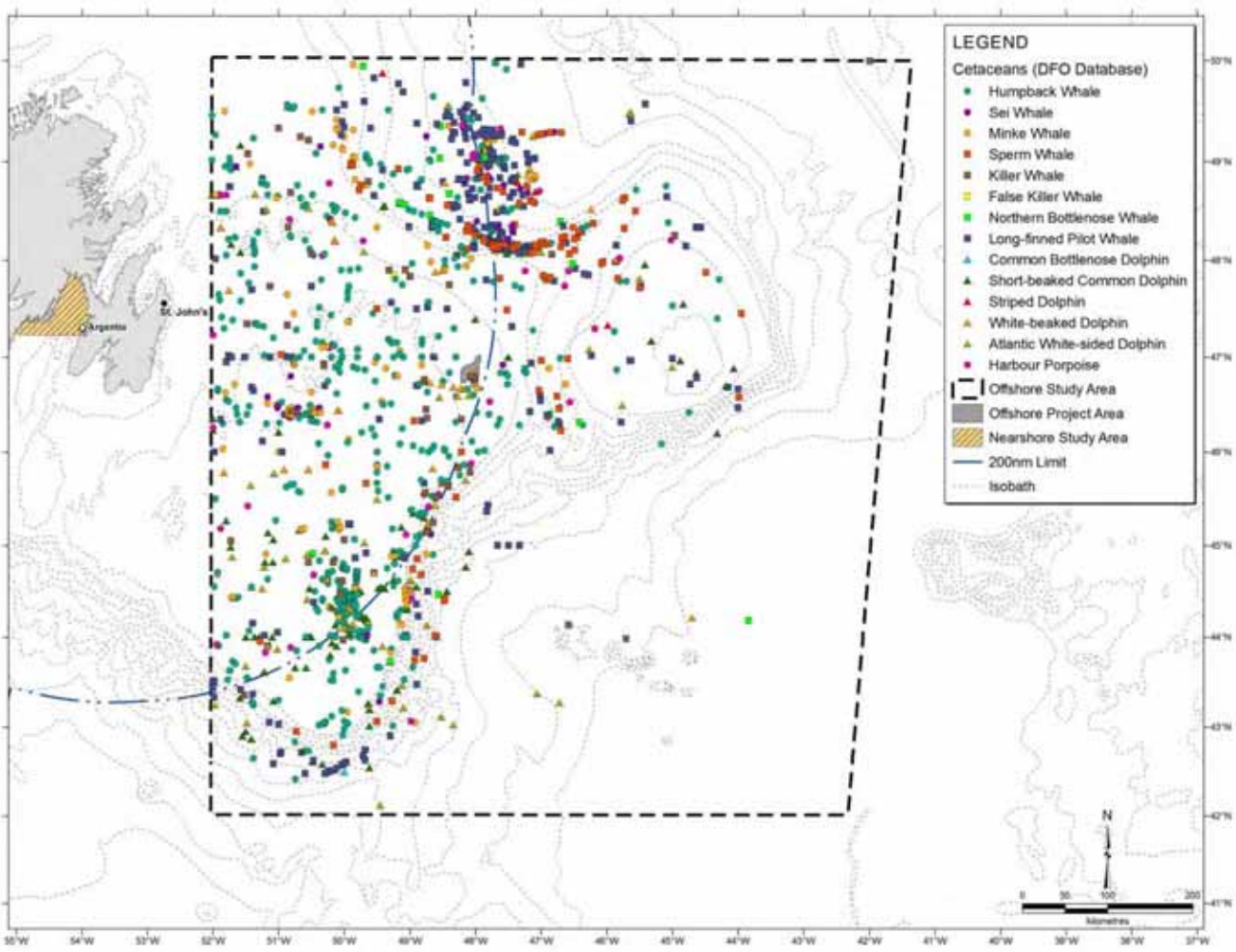
Source: DFO cetacean sightings database (DFO 2007c); J. Lawson 2009, pers. comm.
Note the following caveats associated with the tabulated data:

- The sighting data have not yet been completely error-checked.
- The quality of some of the sighting data is unknown.
- 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.
- Sighting effort has not been quantified (i.e., the numbers cannot be used to estimate true species density or real abundance).
- 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.
- Numbers sighted have not been verified (especially in light of the significant differences in detectability among species).
- For completeness, these data represent an amalgamation of sightings from a variety of years (e.g., since 1945) and seasons. Hence, they may obscure temporal or real patterns in distribution (e.g., the number of pilot whales sighted in nearshore Newfoundland appears to have declined since the 1980s but the total number sighted in the database included here suggest they are relatively common)




Source: DFO cetacean sightings database (DFO 2007); J. Lawson 2009, pers. comm.

**Figure 11-3 Locations of Historical Sightings of Marine Mammals in the Nearshore Study Area (1945 to 2007)**




Source: DFO cetacean sightings database (DFO 2007c); J. Lawson 2009, pers. comm.

**Figure 11-4 Locations of Historical Sightings of Marine Mammals in the Offshore Study Area (1945 to 2007)**

## 11.3.2 Species Profiles

### 11.3.2.1 Baleen Whales (Mysticetes)

Five species of baleen whales may occur in the Study Areas, two of which have garnered special status under SARA (see Section 12.3.2). Nearly all species of baleen whales became depleted due to commercial whaling, but it appears that some, including North Atlantic humpback whales, are showing signs of recovery (Best 1993). All of the species occurring in eastern Newfoundland presumably migrate to lower latitudes during winter months, although a small number of animals appear to remain in Newfoundland waters year-round. An aerial survey of cetaceans was conducted in the Northwest Atlantic during the summer of 2007 (Lawson and Gosselin 2009). The most common species sighted during the Newfoundland portion of this survey was the humpback whale, followed by minke and fin whales (Lawson and Gosselin 2009). It was noted that few small cetaceans were sighted in the Newfoundland and Labrador Strata despite

good conditions and considerable effort. This may have resulted from the late arrival of cetaceans in the Newfoundland and Labrador region in 2007, as borne out by reports from fisheries officers, fishers and tour operators, and the fact that more marine mammal sightings were recorded late in the survey (Lawson and Gosselin 2009).

Each summer, most baleen whales arrive in Placentia Bay in late spring or early summer and the more abundant species remain until September or October. They feed primarily on capelin, but also feed on krill, squid, herring and sand lance. The whales follow the migration of capelin and are common around inshore Newfoundland during the summer. The arrival of capelin to the head of Placentia Bay generally occurs in June and July and it is likely that baleen whales would be most abundant during these months. Most whales have moved offshore and have begun to migrate south by late October (Lien 1985). The density of baleen whales (minke, fin, humpback and unidentified baleen whales combined) based upon recent boat-based surveys in the Nearshore Study Area during August 2006-April 2007 was 0.008 baleen whales per $km^2$ (Abgrall and Moulton 2007).

**Humpback Whale**

Humpback whales have a cosmopolitan distribution, but typically occur in coastal regions or over the continental shelf (Jefferson et al. 2008). There are an estimated 11,570 individuals in the North Atlantic (Stevick et al. 2003), but Whitehead (1982) estimated a total of 1,700 to 3,200 animals in the Newfoundland and Labrador population. On the Southeast Shoal of the Grand Banks, approximately 900 individuals were estimated to use the area for summer foraging on capelin, their primary prey in Newfoundland waters (Whitehead and Glass 1985). The North Atlantic population is thought to be increasing (Stevick et al. 2003) and is no longer listed under SARA (COSEWIC 2003a).

Humpback whales undergo annual migrations from summer foraging grounds in high latitudes to tropical breeding grounds during the winter. Four distinct summer foraging concentration areas in the North Atlantic have been described, based on genetic and individual identification studies: the Gulf of Maine, eastern Canada, western Greenland, and the eastern North Atlantic (Stevick et al. 2006). Winter breeding occurs in the West Indies in three primary areas: the Virgin Bank, Puerto Rico, and the Dominican Republic (Katona and Beard 1990). Additionally, not all individuals migrate to the tropics each year, with some presumably remaining near their foraging grounds in mid- and high-latitudes during winter (Clapham et al. 1993).

Humpback whales often occur singly or in small groups of two to three, but large aggregations can occur in feeding or breeding areas (Clapham 2000). Hay (1982) reported an average group size of 2.87 animals (ranging from one to eight) for an August 1980 aerial survey off Newfoundland and Labrador, similar to group sizes of 1 to 10 observed on the Southeast Shoal of the Grand Banks during June and July of 1982 and 1983 (Whitehead and Glass 1985). During summer feeding periods, humpbacks generally dive for less than five minutes, and dives that last greater than 10 minutes are atypical (Clapham and Mead 1999).

The humpback whale is common in Newfoundland waters, especially during summer. Humpbacks begin arriving in offshore areas by April and remain until October; they occur in inshore areas primarily from June to September. Some humpbacks likely stay in Newfoundland waters year-round. In the Jeanne d'Arc Basin, humpback whales were

the most commonly sighted baleen whale during each seismic survey from 2005 to 2008, making up approximately 91 percent of the identified not at-risk baleen whale sightings (Table 11-3, Figure 11-1). They were also the most frequently sighted baleen whale species in the Orphan Basin during seismic monitoring programs in 2004 and 2005 (Moulton et al. 2005, 2006a) and the second most frequently sighted baleen whale species during CSEM monitoring programs in 2006 and 2007 (Abgrall et al. 2008b). The humpback whale was the most frequently reported species in the DFO cetacean sightings database (DFO 2007c) in the Offshore Study Area (Table 11-6, Figure 11-2).

Humpback whales also frequently occur during the summer period in Placentia Bay. Abundance peaks during June and July (DFO cetacean sightings database (DFO 2007c)), but some arrive as early as mid-April (Abgrall and Moulton 2007). The inshore abundance of humpback whales (and other baleen whale species) is related to the relative abundance of prey species, primarily capelin (Piatt et al. 1989). In coastal areas of northern Newfoundland, humpback whales were most frequently observed feeding in waters less than 1.9 km (1 nm) from shore, although they also occurred in areas greater than 9 km (5 nm) from shore (Perkins and Whitehead 1977). A humpback whale density of 0.004 individuals per km² was observed during an aerial survey conducted in Placentia Bay on 6 August 1980 (Hay 1982). The humpback whale was the most frequently reported species in the DFO cetacean sightings database (DFO 2007c) in the Nearshore Study Area (Table 11-6, Figure 11-3). During recent boat-based surveys of Placentia Bay, four sightings of humpbacks (five individuals) occurred in August 2006; no humpbacks were identified in September or October (Abgrall and Moulton 2007). All humpback sightings occurred west and southwest of Placentia within approximately 10 km of the coast (Figure 11-2).

Thus, humpback whales are common in both the Offshore and Nearshore Study Areas during early summer to fall, and a smaller number of animals may be present year-round.

**Sei Whale**

The distribution of sei whales is not well understood, but it is found in all oceans and appear to prefer mid-latitude temperate waters (Jefferson et al. 2008). There are two stocks of sei whales recognized in the Northwest Atlantic: a more well-known Nova Scotia stock whose distribution extends from the northeast US to southern Newfoundland; and a Labrador Sea stock (Waring et al. 2009). The Nova Scotia stock is estimated to contain 207 individuals, but there is no current population estimate for the Labrador Sea stock (Waring et al. 2009). It is unclear to which population animals occurring off eastern Newfoundland belong.

Sei whales tend to be found in pelagic regions, most often in areas with steep bathymetric relief like continental shelf breaks, seamounts, canyons, or basins near banks and ledges (Kenney and Winn 1987; Gregr and Trites 2001). Sei whale typically occurs alone or in groups of two to five, and females are larger than males (Jefferson et al. 2008). Although it sometimes consume small fish, primary prey consists of euphausiids and copepods (Flinn et al. 2002).

Mitchell and Chapman (1977) hypothesized that sei whales in the Northwest Atlantic are migratory, moving from spring feeding areas on or near Georges Bank to the Scotian Shelf in June and July, eastward to Newfoundland and the Grand Banks in late summer,

back to the Scotian Shelf in fall, and offshore and south during winter. These authors estimated a minimum stock size of 870 individuals, based on mark-recapture data from the 1960s to 1970s. During seismic surveys in the Jeanne d'Arc Basin, there has been one confirmed sei whale sighting and one possible sighting (either a sei or fin whale) (Table 11-4, Figure 11-3). However, sei whales were encountered several times in the Orphan Basin (Moulton et al. 2005, 2006a; Abgrall et al. 2008b). There were at least 46 sei whale sightings reported in the DFO cetacean sightings database (DFO 2007c) in the Offshore Study Area (Table 11-7, Figure 11-4). The available information suggests that sei whales are present during summer and fall months, but are likely uncommon, in the Offshore Study Area.

There is little information on the status of sei whales in Placentia Bay, but the sei whale tends to be a more pelagic species and is not typically reported in coastal Newfoundland. In addition, it is often difficult to differentiate between sei whales and fin whales in the field. It is possible that some reports of fin whales could actually be sei whales. There was one sighting of six sei whales reported in the DFO cetacean sightings database (DFO 2007c) (Table 11-6) and none during marine mammal surveys in the Nearshore Study Area (Figure 11-2). Given the information available, sei whales are expected to be rare in the Nearshore Study Area throughout the year.

**Minke Whale**

The smallest of the baleen whales, the minke whale is cosmopolitan in distribution and can be found in polar, temperate and tropical waters (Jefferson et al. 2008). Four populations are recognized in the North Atlantic: the Canadian east coast, west Greenland, central North Atlantic, and northeastern North Atlantic stocks (Waring et al. 2009). An estimated 3,312 individuals occur in the Canadian east coast stock, which ranges from the continental shelf of the northeast US to the eastern half of Davis Strait (Waring et al. 2009).

Minke whales often occur singly or in small groups of two or three, although large aggregations can form in areas where prey concentrates (Jefferson et al. 2008). Off coastal portions of northern Newfoundland, Perkins and Whitehead (1977) most frequently observed single minke whales, but groups of up to five animals were occasionally observed. Occasionally minke whales approach vessels, but their small size, inconspicuous blows, and brief surface durations can make them otherwise challenging to detect at sea (Stewart and Leatherwood 1985). Foraging typically occurs over the continental shelf on small schooling fish, and minke whales appear to make short duration dives (Stewart and Leatherwood 1985). Seasonal movements in many parts of the world have been noted and generally mirror the abundance and distribution of their primary prey species (Macleod et al. 2004). Their presence in the Gulf of St. Lawrence has also been linked to thermal fronts that presumably function to concentrate prey (Doniol-Valcroze et al. 2007).

Minke whales regularly occur in coastal areas and the offshore banks of eastern Newfoundland. In the Jeanne d'Arc Basin, minke whale was the second most frequently observed not at-risk baleen whale (after humpback whales) during seismic monitoring programs, representing approximately 13 percent of all identified not at-risk baleen whale sightings (Table 11-4, Figure 11-1). There were also multiple minke whale sightings each year during monitoring programs in the Orphan Basin (Table 11-4, Figure 11-1). Minke whales were commonly reported in the DFO cetacean sightings

database in the Offshore Study Area (Table 11-7, Figure 11-4). Thus, minke whales can be considered common in the Offshore Study Area, particularly from late spring to early fall.

The coastal presence of minke whales in eastern Newfoundland is linked to the presence and abundance of capelin (Sergeant 1963), with minke whales the second most frequently observed species (after humpback whales) in nearshore areas (Piatt et al. 1989). Boat-based surveys conducted in the southeastern area of Placentia Bay (near Cape St. Mary's) in 1993 and 1994 found relative abundances of 0.26 and 0.66 minke whales per hour, respectively (Marques 1996). Twelve records of minke whale sightings were reported in the DFO cetacean sightings database (DFO 2007c) for the Nearshore Study Area (Table 11-6, Figure 11-3). Given the available information, minke whales are expected to be common in Placentia Bay during summer and are likely present at lower densities in early spring and winter.

#### 11.3.2.2 Toothed Whales (Odontocetes)

Twelve species of toothed whales may occur in the two Study Areas (see Table 11-2). These species include the sperm whale, the largest living toothed whale (approximately 18 m for an adult male (Reeves and Whitehead 1997)), as well as one of the smallest odontocetes, the harbour porpoise (approximately 1.6 m for an average adult (COSEWIC 2006a)). Many of these species occur seasonally in the Study Areas, but little is known about their distribution and population sizes.

**Sperm Whale**

Sperm whales are widely distributed, occurring from the edge of polar pack ice to the equator, but is most common in tropical and temperate waters (Jefferson et al. 2008). Whitehead (2002) estimated a total of 13,190 sperm whales for the Iceland-Faroes area, the area northeast of it, and the east coast of North America combined, but Waring et al. (2009) estimated a total of only 4,804 sperm whales in the North Atlantic.

Sperm whale abundance and distribution in an area can vary in response to prey availability, particularly mesopelagic and benthic squid (Jaquet and Gendron 2002; Jaquet et al. 2003). Sperm whales tend to occur in deep waters off the continental shelf, particularly areas with high secondary productivity and steep slopes (Jaquet and Whitehead 1996; Waring et al. 2001). Distribution has also been linked to warm core rings of the Gulf Stream off the US continental shelf, with sightings occurring in water depths from 1,539 to 4,740 m deep (Griffin 1999). Sperm whales routinely dive to hundreds of metres, with maximum depths up to 3,000 m; foraging dives may last up to an hour and occur at depths below 1,000 m (Whitehead and Weilgart 2000).

Males tend to range farther north than females, making sperm whales encountered in eastern Newfoundland more likely to be males. Adult females and juveniles form large aggregations in warm tropical and sub-tropical regions, but males typically occur singly or in small same-sex groups and occur at higher latitudes (Whitehead et al. 1992; Whitehead and Weilgart 2000; Whitehead 2003). However, males can also sometimes form large aggregations of 20 to 30 individuals (Whitehead 2003), and mixed groups containing females and juveniles have occasionally been observed in higher latitudes (e.g., Whitehead and Weilgart 2000).

No sperm whales were observed within the Jeanne d'Arc Basin during seismic monitoring programs, but were regularly sighted in deeper waters of Orphan Basin (Table 11-4, Figure 11-1). Sperm whales were commonly reported in the DFO cetacean sightings database (DFO 2007c) in the Offshore Study Area (Table 11-5, Figure 11-4). Sperm whales may periodically occur in the Offshore Study Area, but are relatively uncommon; they would most likely be found in deeper portions of the Offshore Study Area and during summer months. It has been noted that sperm whales have been attracted to fishing operations on the Grand Banks and, therefore, may approach other vessels as well (DFO, pers. comm.).

Sperm whales have rarely been observed in coastal Newfoundland, and would be most likely in areas with deep water and steep slopes. There were two sightings of sperm whales reported in the DFO cetacean sightings database (DFO 2007c) in the Nearshore Study Area (Table 11-6, Figure 11-3). One was sighted a few kilometres south of the Nearshore Study Area during boat-based surveys in October 2006 (Abgrall and Moulton 2007). Thus, sperm whale occurrences are expected to be uncommon in the Nearshore Study Area.

**Long-finned Pilot Whale**

Long-finned pilot whales are widespread in the North Atlantic (Jefferson et al. 2008). There is an estimated 31,139 individuals in the Northwest Atlantic (although that number could also contain some short-finned pilot whales) (Waring et al. 2009), and they are abundant year-round residents of Newfoundland waters (Nelson and Lien 1996). Hay (1982) estimated a total of 13,167 individuals in eastern Newfoundland and southern Labrador waters.

Pilot whales are sexually dimorphic, such that males are longer than females and have larger dorsal fins as well as more pronounced melons (Jefferson et al. 2008). Pilot whales studied in Nova Scotia seem to form long-term social groups of related individuals, with minimal dispersal from natal groups (Ottensmeyer and Whitehead 2003). Average group size was 20 individuals, but ranged from 2 to 135 (Ottensmeyer and Whitehead 2003). Pilot whales appear to associate with the continental shelf break, slope waters and areas of high sub-surface relief, and often have inshore-offshore movements that coincide with their prey (Jefferson et al. 2008). Primary prey in nearshore Newfoundland has been identified as short-finned squid (Sergeant 1962), but they are also known to consume other species of cephalopod and fish (Nelson and Lien 1996).

Pilot whales are regular inhabitants of eastern Newfoundland. In the Jeanne d'Arc Basin, pilot whales were observed during all but the late fall 2005 seismic monitoring programs, and were also frequently sighted in the Orphan Basin (Table 11-4, Figure 11-1). The long-finned pilot whale was the second most frequently sighted not at-risk species in the Offshore Study Area, according to the DFO cetacean sightings database (DFO 2007c) (Table 11-7, Figure 11-4). Long-finned pilot whales are expected to be common year-round in the Offshore Study Area, particularly during summer and fall.

Pilot whales also frequently occur in coastal Newfoundland. Prior to 1900, small harvests of pilot whales were taken in Newfoundland bays by whalers and fishermen driving groups ashore. There have been 17 sightings of long-finned pilot whales in the Nearshore Study Area recorded in DFO's cetacean sightings database (DFO 2007c)

(Table 11-6, Figure 11-3); pilot whales are most frequently recorded in July (DFO, unpublished data). Eighty-two percent of these sightings occurred during June to August, with pilot whales most frequently recorded in July (DFO, unpublished data). However, no pilot whales were sighted in Placentia Bay during an aerial survey on 6 August 1980 (Hay 1982). Also, no pilot whales were sighted during boat-based surveys conducted in 2006-2007 (Abgrall and Moulton 2007). Long-finned pilot whales may occur in the Nearshore Study Area year-round.

**Risso's Dolphin**

Risso's dolphins are widely distributed in tropical and warm temperate oceans (Jefferson et al. 2008). In the Northwest Atlantic, 20,479 individuals are estimated to occur from Florida to eastern Newfoundland (Waring et al. 2009). Eastern Canada appears to be at the northern limit of the Risso's dolphin's range, where an unknown number occur, but are considered rare (Baird and Stacey 1991).

Risso's dolphin group sizes generally range from 10 to 100 animals, but groups of up to 4,000 individuals have been reported (Jefferson et al. 2008). They are often sighted in association with other cetacean species, and are thought to be deep divers. Squid are presumed to be their primary prey, but Risso's dolphin also consumes crustaceans and other cephalopods (Jefferson et al. 2008). Risso's dolphin is primarily associated with steep portions of the continental slope that may concentrate cephalopod prey (Baumgartner 1997). Off the northeast US coast, they are distributed along the continental shelf edge during spring, summer, and autumn, but range into pelagic regions during winter (Waring et al. 2009).

Risso's dolphins are relatively abundant in warm temperate and tropical waters, but rarely range as far north as eastern Canada waters (Baird and Stacey 1991). In the Jeanne d'Arc Basin, there have been no sightings of Risso's dolphin during summer and fall monitoring programs (Table 11-4), nor have any been recorded in the deeper Orphan Basin (Table 11-4). Also, Risso's dolphin has not been recorded in the DFO cetacean sightings (Table 11-7). While Risso's dolphin may occur in the Offshore Study Area, particularly deeper portions, its presence is likely to be rare.

There are no published records of Risso's dolphin occurring in coastal Newfoundland waters (nor stranding records). Given the available information on Risso's dolphin occurrence and preference for deep waters, their presence in the Nearshore Study Area is likely to be very rare.

**Common Bottlenose Dolphin**

Bottlenose dolphins are distributed widely in tropical and temperate waters, occupying a variety of habitats (Jefferson et al. 2008). In the Northwest Atlantic, there are two morphologically and genetically distinct stocks, referred to as the coastal and offshore forms (Hoelzel et al. 1998). The offshore form tends to occur along the outer continental shelf and slope in the Northwest Atlantic, while the coastal form occurs from New York to the Gulf of Mexico along the Atlantic coast (Waring et al. 2009). The population of the offshore form, potentially ranging into eastern Newfoundland waters, is estimated to contain 81,588 individuals (Waring et al. 2009).

Groups of 2 to 15 animals are common among bottlenose dolphins, but they can also be observed offshore in groups of hundreds (Shane et al. 1986). Group organization can be fluid or long-term and is based on several factors like age, sex, individual relatedness and reproductive condition (Connor et al. 2000). Bottlenose dolphins consume a variety of fish species, cephalopods and shrimp by employing a number of foraging strategies (Connor et al. 2000).

The distribution of bottlenose dolphins in higher latitudes appears to be seasonal, with a more northerly range during summer months (Shane et al. 1986). Bottlenose dolphins are considered at the northern limit of their range in eastern Newfoundland waters (Baird et al. 1993b). None were sighted during the monitoring programs in the Jeanne d'Arc Basin (Table 11-4), but there was a single sighting of 15 individuals in the Orphan Basin (Moulton et al. 2006a). There were two bottlenose dolphin sightings reported in the DFO cetacean sightings database (DFO 2007c) (Table 11-7). While it is possible that bottlenose dolphins will occur in the Offshore Study Area, particularly during summer, they are likely to be rare.

There are no published records of bottlenose dolphins in nearshore eastern Newfoundland and this species was not recorded in the DFO cetacean sightings database (DFO 2007c) (Table 11-6). The available information suggests that bottlenose dolphins will not occur in the Nearshore Study Area.

**Short-beaked Common Dolphin**

The short-beaked common dolphin is widely distributed over the continental shelf in temperate, tropical and subtropical regions (Jefferson et al. 2008). In the Northwest Atlantic, its distribution ranges up to 47°N to 50°N off of Newfoundland (Jefferson et al. 2009). An estimated 120,743 individuals reside in the Northwest Atlantic (Waring et al. 2009), but an unknown number are found in eastern Canada (Gaskin 1992).

Short-beaked common dolphins form groups ranging in size from several dozens to over 10,000, often moving rapidly with many aerial behaviours such as porpoising and bowriding (Jefferson et al. 2008). They are found in a variety of habitats, ranging from 100 to 2,000 m deep, but appear to prefer areas with high seafloor relief (Selzer and Payne 1988) and are often associated with features of the Gulf Stream (Hamazaki 2002). The abundance and distribution of short-beaked common dolphin also coincides with peaks in abundance of mackerel, butterfish and squid (Selzer and Payne 1988).

Gaskin (1992) indicated that common dolphins can be abundant off the coast of Nova Scotia and Newfoundland for a few months during the summer. Whitehead and Glass (1985) reported seven sightings of common dolphins during surveys on the Southeast Shoal of the Grand Banks in June and July of 1982 and 1983, with group sizes ranging from 5 to 50 individuals. There were eight sightings of common dolphins on the Jeanne d'Arc Basin during seismic monitoring programs (Table 11-4). During monitoring programs in the adjacent Orphan Basin, there were a total of 11 common dolphin sightings (Table 11-4). There were 120 sightings of common dolphins reported in the DFO cetacean sightings database (DFO 2007c) in the Offshore Study Area (Table 11-7). During summer, it is likely that short-beaked common dolphins will occur in the Offshore Study Area.

Nearshore sightings of common dolphins in eastern Newfoundland are less frequent than offshore sightings. One sighting of three common dolphins in the Nearshore Study Area was recorded in the DFO cetacean sightings database (DFO 2007c); this sighting was made in August (Table 11-6). No common dolphins were identified during recent boat-based surveys in Placentia Bay (Abgrall and Moulton 2007). Migration of common dolphins onto the continental shelf off Newfoundland occurs during summer and autumn when water temperatures exceed 11°C (Sergeant et al. 1970). While they occur in Placentia Bay, the occurrence of common dolphins in the Nearshore Study Area is likely uncommon.

**Striped Dolphin**

Striped dolphins are widely distributed in global warm temperate to tropical waters, with its northern range in the Atlantic Ocean extending into eastern Canada waters (Baird et al. 1993a). There are an estimated 94,462 striped dolphins in the Northwest Atlantic (Waring et al. 2009), but an unknown number use eastern Canada waters (Baird et al. 1993a).

Striped dolphins can form large groups of thousands of animals, but usually is found in group sizes of several dozen to 500 (Jefferson et al. 2008). Preferred habitats for striped dolphins include deep water areas along the edge and seaward of the continental shelf, especially areas with warm currents (Baird et al. 1993a). Striped dolphin distribution has also been associated with upwelling area or convergence zones (Au and Perryman 1985). Archer and Perrin (1999) suggested that striped dolphins are feeding at depths of 200 to 700 m, with small mid-water fishes or squid representing their primary prey. Sightings off the northeastern US coast have been focused along the 1,000-m depth contour in all seasons and associated with the northern edge of the Gulf Stream and warm core rings (Waring et al. 2009).

Offshore waters of the Grand Banks are considered to be at the northern limit of the striped dolphin's range. No striped dolphins have been observed within Jeanne d'Arc Basin (Table 11-4), but a group of approximately 25 individuals was sighted in the southern portion of the Offshore Study Area in September 2008 (Abgrall et al. in prep.). During monitoring programs in the Orphan Basin, there were a total of three sightings (Table 11-4). There were four sightings of striped dolphins in the DFO cetacean sightings database (DFO 2007c) in the Offshore Study Area (Table 11-7). The available information suggests that the presence of striped dolphins is likely to be uncommon in the Offshore Study Area, but they could potentially occur there during summer and fall.

There are no published records of striped dolphins occurring in coastal regions of eastern Newfoundland and this species was not recorded in the DFO cetacean sightings database (DFO 2007c) in the Nearshore Study Area (Table 11-6). Based on the paucity of striped dolphin nearshore records and the species apparent preference for deep shelf edge and offshore waters, it is unlikely that striped dolphins will occur in the Nearshore Study Area.

**Atlantic White-sided Dolphin**

Atlantic white-sided dolphins are found in temperate and sub-Arctic regions of the North Atlantic, primarily in deep waters of the outer continental shelf and slope (Jefferson et al. 2008). At least three distinct stocks (Gulf of Maine, Gulf of St. Lawrence and Labrador

Sea) may occur in the North Atlantic, but this has not been confirmed (Waring et al. 2009). There is an estimated 63,368 individuals in the Northwest Atlantic (Waring et al. 2009), but their abundance off eastern Newfoundland is unknown.

Atlantic white-sided dolphins are gregarious, with an average group size of 52 and ranging from two to 2,500; larger group sizes tend to be observed from August to October (Weinrich et al. 2001). Calving appears to occur from May to August, but peaks in June and July (Weinrich et al. 2001). Prey items range from cephalopods to pelagic or benthopelagic fishes like capelin, herring, hake, sand lance and cod (Selzer and Payne 1988; Weinrich et al. 2001). Primary habitat appears to coincide with the 100-m depth contour of the continental shelf, with sightings more common in areas with high sub-surface relief with low sea surface temperatures and salinity (Selzer and Payne 1988).

Atlantic white-sided dolphins are regular inhabitants of eastern Newfoundland waters. They were the most frequently identified dolphin species during four years of summer and fall monitoring programs in the Jeanne d'Arc Basin (Table 11-4). Atlantic white-sided dolphins were also frequently observed in and near Orphan Basin (Table 11-4). There were 79 sightings of Atlantic white-sided dolphins reported in the DFO cetacean sightings database (DFO 2007c) in the Offshore Study Area (Table 11-7). The available data indicates that Atlantic white-sided dolphins are common in the Offshore Study Area, particularly from June to October.

Based on the DFO cetacean sightings database (DFO 2007c), this species appears to have a scattered distribution along the south coast of Newfoundland. Six sightings of white-sided dolphins have been recorded in the Nearshore Study Area in June, August, and October (Table 11-6). This species was observed along all three survey routes in the Nearshore Study Area, with a cluster of sightings east of Long Island and two sightings in the middle of Placentia Bay during September (Figure 11-2). White-sided dolphin is expected to be common in the Nearshore Study Area, mostly from June to September.

**White-beaked Dolphin**

White-beaked dolphins occur in cold temperate and sub-Arctic waters in the North Atlantic and have a more northerly distribution than most other dolphin species (Jefferson et al. 2008). There are an estimated 2,003 individuals in the Northwest Atlantic (Waring et al. 2009), but it is unknown how many occur off eastern Newfoundland.

Sometimes white-beaked dolphins are observed in association with other cetacean species, and group sizes are typically less than 30 individuals; however, groups sizes ranging up to many hundreds have been recorded (Lien et al. 2001). Prey items include squid, crustaceans and a variety of small mesopelagic and schooling fishes like herring, cod, haddock and hake (Jefferson et al. 2008). White-beaked dolphin are generally observed in continental shelf and slope areas, but are also known to use shallow coastal regions (Lien et al. 2001). It is presumed that white-sided dolphin remains at relatively high latitudes throughout the fall and winter (Lien et al. 2001).

While less common than some other dolphin species, white-beaked dolphin is thought to be a year-round resident of eastern Newfoundland. White-beaked dolphin was seen during each summer and fall in the Jeanne d'Arc Basin, other than 2006 (Table 11-4).

White-beaked dolphins were also sighted in and near the Orphan Basin (Table 11-4). There were 51 sightings of white-beaked dolphin reported in the DFO cetacean sightings database (DFO 2007c) in the Offshore Study Area (Table 11-7). Given the available information, white-beaked dolphin appears to be common in the Offshore Study Area, especially during spring-fall.

White-beaked dolphins also occur in nearshore areas of eastern Newfoundland. Sergeant and Fisher (1957) suggested that white-beaked dolphins tend to occur in coastal Newfoundland during spring and fall, from at least March to May and October to November, with smaller group sizes (usually six to eight individuals) than those of Atlantic white-sided dolphins.

Hay (1982) estimated a total of 5,539 individuals occur in eastern Newfoundland and southern Labrador based on observations during an August 1980 aerial survey, noting that high densities were recorded in Fortune and Placentia bays. Sightings of white-beaked dolphins have been recorded in the Nearshore Study Area from April to September, with the majority of sightings in August (DFO, unpublished data). There were 16 sightings of white-beaked dolphin reported in the DFO cetacean sightings database (DFO 2007c) in the Nearshore Study Area (Table 11-6). During boat-based surveys in the Nearshore Study Area, white-beaked dolphins were observed in August (two sightings of 20 dolphins) and March (one sighting of eight individuals; Figure 11-2; Abgrall and Moulton 2007). Sightings occurred north of Long Island and north of Red Island (Figure 11-2). Ice entrapments of this species along the Newfoundland northeast, south and west coasts (Hai et al. 1996), suggest that like blue whales, some white-beaked dolphins remain associated with the ice edge through winter (J. Lawson, DFO, pers. comm.). As many as 150 white-beaked dolphins were trapped by pack ice near Point Verde, Placentia Bay, in March 1983 (Hai et al. 1996). White-beaked dolphin is likely common in the Nearshore Study Area during spring and fall, although it is generally less common than other dolphin species.

#### 11.3.2.3 True Seals (Phocids)

Four species of seals are known to occur in the Nearshore and Offshore Study Areas (see Table 11-3). Several fish species (primarily cod, capelin, sand lance and halibut) and invertebrates (generally squid and shrimp) are consumed by seals, but diets can vary considerably among years, seal species, geographic regions and seasonally (Hammill and Stenson 2000).

**Harbour Seal**

Harbour seals have a widespread distribution in the northern hemisphere, but are generally only found in coastal waters (Jefferson et al. 2008). In the Northwest Atlantic, harbour seals range from northern Florida to northern Baffin Island and along Greenland's southern coast (Bigg 1981). There are an estimated 99,340 individuals in the Northwest Atlantic (Waring et al. 2009). Hammill and Stenson (2000) estimated a total of approximately 5,120 harbour seals in Newfoundland and Labrador in 1996, and further information suggests there may be at least 1,000 animals in coastal Newfoundland (Sjare et al. 2005a; COSEWIC 2007a).

Harbour seals are found in coastal areas, rarely more than 20 km from shore, and often enter bays, estuaries and inlets where they sometimes also follow anadromous

salmonids up coastal rivers (Baird 2001). They periodically haul out of the water at coastal sites, usually rocky outcroppings and intertidal ledges. Primary prey species in Newfoundland include winter flounder, cod and sculpins (Sjare et al. 2005a). In Nova Scotia, harbour seals pup in the spring, primarily in May and June, and pups are nursed for approximately 24 days (Bowen et al. 2001). No studies are available to describe pupping patterns in Newfoundland, but similar patterns are expected. Mating also tends to occur during pupping season. Moulting occurs from mid-summer to early fall, and harbour seals haul out more frequently than at other times of the year. Harbour seals are primarily considered a coastal species, with limited dispersal from preferred haul out sites, but pups and juveniles have shown movements up to hundreds of kilometres over the continental shelf from haul out sites (Small et al. 2005). Harbour seals tagged in the St. Lawrence estuary were shown to migrate an average of 266 km to wintering locations exhibiting lower ice densities, but remained closer to shore (within 11 km) and in shallow areas, traveling only short distances (15 to 45 km), during ice-free conditions (Lesage et al. 2004).

Harbour seals are considered year-round residents of coastal Newfoundland (Sjare et al. 2005a). In comparison with other seal species in Newfoundland waters, spatial and temporal distribution and abundance is poorly known (Hammill and Stenson 2000). Small numbers have been sighted during summer and fall observations on the northeastern Grand Banks, in the Jeanne d'Arc Basin or Orphan Basin (Moulton et al. 2005, 2006a; Lang et al. 2006; Abgrall et al. 2008a, 2008b; Lang and Moulton 2008). The Offshore Study Area is within the maximum range reported for harbour seals; however, harbour seals are unlikely to occur there based on their preference for coastal waters.

In recent years (2001 to 2003), DFO has conducted boat- and shore-based surveys at known harbour seal haul out sites along the south coast of Newfoundland (Sjare et al. 2005a). Although the surveys do not provide population estimates, they do provide the best available (and most recent) information for local abundance of harbour seals. Small numbers of harbour seals were counted in Placentia Bay (13 to 27 individuals). Harbour seals were observed at King Island (adjacent to Merasheen Island), including a female and pup. However, relatively little is known about breeding activity of harbour seals at these and other sites within the Nearshore Study Area.

**Harp Seal**

The harp seal is found throughout the North Atlantic and Arctic Ocean, from the Gulf of St. Lawrence to Russia (Jefferson et al. 2008). Harp seals are the most abundant seal in the Northwest Atlantic, with an estimated population size of 8 million in 2008 (DFO 2011d). The majority of these seals aggregate off the east coast of Newfoundland and Labrador to pup and breed, with the remainder of the animals whelping in the Gulf of St. Lawrence (Lavigne and Kovacs 1988).

Harp seal diets off eastern Newfoundland and Labrador were estimated to primarily consist of capelin, Arctic cod and sand lance, although Atlantic herring, Atlantic cod, redfish and Greenland halibut were also substantial contributors to their diet (Hammill and Stenson 2000). During the summer, the Northwest Atlantic population of harp seals is found in the Canadian Arctic and Greenland before migrating south in the fall (DFO 2000). Dedicated at-sea surveys and data from satellite-tagged animals indicate that harp seals spend the majority of their time in offshore areas of southern Labrador and

eastern Newfoundland during the winter (Stenson and Sjare 1997; Lacoste and Stenson 2000). Pups are born on the ice in late February or March, are nursed for approximately 12 days, then mate as adults and disperse (DFO 2000). Births typically begin in early March and peak around March 8 to 10 (Stenson et al. 2005). Older seals also aggregate to moult off northeastern Newfoundland and in the northern Gulf of St. Lawrence in April and May before migrating northward (DFO 2000).

The Jeanne d'Arc Basin and adjacent areas overlap with regions where harp seals have been observed during January and February (Lacoste and Stenson 2000). In the Jeanne d'Arc Basin, there were 14 harp seal sightings (Table 11-4); all but one sighting occurred in June. There were also seven harp seal sightings in Orphan Basin (Table 11-4). Additionally, during years when pack ice extends into Jeanne d'Arc Basin, harp seals may use the region for spring pupping, mating and moulting. Thus, from about December to June, harp seals will likely commonly occur in the Offshore Study Area.

Harp seals can also occur in nearshore areas of Newfoundland and Labrador during the spring, as suggested by their incidental capture in the nearshore lumpfish fishery in northeast Newfoundland from April to July (Sjare et al. 2005b). Harp seal is expected to be uncommon in the Nearshore Study Area.

**Hooded Seal**

Hooded seals occur in the North Atlantic, ranging from Nova Scotia to the high Arctic (Jefferson et al. 2008). However, it is not uncommon for hooded seals, particularly juveniles, to occur outside their normal range (Waring et al. 2009). There are four primary pupping and mating regions in the North Atlantic: the Gulf of St. Lawrence; northeast Newfoundland; Davis Strait; and east Greenland (Jefferson et al. 2008). A total of 593,500 individuals are estimated to occur in the Northwest Atlantic, with the majority of the population, or 535,800 animals, pupping and mating off northeast Newfoundland (Hammill and Stenson 2006a).

Hooded seals seem to prefer deeper water and occur farther offshore than harp seals (Lavigne and Kovacs 1988). Birth takes place on the ice, and pups are weaned in approximately four days, after which pups are abandoned by the female (Lavigne and Kovacs 1988). On average, pupping off northeast Newfoundland is completed by 28 March, but has ranged from March 18 to April 4; pups may spend several more weeks on the ice before entering the water and dispersing (Hammill and Stenson 2006b). Following whelping, hooded seals aggregate in the pack ice off eastern Greenland to moult during June-July before dispersing to the Greenland Sea or Davis Strait during the summer and fall (see Hammill and Stenson 2006a). Little is known about their winter distribution, but they have been observed feeding around the northern edge of the Grand Banks during winter (Stenson and Kavanagh 1994). Recent work suggests that hooded seals move along the continental shelf to Davis Strait and Baffin Bay after moulting in July, followed by southerly migrations into the Labrador Sea, before reaching breeding grounds in the spring (Andersen et al. 2009).

No hooded seals were sighted during the summer and fall monitoring programs in the Jeanne d'Arc Basin, or during summer monitoring in the Orphan Basin (Table 11-4). Recent studies of satellite-tagged hooded seals indicate that at least some individuals enter the Offshore Study Area in February, presumably to reach the Flemish Cap for winter foraging (Andersen et al. 2009). Hooded seals have also been shown to transit

through and near the Offshore Study Area during transit to moulting areas in May and June (Bajzak et al. 2009). The available information on their offshore distribution suggests that hooded seals may occasionally occur in the Offshore Study Area during winter and spring, particularly if seasonal pack ice extends into the Offshore Study Area.

Hooded seals that breed in the Gulf of St. Lawrence predominantly migrate along the eastern and southern Newfoundland coast and enter (in December prior to breeding) or exit (by May following breeding) the Gulf via Cabot Strait; thus, animals presumably at least pass the entrance to Placentia Bay (Hammill 1993; Andersen et al. 2009; Bajzak et al. 2009). Juvenile hooded seals may also occasionally wander deeper into Placentia Bay and other coastal areas of eastern Newfoundland, especially during winter and spring. Based on available information, it is expected that hooded seal would be an uncommon visitor to the Nearshore Study Area.

**Grey Seal**

Grey seals are found throughout cold temperate to sub-Arctic waters of the North Atlantic, including areas of Nova Scotia, the Gulf of St. Lawrence and Newfoundland (Jefferson et al. 2008). The largest breeding colony in the North Atlantic is on Sable Island, south of Nova Scotia, consisting of approximately 250,000 individuals (Thomas et al. 2007). There are an estimated 304,000 animals that breed on Sable Island, Nova Scotia's eastern shore, and in the Gulf of St. Lawrence, accounting for essentially all of the pup production in the Northwest Atlantic (Thomas et al. 2007). An unknown number are found off eastern Newfoundland.

Grey seals tend to be less tied to coastal and island rookeries than is harbour seal, but foraging still appears to be restricted to continental shelf regions (Austin et al. 2006). Grey seal prey species include herring, Atlantic cod and sand lance (Lesage and Hammill 2001). Pupping occurs between September and March, with a peak in January in Canada (Lesage and Hammill 2001).

The number of grey seals entering either the Nearshore or Offshore Study Area is unknown, but is likely small. None have been sighted during summer and fall monitoring programs in the Jeanne d'Arc Basin or during summer in the Orphan Basin (Table 11-4). Based on available information, it is expected that grey seal would be rare in either the Offshore or Nearshore Study Area.

#### 11.3.2.4 Northern River Otter

The northern river otter occurs throughout Canada, along rivers, lakes and ocean coasts. In various areas of its range, this species lives a largely marine existence or may alternate between coastal and interior habitats (Larsen 1984; Stenson et al. 1984). It is adapted to an aquatic existence, having webbed feet, a streamlined shape and a powerful tail. Although population estimates are not available, one of the highest river otter densities in Newfoundland occurs in coastal waters from the southern extent of Merasheen Island to the head of Placentia Bay. There, some river otters have adopted a primarily marine lifestyle. The complexity of the shoreline may be an important habitat component favouring the extensive use of the bay by otters (Goudie and Jones 2007).

It is likely that the population of otters using Placentia Bay is relatively contiguous given the large home range of this species (Goudie and Jones 2007). In the 1970s, one

juvenile otter captured and tagged in the Kings Island area of Merasheen archipelago was later caught by a trapper in Come-by-Chance area, representing a 40 to 50 km range (D. Slade, pers. comm.). In Bonavista Bay, the home range of otters was shown to be greater than 100 km (Coté et al. in prep.)

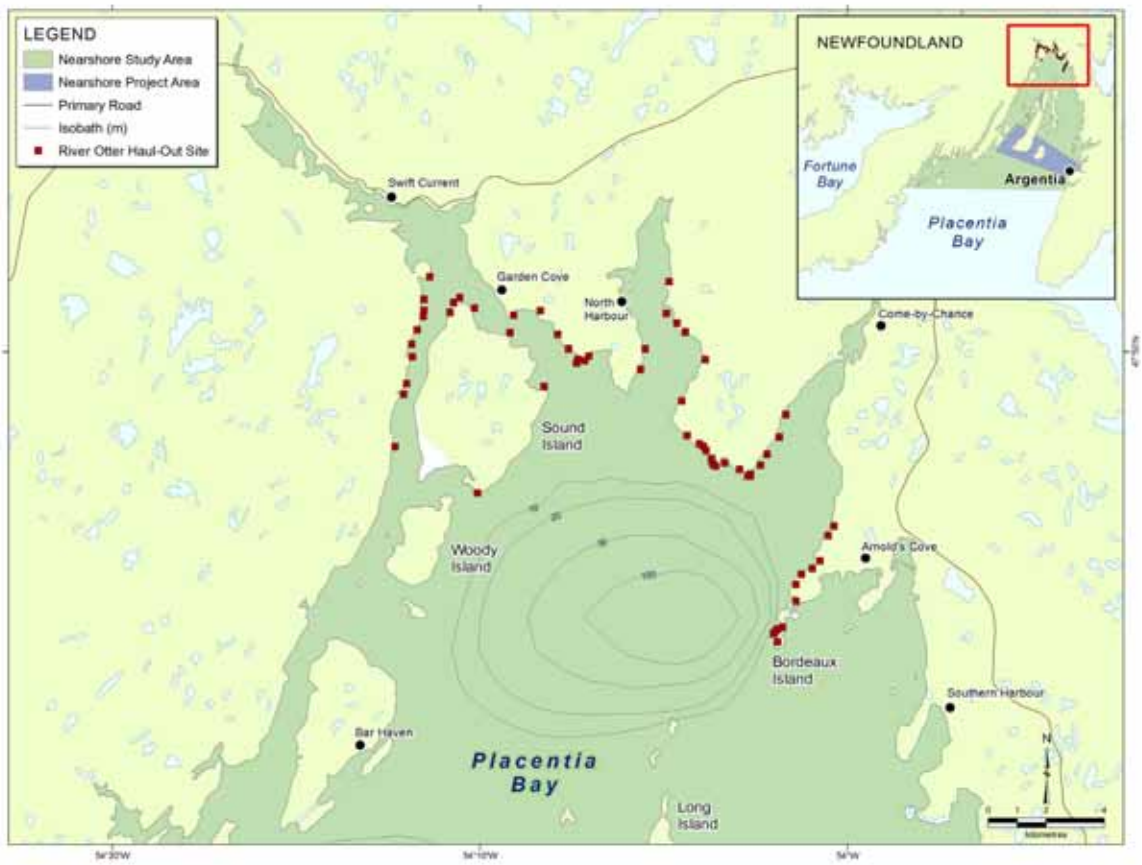
Despite its historic presence, exploratory research commencing in the 1970s, local knowledge and traditional trapping activity, there remains very limited and only fragmented information of this mammal in the Nearshore Study Area. Baseline data on the presence of otters at the head of Placentia Bay were collected for an environmental assessment of a proposed oil refinery. Shoreline surveys for river otter haul out sites (or rubs) were conducted during three days in April 2007, in an area extending from Bordeaux Island in the east to Sound Island in the west. The shoreline was accessed via a boat and sites known to be used by otters as rubs, as well as additional sites detected while in the field, were visited and classified according to use (time since last use, degree of use). Select sites were revisited during two days in May 2007 to assess the "long-term" use by otters. The results of the otter surveys are described in detail in Goudie and Jones (2007) and are summarized below.

In April 2007, 62 otter haul out sites were identified in the head of Placentia Bay, extending from Sound Island to Bordeaux Island; 39 of those sites had signs of recent use (Figure 11-5; Goudie and Jones 2007). Goudie and Jones (2007) noted low estimates of river otter use in the vicinity of Whiffen Head. It appears that river otters may use the eastern side of Placentia Bay from Bordeaux Island north less than the areas to the west; this could be due to increased industrial activity, infrastructure, and associated shipping traffic in that area (Goudie and Jones 2007). Nonetheless, instances of frequent use by otters were located on select promontories located less than 1.5 km from the Come By Chance loading/unloading jetty (Goudie and Jones 2007). Slade and Pitcher (1971) also noted a high incidence of otter activity near Come By Chance and North Harbour. Sixteen otter rubs were located within the boundaries of the Nearshore Project Area and several others were located nearby (Figure 11-5). Most of these haul out sites were actively being used during the initial survey in April 2007 and there was evidence of re-use about a month after the initial survey (Goudie and Jones 2007). The coast of the Nearshore Project Area is an area of active use by otters, but the overall biological importance of rubs in the Nearshore Project Area is unknown.

Incidental to aerial surveys for nesting bald eagles conducted in June 2006, 35 sites were identified as otter haul outs in the inner and eastern portion of Placentia Bay, extending from Arnold's Cove south to Northern Head, Cape St. Mary's (Goudie and Mactavish 2007). Dedicated surveys for otter haul out sites in 2006 located 21 sites used by otters in the area of Long Harbour-St. Croix Bay to the Iona Islands (Goudie 2007). River otter signs were evenly distributed among the mainland shoreline of Long Harbour proper and the archipelago complex of the Iona and Brine Islands (Goudie 2007).

The diet of river otters is mainly comprised of fish, but invertebrates, amphibians, birds and small mammals are also taken depending on availability (Banfield 1975). In Placentia Bay, otters prey on cunners, gunnels/pouts, sculpins, flounders and sticklebacks; lobsters are also taken (Ian Goudie, LGL, pers. obs.). River otters mate in late winter/early spring and have a delayed implantation of up to 290 to 380 days, with a gestation period of 60 to 62 days (Banfield 1975). Two to three young are typically born in March to April; however, they do not leave the den with the female until 10 to 12 weeks of age. During that time, females are localized to den/rearing sites, and little is

known regarding their periodic movement rates or distance travelled away from the young. A denning and brood rearing site, first identified in the 1970s (D. Slade, retired Wildlife Officer, pers. comm.) on the western shoreline of the channel separating Sound Island and the mainland (see haul out site R41 in Figure 11-5), still appears to be an important area for otters, as evidenced by signs of frequent use (Goudie and Jones 2007).




Source: Goudie and Jones 2007.

**Figure 11-5 Locations of Otter Haul Out Sites Identified along the Inner Shorelines of Placentia Bay, Sound Island to Bordeaux Island**

The population of river otters is considered stable in Newfoundland, and harvesting is permitted. The furbearer trapping season for this species generally occurs from mid-October to mid-March. In the head of Placentia Bay, trapping is presently conducted by residents of Arnold's Cove, North Harbour, Garden Cove and Swift Current.

### 11.3.3 Sea Turtles

Sea turtles are likely not common in the Nearshore and Offshore Study Areas, but are important to consider given their threatened or endangered status, both nationally and internationally. Three species could potentially occur in the Nearshore and/or Offshore Study Areas (Table 11-8): the leatherback sea turtle, loggerhead sea turtle, and Kemp's ridley sea turtle. Both leatherback and loggerhead sea turtles are seen with some

regularity (although loggerheads to a lesser extent) off Newfoundland in summer and fall (Goff and Lien 1988; Witzell 1999; Ledwell and Huntington 2009). Less is known about the distribution of Kemp's ridley sea turtle in eastern Canada, but it is considered rare. Of these species, only the leatherback sea turtle (Atlantic population) is listed on SARA Schedule 1; it is considered endangered under SARA and COSEWIC. All three species have special status on a global scale (see species profiles). The leatherback and loggerhead sea turtle are described further in Sections 12.3.2.8 and 12.3.2.9, respectively.

**Table 11-8 Sea Turtles Known to Occur in the Nearshore and Offshore Study Areas**

| Species | Nearshore Study Area | | Offshore Study Area | | SARA Status (A) | COSEWIC Status (B) | Known Activities | Habitat |
|---|---|---|---|---|---|---|---|---|
| | Occur-rence | Timing | Occur-rence | Timing | | | | |
| Leatherback Sea Turtle | Uncommon | Jul-Oct | Uncommon | Jun-Nov | Schedule 1: Endangered | E | Feeding | Channel, Bays |
| Loggerhead Sea Turtle | Very rare | Summer | Rare | Summer | NS | E | Feeding | Channel |
| Kemp's Ridley Sea Turtle | Very rare | Summer | Very rare | Summer | NS | NC | Feeding | Channel |

Notes:
(A) Species designation under SARA; NS = No Status.
(B) Species designation under COSEWIC: E = Endangered, NC = Not Considered.

Marine mammal monitoring programs, as discussed in Section 11.3.1.1, provide relevant information on the spatial and temporal distribution of sea turtles in the area. As noted earlier, the data represent only the late spring, summer and fall seasons (and typically only portions of the summer), and sea turtle observations may be biased by potential responses to noise from the airgun arrays. During the monitoring programs in the Jeanne d'Arc Basin, there was a single sighting of a loggerhead sea turtle approximately 240 km south of Jeanne d'Arc Basin in September 2008 (Abgrall et al. 2008a, 2009). Sightings of leatherback sea turtles are described in Chapter 12.

### 11.3.3.1 Fisheries and Oceans Canada Sightings Database

DFO in St. John's has compiled a database of sea turtle sightings in waters around Newfoundland and Labrador. These data provide some indication of which species can be expected to occur in the area, but they cannot, at this point in the development of the database, provide any fine-scale quantitative information as the database typically does not include observation effort. However, no additional sea turtle observations were reported in the Nearshore or Offshore Study Areas that were not already described in the offshore monitoring of seismic activity in Jeanne d'Arc and Orphan Basins.

### 11.3.3.2 Species Profiles

#### Kemp's Ridley Sea Turtle

Kemp's ridley sea turtles have a more restricted distribution than other sea turtles, primarily in the Gulf of Mexico (Spotila 2004). Some juveniles exhibit the widest range, sometimes feeding along the US east coast and rarely into the Canadian Atlantic (Spotila 2004). It is estimated that there are only approximately 5,000 nesting females worldwide (Spotila 2004), but it is unknown how many enter Canadian waters annually.

Kemp's ridley turtles have not been considered by COSEWIC and have no status under SARA.

Nesting is focused within a small region of the central and southern Gulf of Mexico during May to late July, and only immature turtles seem to travel outside the Gulf of Mexico into more northerly waters (Morreale et al. 2007). Musick et al. (1994) suggested that juvenile Kemp's ridley sea turtles that travel north of Cape Hatteras, North Carolina, probably do so in April and return southward by November. In general, it appears the Kemp's ridley sea turtles prefer shallow water.

While adults rarely range beyond the Gulf of Mexico, juveniles have been sighted along the southeast coast of Newfoundland near St. Mary's Bay and along southern Nova Scotia (Ernst et al. 1994). There are apparently no sightings or reports of Kemp's ridley sea turtles in Placentia Bay or the Jeanne d'Arc Basin. The available information suggests that their presence in both areas is likely to be very rare and only occur during summer or fall.

## 11.4 Project-Valued Environmental Component Interactions and Existing Knowledge of Environmental Effects

WREP activities can interact with marine mammals (and marine-related mammals like the river otter) and sea turtles by causing changes in habitat quantity, changes in habitat quality, or potential mortality. The interactions that are expected to have the most environmental effects are discussed in this section; interactions with fewer expected environmental effects are discussed in Section 11.5.

Underwater sound produced by the WREP's activities will be the primary source of potential effects on marine mammals and sea turtles. WREP activities that will produce underwater noise include pile driving, vessel and helicopter traffic, dredging, drilling and geophysical surveys. These activities could affect the habitat quality for marine mammals and sea turtles. Marine mammals rely heavily on the use of underwater sounds to communicate and to gain information about their surroundings. Experiments also show that they hear and may react to many anthropogenic sounds.

The environmental effects of noise on marine mammals (and likely sea turtles) are highly variable, and can be categorized as follows (based on Richardson et al. 1995):

- The noise may be too weak to be heard at the location of the animal (i.e., lower than the prevailing ambient noise level, the hearing threshold of the animal at relevant frequencies, or both).

- The noise may be audible but not strong enough to elicit any overt behavioural response (i.e., the animal may tolerate it).

- The noise may elicit behavioural reactions of variable conspicuousness and variable relevance to the well-being of the animal; these can range from subtle effects on respiration or other behaviours (detectable only by statistical analysis) to active avoidance reactions.

- Upon repeated exposure, animals may exhibit diminishing responsiveness (habituation), or disturbance effects may persist; the latter is most likely with sounds that are highly variable in characteristics, unpredictable in occurrence and associated with situations that the animal perceives as a threat.

- Any anthropogenic noise that is strong enough to be heard has the potential to reduce (mask) the ability of marine mammals to hear natural sounds at similar frequencies, including calls from conspecifics, echolocation sounds of odontocetes and environmental sounds such as surf noise or (at high latitudes) ice noise.

- Very strong sounds have the potential to cause temporary or permanent reduction in hearing sensitivity, or other physical or physiological effects (and in extreme cases (i.e., exposure to large explosives), mortality). Received sound levels must far exceed the animal's hearing threshold for any temporary threshold shift (TTS) to occur. Received levels must be even higher for a risk of permanent hearing impairment.

To aid in the assessment of potential effects of noise from WREP activities on marine mammals and sea turtles, a description of the hearing abilities of marine mammals and sea turtles and a review of noise criteria for assessing effects are summarized below.

The hearing abilities of baleen whales have not been measured directly. Behavioural and anatomical evidence indicates that they hear well at frequencies below 1 kHz (Richardson et al. 1995; Ketten 2000). For baleen whales as a group, the functional hearing range is thought to be approximately 7 Hz to 22 kHz; they constitute the "low-frequency" (LF) hearing group (Southall et al. 2007). The hearing systems of baleen whales are undoubtedly more sensitive to LF sounds than are the ears of the small toothed whales that have been studied directly. Thus, baleen whales are likely to hear LF sounds (like airgun pulses and pile driving) farther away than can small toothed whales and, at closer distances, these sounds may seem more prominent to baleen than to toothed whales.

The small to moderate-sized toothed whales whose hearing have been studied have relatively poor hearing sensitivity at frequencies below 1 kHz, but extremely good sensitivity at, and above, several kHz. There are very few data on the absolute hearing thresholds of most of the larger, deep-diving toothed whales, such as the sperm and beaked whales. However, Mann et al. (2005) report that a Gervais' beaked whale (*Mesoplodon europaeus*) could detect frequencies of 5 to 80 kHz, with the most sensitivity at 80 kHz. Most of the odontocete species have been classified as belonging to the "mid-frequency" (MF) hearing group, and the MF odontocetes (collectively) have functional hearing from approximately 150 Hz to 160 kHz (Southall et al. 2007). However, individual species may not have quite so broad a functional frequency range. Very strong sounds at frequencies slightly outside the functional range may also be detectable. The remaining odontocetes (porpoises, river dolphins and members of the genera *Cephalorhynchus* and *Kogia*) are distinguished as the "high frequency" (HF) hearing group. They have functional hearing from approximately 200 Hz to 180 kHz (Southall et al. 2007).

Underwater audiograms have been obtained using behavioural methods for three species of phocid seals, two species of monachid seals, two species of otariids and the walrus (reviewed in Richardson et al. 1995; Kastak and Schusterman 1998, 1999;

Kastelein et al. 2002). The functional hearing range for pinnipeds in water is considered to extend from 75 Hz to 75 kHz (Southall et al. 2007), although some individual species (especially the eared seals) do not have that broad an auditory range (Richardson et al. 1995). Compared to odontocetes, pinnipeds tend to have lower best frequencies, lower high-frequency cutoffs, better auditory sensitivity at low frequencies and poorer sensitivity at the best frequency.

River otters appear to have their best hearing sensitivity at 16 kHz, with some sensitivity from approximately 460 Hz to 33 kHz (Gunn 1988). The limited available data indicate that the frequency range of best hearing sensitivity by sea turtles extends from approximately 250 to 300 Hz to 500 to 700 Hz (Ridgway et al. 1969; Bartol et al. 1999). Sensitivity deteriorates at either lower or higher frequencies. However, there is some sensitivity to frequencies as low as 60 Hz, and probably down to 30 Hz.

The US National Marine Fisheries Service (NMFS) concluded that cetaceans and pinnipeds should not be exposed to impulse noise (e.g., impact pile driving, airguns) at received levels exceeding 180 dB and 190 dB re 1 µPa (rms), respectively; the 180 dB criterion is also used for sea turtles (NMFS 1995, 2000a, 2000b). These exposure criteria used by NMFS were intended as a precautionary estimate below which hearing impairment (TTS) would not occur from airgun pulses. There was no empirical evidence illustrating that higher levels of pulsed sound would cause hearing or other injuries. In Canada, minimum exposure criteria for injury to marine mammals (and sea turtles) have not been established. Some jurisdictions in Canada have used the 180 dB re 1 µPa (rms) criteria for whales to establish a safety zone for seismic surveys. The *Statement of Canadian Practice with respect to the Mitigation of Seismic Sound in the Marine Environment* specifies a 500-m safety zone for endangered and threatened whales and sea turtles.

Southall et al. (2007) have produced scientific recommendations for updated marine mammal noise exposure criteria for various marine mammal groups and sound types; they proposed levels above which there is a scientific basis for expecting that noise exposure would cause injury to occur. These new exposure criteria incorporate frequency-weighting functions (M-weighting) for assessing the effects of sound on marine mammals, which accounts for the major differences in auditory capabilities across marine mammal groups and species. Minimum exposure criteria for injury are defined as the energy level at which single exposure is estimated to cause onset of permanent hearing loss (Permanent Threshold Shift or PTS); TTS is not considered an injury (Southall et al. 2007; Le Prell 2012). Southall et al. (2007) concluded that PTS might occur if cetaceans and pinnipeds are exposed to pulsed sounds with peak sound pressure levels (SPL) exceeding 230 dB re 1 µPa (peak) (or 198 dB re 1 $\mu Pa^2 \cdot s$) or 218 re 1 µPa (peak) (or 186 dB re 1 $\mu Pa^2 \cdot s$), respectively. Southall et al. (2007) concluded that PTS might occur if cetaceans and pinnipeds are exposed to pulsed sounds (e.g., impact pile driving; airguns) with peak SPL exceeding 230 dB re 1 µPa (peak) (or 198 dB re 1 $\mu Pa^2 \cdot s$) or 218 re 1 µPa (peak) (or 186 dB re 1 $\mu Pa^2 \cdot s$), respectively. For continuous sounds, PTS might occur at the same peak pressures as for pulsed sounds, but PTS may also occur if cetaceans and pinnipeds are exposed to sound exposure levels (SEL) of 215 dB or 203 dB re 1 $\mu Pa^2 \cdot s$, respectively (Southall et al. 2007). The conclusion that the TTS threshold is higher for non-impulse compared with impulse sound is somewhat speculative. The available TTS data for a beluga exposed to impulse sound are extremely limited, and the TTS data from a beluga and bottlenose dolphin exposed to non-pulse sound pertain to sounds at 3 kHz and above.

Follow-on work has shown that the SEL necessary to elicit TTS can depend substantially on frequency, with susceptibility to TTS increasing with increasing frequency above 3 kHz (Finneran and Schlundt 2010, 2011; Finneran 2012).

Southall et al. (2007) use the onset of TTS as a criterion for "behavioural" disturbance of cetaceans exposed to a single pulse (see page 448 in Southall et al. 2007). For cetaceans, the unweighted peak sound pressure of 224 dB re 1 µPa (peak) and M-weighted SEL values of 183 dB re 1 $\mu Pa^2 \cdot s$ are recommended as disturbance criteria (i.e., received levels that exceed either of these levels are considered to have greater potential to elicit a biologically important behavioural response). For pinnipeds exposed to a single pulse in water, the peak sound pressure of 212 dB re 1 µPa (peak) and weighted SEL values of 171 dB re 1 $\mu Pa^2 \cdot s$ are recommended as disturbance criteria. The US NMFS uses a sound level criterion for disturbance of 160 dB re 1 µPa (rms) for marine mammals.

### 11.4.1 Nearshore

In the Nearshore Study Area, underwater noise could result from WREP activities such as possible pile driving, vessel traffic, dredging of the bund wall and sections of the tow-out route to the deepwater site, and geophysical surveys (i.e., side scan sonar and geohazard surveys). These activities could affect the habitat quality for marine mammals and sea turtles. In addition, vessel traffic could affect marine mammals and sea turtles through direct mortality.

#### 11.4.1.1 Graving Dock Construction

During graving dock construction, underwater noise could result from WREP activities such as possible pile driving; pile driving would occur on land. Underwater noise from pile driving is expected to be negligible. Nonetheless, the possible effects of sounds from pile driving on marine mammals and sea turtles are described here.

Behavioural reactions of marine mammals and sea turtles to sound are difficult to predict. Reactions to noise, if any, depend on species, state of maturity, experience, activity, reproductive state, time of day and many other factors (Richardson et al. 1995; Wartzok et al. 2004; Southall et al. 2007; Weilgart 2007). Various authors have noted that even marine mammals that show no obvious avoidance or behavioural changes may still be adversely affected by noise (Brodie 1981; Richardson et al. 1995; Romano et al. 2004; Weilgart 2007; Wright et al. 2009, 2011). For example, some research suggests that animals in poor condition or in an already stressed state may not react as strongly to human disturbance as would more robust animals (e.g., Beale and Monaghan 2004).

If a marine mammal or sea turtle does react to an underwater sound by changing its behaviour or moving a small distance, the effects of the change are unlikely to be critical to the individual, let alone the stock or population. However, if a sound source displaces marine mammals or sea turtles from an important feeding or breeding area for a prolonged period, effects on individuals and populations could be substantial (e.g., Lusseau and Bejder 2007; Weilgart 2007).

**Effects of Pile Driving**

Pile driving, vibratory and/or impact, may be required during bund wall construction (placement of sheet piles). The effects of sounds from in-water pile driving could include one or more of the following: tolerance; masking of natural sounds; behavioural disturbance; and at least in theory, temporary or permanent hearing impairment, or non-auditory physical or physiological effects. However, given that pile driving during the WREP will be on land, sound transmission to the water is expected to be negligible.

### 11.4.1.2 Concrete Gravity Structure Construction and Installation

Underwater noise will be produced during WREP activities associated with the construction and installation of the CGS. Underwater sounds will be produced by vessels, helicopters, geophysical surveys (i.e., side scan sonar and geohazard surveys) and dredging of the bund wall and possibly sections of the tow-out route to the deepwater site. These activities could affect the habitat quality for marine mammals and sea turtles. The environmental effects could include masking of natural sounds, behavioural disturbance, hearing impairment and possibly injury. Vessel traffic could also affect marine mammals and sea turtles through direct mortality. The possible effects of dredging, vessel traffic and helicopter overflights are described below. The possible effects of geophysical surveys are discussed in terms of seismic surveys in Section 11.4.2.

**Effects of Dredging**

In nearshore shallow water regions, dredges can be strong sources of low frequency underwater noise (Richardson et al. 1995). Because low frequency sound attenuates rapidly in shallow water, underwater sound produced by dredging is normally undetectable at ranges beyond 25 km (Richardson et al. 1995). Dredging that occurs consistently over long periods can create a higher potential for disturbance, which could result in changes in habitat use for marine mammals and sea turtles. Limited information is available on the behavioural changes of marine mammals (and none for sea turtles) resulting from dredging operations, but generally, animals have been reported to continue using habitats near dredging operations. Dredging operations will be temporary and of limited duration; dredging to remove the shoreline berm will take approximately six to eight weeks, whereas dredging of the tow-out channels will take approximately four to six weeks. Proper planning and equipment design will reduce the duration of dredging activities and hence the environmental effect on marine mammals and sea turtles.

Gray whales in Laguna Guerrero Negro provide the best documented case of a long-term change in baleen whale distribution as a result of industrial activities including dredging. It is thought that constant dredging operations needed to keep a channel open for shipping of salt (from 1957 to 1967) may have been the main source of disturbance to the whales and decline of whale numbers from 1964 to 1970 (Bryant et al. 1984). Gray whales reoccupied the lagoon after shipping of salt subsided. However, recent surveys suggest that the seasonal abundance of gray whales in the lagoon has decreased 90 percent since the 1980s. Fishermen in the area suggested that this decline of whales may be due to the natural closure of the lagoon entrance as sand accumulates in the absence of dredging (Urbán-Ramirez et al. 2003).

In the MacKenzie Estuary, Canada, belugas have been reported to approach as close as 400 m to stationary dredges, but were more sensitive to barge traffic associated with the dredging (Ford 1977; Fraker 1977). In contrast, in 1999, Cook Inlet beluga whales were seen in waters near the docks at the Port of Anchorage, Alaska, during vessel transits from a dredging operation near Fire Island, but no whales were observed near the dredging site itself (Moore et al. 2000).

**Effects of Vessel Traffic**

Sounds from vessel traffic associated with the WREP will likely result in a temporary change in habitat quality for marine mammals and sea turtles. The CGS tow-out to the deep-water mating site will employ four tugs and take approximately two to four days. The WHP will be at the deep-water mating site for six to eight weeks. During the topsides mating, there will be an accommodation vessel, a tug and supply vessel. A logistics vessel will transit between the deep-water mating site and the Port of Argentia three to four times per week.

Vessel noise is most likely to cause masking or behavioural responses in marine mammals and sea turtles. However, sound levels are not expected to be high enough to cause physical or physiological effects on marine mammals or sea turtles (see Richardson et al. 1995). The greatest and most continuous vessel noise source during construction will result from tugs and barges (see Blackwell and Greene 2006). Sound levels that would have the potential to induce hearing impairment in marine mammals and sea turtles (180 and 190 dB re 1 µPa (rms)) have been modelled to occur in an area less than 5 m from the tugs used in the WREP (JASCO 2012).

Masking by vessel sounds of marine mammal calls may also occur if the frequencies produced overlap. Through use of an analytical paradigm, Clark et al. (2009) found that of the large baleen whales, the endangered North Atlantic right whale may be most prone to communication masking due to commercial vessel traffic. They found that two commercial ships in the Stellwagen Bank National Marine Sanctuary, US, could cause an 84 percent reduction in the whale's communication space for at least 13.2 h a day. However, the biological repercussions of a loss of communication space are unknown (Clark et al. 2009).

Based on evidence from terrestrial mammals and humans, sound is also a potential source of stress (Wright and Kuczaj 2007; Wright et al. 2007a, 2007b, 2009, 2011). However, limited information is available on sound-induced stress in marine mammals, or on its potential (alone or in combination with other stressors) to affect the long-term well-being or reproductive success of marine mammals (Fair and Becker 2000; Hildebrand 2005; Wright et al. 2007a, 2007b). Such long-term effects, if they occur, would be associated with chronic noise exposure (see Tyack 2008). Rolland et al. (2012) suggested that ship noise causes increased stress in right whales; they showed that baseline levels of stress-related faecal hormone metabolites decreased in North Atlantic right whales with a 6 dB decrease in underwater noise from vessels. How this type of chronic stress may affect right whales or other listed species is unknown.

Marine mammal responses to ships are presumably responses to noise, but visual or other cues are also likely involved. Sound source levels for most small ships, including tugs and barges, are above the 160 dB re 1 µPa (rms) criterion considered for behavioural disturbance (Richardson et al. 1995). Estimated sound levels from a single

tug were much lower relative to other sources of construction noise. Sound levels of 160 dB re 1 µPa (rms) were estimated to occur within 22 m of a WREP tug (JASCO 2012).

Factors such as species, maturity, experience, behaviour state, reproductive state and time of day likely affect marine mammal and sea turtle responses to vessels. Marine mammal response (or lack thereof) to ships and boats is summarized in Richardson et al. (1995) for studies pre-1995. A review of more recent studies assessing the responses of marine mammals to the presence of vessels is included in LGL (2007a: Section 5.6.6.3) and is summarized below.

Baleen whales may approach or avoid boats (Watkins 1986). Baleen whales may show little reaction or slow, inconspicuous avoidance reactions to boats that are moving slowly on a steady course. If the vessel changes course and/or speed, whales likely will swim rapidly away. Avoidance is strongest when the boat travels directly towards the whale. Reactions of baleen whales to boat and other noises include changes in swimming direction and speed, blow rate and the frequency and kinds of vocalizations (Richardson et al. 1995). Avoidance was strongest when boats approached directly or when vessel noise changed abruptly (Watkins 1986; Beach and Weinrich 1989). Humpback whales responded to boats at distances of at least 0.5 to 1 km, and avoidance and other reactions have been noted in several areas at distances of several kilometres (Jurasz and Jurasz 1979; Baker et al. 1982, 1983; Bauer 1986; Dean et al. 1985; Bauer and Herman 1986; Baker and Herman 1989). During some activities and at some locations, humpbacks exhibit little or no reaction to boats (Watkins 1986). McKenna (2011) and Melcón et al. (2012) reported that blue whales changed their vocalization rates in response to nearby ship noise; calls increased with increasing received sound levels. Blue whales may have changed their vocalization rates to overcome potential masking effects from ship noise.

Similarly, other cetaceans are known to increase the source levels of their calls in the presence of elevated sound levels, shift their peak frequencies in response to strong sound signals, or otherwise modify their vocal behaviour in response to increased noise (Dahlheim 1987; Au 1993; reviewed in Richardson et al. 1995; Lesage et al. 1999; Terhune 1999; Nieukirk et al. 2005; Scheifele et al. 2005; Parks et al. 2007, 2009, 2011; Hanser et al. 2009; Holt et al. 2009; Di Iorio and Clark 2010; McKenna 2011; Castellote et al. 2012; Risch et al. 2012). If cetaceans exposed to strong sounds sometimes respond by changing their vocal behaviour, this adaptation, along with directional hearing and preadaptation to tolerate some masking by natural sounds (Richardson et al. 1995), would all reduce the importance of masking by vessel noise.

Variable reactions, from minor to overt, have been noted for toothed whales; responses include reductions in foraging, possible habituation, increased diving, frequent changes in direction, approach and bow-riding, increased rate and sound level of vocalizations, modified behavioural state, general avoidance, or selection of different habitat. Dolphins may tolerate and often approach boats of all sizes and ride the bow and stern waves (Shane et al. 1986; Williams et al. 1992). At other times, dolphin species that are known to be attracted to boats will avoid them. This avoidance is often linked to previous boat-based harassment of the animals (Richardson et al. 1995). Other species avoid boats. Generally, small cetaceans avoid boats when they are approached within 0.5 to 1.5 km, with some species showing avoidance at distances of 12 km (Richardson et al. 1995). Behavioural changes in response to vessel traffic have also been documented

(e.g., Lusseau 2003, 2004, 2005; Stockin et al. 2008). Seals sometimes investigate oncoming vessels while others appear to avoid vessels.

To the best of our knowledge, there are no systematic data on river otter reactions to ships and boats. There is some limited information (with no details about sound levels) about responses of other otter species to other anthropogenic disturbance sources. The Eurasian otter (*Lutra lutra*) did not show changes in distribution or frequency of use of shelters in response to human disturbance, neither at a riverine locality (Green et al. 1984) nor in a coastal area (MacDonald and Mason 1980). Similarly, in Southeastern Brazil, human disturbance around shelters did not influence use by neotropical river otters, *L. longicaudis* (Pardini and Trajano 1999). In contrast, an inverse relationship between human disturbance and the abundance of otter shelters were noted by O'Sullivan (1993) for *L. lutra* at a riverine site, and by Verwoerd (1987) for the African river otter, *Aonyx capensis*, in a coastal area. In a South Indian river system, smooth-coated otters avoided areas with high levels of human disturbance by fishing activities and people; the frequency of visits to disturbed sites was lower than that to undisturbed sites, but the number of sites did not differ between disturbed and undisturbed areas (Shenoy et al. 2006).

Sea turtles are uncommon in the Nearshore Study Area and typically only occur there during late summer or early fall. Generally, sea turtles flee or dive when approached closely by a vessel. During a study in Morton Bay, Queensland, turtles were observed to flee from slow moving vessels (approximately 4 km/hr) in 60 percent of observations (Hazel et al. 2007).

The presence of vessels during various WREP activities can also increase the risk of direct mortality via vessel collisions with marine mammals. Fin whales are the most commonly reported whale to be struck by vessels, followed by humpback whales and North Atlantic right whales (Jensen and Silber 2003; Vanderlaan and Taggart 2007). Minke whales, sei whales and sperm whales were not as frequently struck, proportionally, but have been reported (Vanderlaan and Taggart 2007). Published accounts of ship strikes suggest that most whales are not seen beforehand or are seen at the last minute (Laist et al. 2001).

Evidence suggests that a greater rate of mortality and serious injury to large whales is correlated with a greater vessel speed at the time of a ship strike (Laist et al. 2001; Vanderlaan and Taggart 2007). Most lethal and severe injuries to large whales resulting from documented ship strikes have occurred when vessels were travelling at 26 km/h (14 knots) or greater (Laist et al. 2001). Vanderlaan and Taggart (2007), using a logistic regression modelling approach based upon vessel strike records, found that for vessel speeds greater than 28 km/h (15 knots), the probability of a lethal injury (mortality or severely injured) approaches 1.0. The probability of lethal injury declined to approximately 0.2 at speeds of 16 km/h (8.6 knots) (Vanderlaan and Taggart 2007). In a review of 58 large whale ship strikes in which the vessel speed was known, the average speed of vessels involved in ship strikes that resulted in mortality or serious injuries to the whale was found to be 34.5 km/h (18.6) knots (Jensen and Silber 2003). The frequency of incidents of ship strikes more than doubled when vessel speeds were 24 to 28 km/h (13 to 15 knots) as opposed to 18.5 km/h (10 knots) or less (Jensen and Silber 2003). Most lethal or severe injuries are caused by vessels greater than 80 m in length (Laist et al. 2001).

Sea turtles are also at risk from ship strikes as they regularly surface to breathe and often rest at or near the surface. A study carried out to assess the ability of green turtles to avoid vessels in Morton Bay, Queensland, found that the proportion of turtles that displayed a flee response to approaching vessels decreased as speed increased, and that this was most notable for close encounters (Hazel et al. 2007). Turtles were observed to flee from slow moving vessels (approximately 4 km/h) in 60 percent of observations (Hazel et al. 2007). Thus, sea turtle injury or mortality may also occur due to collisions with vessels, particularly with vessels traveling at speeds greater than 4 km/h (Hazel et al. 2007). This study also indicated that a turtles' ability to detect an approaching vessel was vision-dependent and so directly related to water clarity. The study proposed that the vision-dependence of sea turtles explains their inability to evade fast vessels (Hazel et al. 2007).

**Effects of Helicopter Overflights**

Some helicopter traffic may occur during WREP activities in the Nearshore Study Area. It can be difficult to determine whether a marine mammal or sea turtle reacts to the noise or the visual stimuli of the aircraft that is causing the noise/disturbance. In general, marine mammals show variable reactions to aircraft; often they startle and dive during low-altitude overflights.

Baleen whale responses to aircraft (pre-1995 studies) are summarized in Richardson et al. (1995). Those observations showed that whales often react to aircraft overflights by hasty dives, turns, or other changes in behaviour. Whales actively feeding or socializing often seem rather non-responsive, whereas whales in confined waters or with calves sometimes seem more responsive. Minke, bowhead and right whales reacted to aircraft overflights at altitudes of 150 to 300 m by diving, changing dive patterns, or leaving the area (Leatherwood et al. 1982; Watkins and Moore 1983; Payne et al. 1983; Richardson et al. 1985a, 1985b). Helicopter disturbance to humpbacks is a concern off Hawaii, and helicopters are prohibited from approaching humpbacks within a slant range of 305 m (NMFS 1987; Tinney 1988; Atkins and Swartz 1989). Opportunistic observations of bowhead whale responses to a Bell 212 helicopter were acquired during four spring migration periods in the Alaskan Beaufort Sea (Patenaude et al. 2002). The helicopter was found to have numerous prominent tones at frequencies up to 340 Hz, with the most prominent peak at 22 Hz. Sound levels between the peaks were 10 to 15 dB above ambient noise levels. Helicopter overflights elicited detectable responses in 14 percent of 63 bowhead groups. Most observed reactions (abrupt dives, breaching, tail slapping and brief surfacings) by bowheads (63 percent) to the helicopter occurred when it was at altitudes less than or equal to 150 m and lateral distances less than or equal to 250 m. In this and other studies, there was no indication that single or occasional aircraft overflights cause more than brief behavioural responses.

Toothed whale responses to aircraft (pre-1995 studies) are summarized in Richardson et al. (1995). Odontocetes reacting to aircraft may dive, slap the water with flippers or flukes, or swim away. The activity of a toothed whale sometimes appears to influence whether or not there is a behavioural response. Richter et al. (2003) reported that male sperm whales off Kaikoura, New Zealand, spent more time at the surface and showed more frequent heading changes in the presence of aircraft (small fixed-wing planes and helicopters) involved in whale watching activities. Some beluga whales ignored aircraft at flying at 500 m altitude, but dove for longer periods and some times swam away when it was at 150 to 200 m; lone animals sometimes dove in response to flights at 500 m

(Bel'kovich 1960; Kleinenberg et al. 1964). Richardson et al. (1991) reported that off Alaska, some belugas showed no reaction to airplanes or helicopters at 100 to 200 m altitude, while other dove abruptly or swam away in response to overflights at altitudes up to 460 m. The responses of beluga whales in the Alaskan Beaufort Sea to the noise of a Bell 212 helicopter (and Twin Otter fixed-wing aircraft) were assessed by Patenaude et al. (2002). Beluga whales reacted to the helicopter on 15 of 40 occasions. These reactions included immediate dives, changes in heading, changes in behavioural state and apparent displacements. Reactions occurred more often when the helicopter passed at altitudes less than or equal to 150 m than when it passed at altitudes greater than 150 m and statistically significant ($p$ = 0.004) more often when the helicopter's lateral distance from the whales was less than or equal to 250 m versus 250 to 500 m. Beluga whales reacted 50 percent of the time when the helicopter was stationary on the ice with the engines running. In this and other studies, there was no indication that single or occasional aircraft overflights cause more than brief behavioural responses in toothed whales.

Narwhals dove in response to helicopters flying at altitudes lower than 244 m and, to a lesser degree, at 305 m (Kingsley et al. 1994). Some sperm whales showed no reaction to helicopters and airplanes flying over at altitudes of 150 m but some dove immediately (Clarke 1956; Mullin et al. 1991). Richter et al. (2003) reported that male sperm whales off Kaikoura, New Zealand, spent more time at the surface and showed more frequent heading changes in the presence of aircraft (small fixed-wing planes and helicopters) involved in whale watching activities. Dall's porpoise and spinner dolphins reacted abruptly to overflights at 215 to 300 m (Withrow et al. 1985; B. Würsig, in Richardson et al. 1995).

Pinniped responses to aircraft (pre-1995 studies) are summarized in Richardson et al. (1995). Generally, pinnipeds exhibit a greater response to disturbance when on land or ice than in the water, although overflights at low altitudes may cause some animals in the water to dive (Richardson et al. 1995). Helicopter overflights in the Nearshore Study Area may disturb hauled out seals. Hauled out pinnipeds often become alert during an overflight and in many cases rush into the water (Richardson et al. 1995). Low-flying aircraft seem to elicit a stronger reaction, as well as abrupt changes in sounds (Richardson et al. 1995). Helicopters appear to be more disturbing than fixed-wing aircraft (Richardson et al. 1995). When disturbed, harbour seal responses range from an alert head-lift, to changes in haul out pattern, to panicked flight into the water. Fixed-wing aircraft flying at low altitudes below 60 to 120 m and helicopters flying below 305 m may cause panic among adult harbour seals and mortality of young at haul-out beaches (Johnson 1977; Bowles and Stewart 1980; Osborn 1985). Born et al. (1999) assessed the responses of ringed seals hauled out on the ice to overflights by fixed-wing twin-engine aircraft (Partenavia PN68 Observer) and a helicopter (Bell 206 III). Both aircrafts flew over seals at an altitude of 150 m. Overall, 6 percent of the seals (total = 5,040) escaped (left the ice) as a reaction to the fixed-wing aircraft and 49 percent of the seals (total = 227) escaped as a response to the helicopter. Some seals seem to habituate to frequent overflights. In this and other studies, there was no indication that single or occasional aircraft overflights cause more than brief behavioural responses in pinnipeds.

Observations were made of ringed seal behaviour in response to industrial noise (pipe-driving, helicopter overflights) at an artificial island (Northstar Island) in the Alaskan Beaufort Sea (Blackwell et al. 2004). During 55 h of observation, 23 observed ringed seals exhibited little or no reaction to any industrial noise except approaching Bell 212

helicopters; 10 seals looked at the helicopter, one seal departed from its basking site and one seal showed no reaction. Seals that have become habituated to aircraft may show little or no reaction (M. Bigg, in Johnson et al. 1989:53). In California, northern elephant seals (*Mirounga angustirostris*) and California sea lions appeared to be less responsive than harbour seals to overflights (Bowles and Stewart 1980). Generally, jets and helicopters at altitudes above 305 m elicited no reaction, but overflights of helicopters at lower altitude caused some animals to enter the water. Northern sea lions exhibit variable reactions to aircraft (Calkins 1979), but usually some are frightened into the water.

There are currently no available systematic data on sea turtle reactions to helicopter overflights. Given the hearing sensitivities of sea turtles, they can likely hear helicopters, at least when the helicopters are at lower altitudes and the turtles are at relatively shallow depths. It is unknown how sea turtles would respond, but single or occasional overflights by helicopters would likely only elicit a brief behavioural response.

### 11.4.2 Offshore

During the construction and installation phase in the Offshore Study Area, underwater noise will result from activities such as dredging, helicopter overflights, operation of vessels, wellsite and vertical seismic profiling (VSP surveys, other geophysical and geotechnical surveys, installation of subsea equipment, and the WHP, and subsea equipment and hook-up and commissioning. During production and operation, drilling will be taking place. These activities could affect habitat quality and habitat use by marine mammals and sea turtles. In addition, operation of vessels could lead to direct mortality of individuals via collisions. Placement of the WHP at the offshore site location may also affect the marine mammals and sea turtles through a limited reduction in habitat quantity, but this is expected to have negligible effects. The possible environmental effects of subsea drill centre excavation/installation on marine mammals and sea turtles have been summarized previously by LGL (2007a), and include similar activities as outlined below in Section 11.4.2.1.

#### 11.4.2.1 Wellhead Platform Installation/Commissioning

During the installation phase in the Offshore Study Area, underwater noise will result from activities such as operation of vessels (including tow-out), geophysical surveys and helicopter overflights. These activities could affect habitat quality and habitat use by marine mammals and sea turtles. In addition, operation of vessels could lead to direct mortality of individuals via collisions. Effects of helicopters and vessels on marine mammals and turtles were summarized in Section 11.4.1.2 and apply to the Offshore Study Area, as well as the Nearshore Study Area. Potential effects of seismic and other geophysical surveys are discussed below.

**Effects of Geophysical Surveys**

In the Offshore Study Area, geophysical surveys will include VSP as well as geohazard surveys. Similar to seismic surveys, both VSP and geohazard surveys use airguns, but a key difference is the larger array size and longer duration used in seismic surveys. The potential physical and physiological effects of noise from the geohazards equipment (typically a small airgun array, boomer, side scan sonar and echosounders) are of less concern than airgun pulses from 2-D and 3-D surveys given their relatively lower source

levels, emittence in a narrow beam, short duration of the geohazards program, and that some equipment operates at frequencies outside the range of marine mammal and sea turtle hearing abilities. Nonetheless, the possible effects of seismic surveys are summarized below.

The potential physical and physiological effects of seismic programs on marine mammals and sea turtles have recently been reviewed for StatoilHydro's 3-D program in Jeanne d'Arc Basin (LGL 2008), Petro-Canada's 3-D program in Jeanne d'Arc Basin (LGL 2007e) and for Husky's program in northern Jeanne d'Arc Basin (LGL 2005a; Moulton et al. 2006b). Geohazard surveys are less likely to affect marine mammals and sea turtles as reviewed in several environmental assessments for Jeanne d'Arc Basin (LGL 2005a, 2005b, 2005c, 2005d, 2008).

### *Masking*

Geophysical surveys may affect marine mammals and sea turtles through masking. Gedamke et al. (2011) suggested that blue and fin whale communication space may be reduced by 36 to 51 percent when seismic surveys are operating. Nieukirk et al. (2011) also suggested the potential of masking effects from seismic surveys on large whales in Fram Strait and the Greenland Sea. The biological repercussions of a loss of communication space are unknown (Clark et al. 2009).

The duty cycle of airguns is low; the airgun sounds are pulsed, with relatively quiet periods between pulses. In most situations, strong airgun sound will only be received for a brief period (less than 1 s), with these sound pulses being separated by at least several seconds of relative silence, and longer in the case of deep-penetration surveys or refraction surveys. A single airgun array might cause appreciable masking in only one situation: when propagation conditions are such that sound from each airgun pulse reverberates strongly and persists for much or all of the interval up to the next airgun pulse (e.g., Simard et al. 2005; Clark and Gagnon 2006). Situations with prolonged strong reverberation are infrequent. However, it is common for reverberation to cause some lesser degree of elevation of the background level between airgun pulses (e.g., Guerra et al. 2009), and this weaker reverberation presumably reduces the detection range of calls and other natural sounds to some degree.

Although masking effects of pulsed sounds on marine mammal calls and other natural sounds are expected to be limited, there are few specific studies on this. Some whales continue calling in the presence of seismic pulses and whale calls often can be heard between the seismic pulses (e.g., Richardson et al. 1986; McDonald et al. 1995; Greene et al. 1999a, 1999b; Nieukirk et al. 2004; Smultea et al. 2004; Holst et al. 2005a, 2005b, 2006, 2011; Dunn and Hernandez 2009; Cerchio et al. 2011). However, there is one summary report indicating that calling fin whales distributed in one part of the North Atlantic went silent for an extended period starting soon after the onset of a seismic survey in the area (Clark and Gagnon 2006). It is not clear from that preliminary paper whether the whales ceased calling because of masking, or whether this was a behavioural response not directly involving masking. Also, bowhead whales in the Beaufort Sea may decrease their call rates in response to seismic operations, although movement out of the area might also have contributed to the lower call detection rate (Blackwell et al. 2009a, 2009b, 2010, 2011). In contrast, Di Iorio and Clark (2010) found that blue whales in the St. Lawrence Estuary increased their call rates during operations by a lower-energy seismic source. The sparker used during the study

emitted frequencies of 30 to 450 Hz with a relatively low source level of 193 dB re 1 µPa (peak-peak).

Among the odontocetes, there has been one report that sperm whales ceased calling when exposed to pulses from a very distant seismic ship (Bowles et al. 1994). However, later studies of sperm whales found that they continued calling in the presence of seismic pulses (Madsen et al. 2002; Tyack et al. 2003; Smultea et al. 2004; Holst et al. 2006, 2011; Jochens et al. 2008). Madsen et al. (2006) noted that airgun sounds would not be expected to mask sperm whale calls given the intermittent nature of airgun pulses. Dolphins and porpoises are also commonly heard vocalizing while airguns are operating (e.g., Gordon et al. 2004; Smultea et al. 2004; Holst et al. 2005a, 2005b, 2011; Potter et al. 2007). Masking effects of seismic pulses are expected to be negligible in the case of the smaller odontocetes, given the intermittent nature of seismic pulses plus the fact that sounds important to them are predominantly at much higher frequencies than are the dominant components of airgun sounds.

A few cetaceans are known to increase the source levels of their calls in the presence of elevated sound levels, shift their peak frequencies in response to strong sound signals, or otherwise modify their vocal behaviour in response to increased noise (Dahlheim 1987; Au 1993; reviewed in Richardson et al. 1995; Lesage et al. 1999; Terhune 1999; Nieukirk et al. 2005; Scheifele et al. 2005; Parks et al. 2007, 2009, 2011; Hanser et al. 2009; Holt et al. 2009; Di Iorio and Clark 2010; McKenna 2011; Castellote et al. 2012; Risch et al. 2012). It is not known how often these types of responses occur upon exposure to airgun sounds. If cetaceans exposed to airgun sounds sometimes respond by changing their vocal behaviour, this adaptation, along with directional hearing and preadaptation to tolerate some masking by natural sounds (Richardson et al. 1995), would all reduce the importance of masking by seismic pulses.

Pinnipeds have their best hearing sensitivity and/or produce most of their sounds at frequencies higher than the dominant components of airgun sound, but there is some overlap in the frequencies of the airgun pulses and the calls. Although the best hearing sensitivity of sea turtles does include the low frequencies in the range of airguns, they are generally not known to be vocal while in the water. In any case, the intermittent nature of airgun pulses presumably reduces the potential for masking.

***Disturbance***

A change in behaviour, resulting from disturbance and avoidance, is the most likely effect, if any, of seismic and geohazard surveys on marine mammals and sea turtles. The following text provides summaries and updated literature from recent seismic and geohazard survey environmental assessments prepared for the Jeanne d'Arc Basin. The reader is referred to LGL (2005b: Section 6.5.12), Moulton et al. (2006b: Sections 6.1.2 and 6.1.3), LGL (2007e: Section 5.6.6) and LGL (2008) for a detailed review of seismic effects and LGL (2005b, 2005c, 2005d, 2008) for a review of geohazard survey behavioural effects on marine mammals and sea turtles.

Baleen whales tend to avoid operating 2-D and 3-D airguns, but avoidance radii are quite variable. Although baleen whales often show only slight overt responses to operating airgun arrays (e.g., Stone and Tasker 2006; Weir 2008; Moulton and Holst 2010), strong avoidance reactions by several species of mysticetes like bowheads and humpback whales have been observed as far as 20 to 30 km from the source vessel when large

arrays of airguns were used (e.g., Miller et al. 1999; Richardson et al. 1999). Avoidance distances often exceed the distances at which boat-based observers can see whales, so observations from the source vessel are biased. Studies indicate monitoring over broader areas may be needed to determine the range of potential effects of some larger seismic surveys (Richardson et al. 1999; Bain and Williams 2006; Moore and Angliss 2006). In contrast, some whales are often reported to show very little or no overt reactions to airgun pulses at distances beyond a few kilometres, even though the airgun pulses remain well above ambient noise levels out to much longer distances. Because the responses become less obvious with diminishing received sound level, it has been difficult to determine the maximum distance (or minimum received sound level) at which reactions to seismic become evident and, hence, how many whales are affected.

Studies of gray, bowhead, and humpback whales have determined that received levels of pulses in the 160 to 170 dB re 1 µPa (rms) range seem to cause obvious avoidance behaviour in a substantial fraction of the animals exposed. In many areas, 2-D and 3-D seismic pulses diminish to these levels at distances ranging from 4.5 to 14.5 km from the source. A substantial proportion of the baleen whales within this distance range may show avoidance or other strong disturbance reactions to the operating airgun array. In the case of migrating bowhead whales, avoidance extends to larger distances and lower received sound levels. Intensive study of western gray whales summering in feeding areas off Sakhalin Island, Russia, showed that some whales (5 to 10 individuals) moved away from waters inshore of seismic operations to a core feeding area farther south (Yazvenko et al. 2007a), but that there was no measureable effect on bottom feeding by gray whales relative to the seismic survey (Yazvenko et al. 2007b). Humpback whales on their summer feeding grounds in southeast Alaska did not exhibit persistent avoidance when exposed to seismic pulses from a 1.64 L (100 $in^3$) airgun, but some humpbacks seemed “startled” at received levels of 150 to 169 dB re 1 µPa (Malme et al. 1985). Malme et al. (1985) concluded that there was no clear evidence of avoidance, despite the possibility of subtle effects, at received levels up to 172 re 1 µPa (rms). However, Moulton and Holst (2010) reported that humpback whales monitored during seismic surveys in the Northwest Atlantic had statistically significant lower sighting rates and were most often seen swimming away from the vessel during seismic periods compared with periods when airguns were silent. Similarly, Castellote et al. (2012) reported that singing fin whales in the Mediterranean moved away from an operating airgun array and avoided the area of operations even for days after airgun activity had ceased. In addition, Stone (2003) noted that fin/sei whales were less likely to remain submerged during periods of seismic shooting.

Data on short-term reactions (or lack of reactions) of cetaceans to impulsive noises do not necessarily provide information about long-term effects. Generally, it is not known whether impulsive noises affect reproductive rate or distribution and habitat use in subsequent days or years. Castellote et al. (2012) reported that fin whales avoided their potential winter ground for an extended period of time (at least 10 days) after seismic operations in the Mediterranean Sea had ceased. Some populations of mysticetes have continued to grow despite increasing anthropogenic activities, including seismic activities. Long-term data on gray whales show that they continue to migrate annually along the west coast of North America despite intermittent seismic exploration (and much ship traffic) in that area for decades (Appendix A in Malme et al. 1984). Bowhead whales continued to travel to the eastern Beaufort Sea each summer despite seismic exploration in their summer and autumn range for many years. Bowheads were often seen in summering areas where seismic exploration occurred in preceding summers

(Richardson et al. 1987). They also have been observed over periods of days or weeks in areas repeatedly ensonified by seismic pulses. However, it is not known whether the same individual bowheads were involved in these repeated observations (within and between years) in strongly ensonified areas.

Extensive data from vessel-based monitoring programs in United Kingdom waters, the Northwest Atlantic and off Angola suggest that sperm whales in those areas show little evidence of avoidance or behavioural disruption in the presence of operating seismic vessels (Stone 2003; Stone and Tasker 2006; Weir 2008; Moulton and Holst 2010). An at-sea controlled experiment on the effects of airguns on sperm whales in the Gulf of Mexico indicated that sperm whales do not exhibit avoidance reactions to airguns (Miller et al. 2009). However, the experiment did suggest that airgun exposure could lead to subtle changes in the sperm whale foraging behaviour, such as delaying foraging behaviour. One animal that was resting at the survey before the onset of airgun activity remained resting at the surface throughout the duration of airgun activity, but initiated a foraging dive shortly after the airguns ceased (Miller et al. 2009). There are no specific data on responses of beaked whales to seismic surveys, but it is likely that most if not all species show strong avoidance due to their documented tendency to avoid vessels in general. Of note, northern bottlenose whales have been observed to approach within 600 m of seismic vessels operating in the Orphan Basin when the airgun arrays were active (Moulton and Holst 2010).

Dolphins and other small toothed whales are often seen by observers on active seismic vessels, but in general there is a tendency for most delphinids to show some avoidance of operating seismic vessels (e.g., Goold 1996a, 1996b, 1996c; Calambokidis and Osmek 1998; Stone 2003; Moulton and Miller 2005; Holst et al. 2006; Stone and Tasker 2006; Weir 2008; Richardson et al. 2009; Barkaszi et al. 2009; Moulton and Holst 2010). In most cases, the avoidance radii for delphinids appear to be small, on the order of 1 km or less, and some individuals show no apparent avoidance. Some dolphins seem to be attracted to the seismic vessel and floats, and some ride the bow wave of the seismic vessel even when a large array of airguns is firing (e.g., Moulton and Miller 2005). Nonetheless, small toothed whales more often tend to head away or maintain a somewhat greater distance from the vessel, when a large array of airguns is operating than when it is silent (e.g., Stone and Tasker 2006; Weir 2008; Moulton and Holst 2010; Barry et al. 2012). Belugas summering in the Beaufort Sea tended to avoid waters out to 10 to 20 km from an operating seismic vessel (Miller et al. 2005a). Other seismic monitoring studies in the same area have confirmed that the apparent displacement effect on belugas extended farther than has been shown for other small odontocetes exposed to airgun pulses (e.g., Harris et al. 2007).

Visual monitoring from seismic vessels has shown only slight (if any) avoidance of airguns by pinnipeds, and only slight (if any) changes in behaviour (e.g., Harris et al. 2001; Moulton and Lawson 2002; Miller et al. 2005b; Funk et al. 2010; Haley et al. 2010). These studies indicate that pinnipeds frequently do not avoid the area within a few hundred metres of an operating airgun array. However, limited telemetry work suggests that avoidance and other behavioural reactions may be stronger than evident to date from visual studies (Thompson et al. 1998).

In summary, short-term avoidance behaviour is not likely to cause any negative effects on the well-being of marine mammals. Furthermore, lack of avoidance is not necessarily a positive result if it means that the animals remain in a heavily ensonified area where (if

the ship gets close enough) there is a possibility of temporary hearing loss. In general, there seems to be a tendency for most baleen and toothed whales to show some limited avoidance of seismic vessels operating large airgun systems. Seals appear less likely to avoid seismic vessels operating airgun arrays.

There have been far fewer studies of the effects of airgun noise (or indeed any type of noise) on sea turtles than on marine mammals. Four studies (O'Hara and Wilcox 1990; Moein et al. 1994; McCauley et al. 2000a, 2000b; Lenhardt 2002) have focused on short-term behavioural responses of sea turtles in enclosures to airguns; these studies showed that sea turtles generally tend to show avoidance of an operating airgun at some received level. McCauley et al. (2000a, 2000b) noted behavioural responses (increased swimming speed) by caged green and loggerhead turtles when the received level from a single small airgun (20 $in^3$ at 1500 psi) was 166 dB re 1 µPa (rms) and avoidance responses at 175 dB re 1 µPa (rms). Captive loggerhead sea turtles maintained a standoff range of about 30 m in response to a 10 $in^3$ airgun plus two 0.8 $in^3$ "poppers" operating at 2000 psi (O'Hara and Wilcox 1990). Moein et al. (1994) also noted avoidance by enclosed loggerhead turtles in response to airgun sounds (up to 179 dB) at a mean range of 24 m; however, the avoidance response waned quickly. Moein et al. (1994) also noted that TTS apparently occurred in confined loggerhead turtles exposed to many pulses from a single airgun less than 65 m away. Lenhardt (2002) exposed captive loggerhead sea turtles while underwater to seismic airgun (Bolt 600) sounds in a large net enclosure. At received levels of 151 to 161 dB, turtles were found to increase swimming speeds. Similar to the McCauley et al. studies (2000a, 2000b), near a received level of approximately 175 dB, an avoidance reaction was common in initial trials, but habituation then appeared to occur. McCauley et al. (2000a, 2000b) estimated that, for a typical airgun array (2,678 $in^3$, 12-elements) operating in 100 to 120 m water depth, sea turtles may exhibit behavioural changes at approximately 2 km and avoidance around 1 km.

The limited available data indicate that sea turtles will hear airgun sounds and that they are likely to exhibit behavioural changes and/or avoidance within an area of unknown size near a seismic vessel. Holst et al. (2006) reported behavioural changes and/or avoidance near a seismic vessel, but the distances or sound levels at which these responses occurred could not be determined. Weir (2007) reported that 80 percent of basking sea turtles (olive ridley, leatherback and loggerhead) remained at the sea surface in response to airgun sound of Angola. The airguns produced source levels of 220 to 248 dB re 1 µPa at 1 m with peak energy from 10 to 200 Hz. There was no difference in median distance of sightings between full-array and guns-off. In contrast, 57 percent of loggerhead sea turtles in the Mediterranean interrupted basking behaviour and dove in response to airguns with a source level of 252 dB re 1 µPa (peak) (DeRuiter and Larbi Doukara 2012). Received levels of airgun sound ranged from 193 to 197 dB re 1 µPa (peak) at 72 m and from 190 to 193 dB re 1 µPa (peak) at 94 m. The median distance between the airgun array and the turtles when they dove was 150 m (range 50 to 839 m). The likelihood of diving increased as closest point of approach to the vessel decreased.

### *Hearing Impairment*

Temporary or permanent hearing impairment is a possibility when marine mammals and sea turtles are exposed to very strong sounds. The minimum sound level necessary to cause permanent hearing impairment is higher, by a variable and generally unknown

amount, than the level that induces barely-detectable TTS. The level associated with the onset of TTS is often considered to be a level below which there is no danger of permanent damage. As discussed earlier, current NMFS policy regarding exposure of marine mammals to high-level sounds is that cetaceans and pinnipeds should not be exposed to impulsive sounds exceeding 180 and 190 dB re 1 µPa (rms), respectively (NMFS 2000a, 2000b). However, those criteria were established before there was any information about the minimum received levels of sounds necessary to cause TTS in marine mammals. The 180 dB criterion for cetaceans is probably quite conservative (i.e., lower than necessary to avoid auditory injury), at least for delphinids (Southall et al. 2007). The 180-dB criterion is also typically used for sea turtles.

The magnitude of TTS depends on the level and duration of noise exposure, and to some degree on frequency, among other considerations (Kryter 1985; Richardson et al. 1995; Southall et al. 2007). For sound exposures at or somewhat above the TTS threshold, hearing sensitivity recovers rapidly after exposure to the noise ends. Extensive studies on terrestrial mammal hearing in air show that TTS can last from minutes or hours to (in cases of strong TTS) days. More limited data from odontocetes and pinnipeds show similar patterns (e.g., Mooney et al. 2009a, 2009b; Finneran et al. 2010a). However, none of the published data concern TTS elicited by exposure to multiple pulses of sound during operational seismic surveys (Southall et al. 2007).

For baleen whales, there are no data, direct or indirect, on levels or properties of sound that are required to induce TTS. The frequencies at which baleen whales are most sensitive are lower than those at which odontocetes are most sensitive, and natural background noise levels at those low frequencies tend to be higher. As a result, auditory thresholds of baleen whales within their frequency band of best hearing are believed to be higher (less sensitive) than are those of odontocetes at their best frequencies (Clark and Ellison 2004). From this, it is suspected that received levels causing TTS onset may also be higher in baleen whales. Based on available data, TTS is not expected to occur among baleen whales exposed to seismic sound, given the strong likelihood that they would avoid an approaching airgun(s) (or vessel) before being exposed to levels high enough for there to be any possibility of TTS (NSF and L-DEO 2006a, 2006b; Wilson et al. 2006). This assumes that mitigation consisting of ramp up (soft start) procedures is used when commencing airgun operations. It is assumed that this approach provides the opportunity for whales near the seismic vessel to move away before they are exposed to sound levels that might be strong enough to elicit TTS (Wilson et al. 2006). However, the effectiveness of this procedure has not been empirically studied. Gedamke et al. (2011) suggested that some baleen whales whose closest point of approach to a 2-D or 3-D seismic vessel is 1 km or more could experience TTS. To determine how close an airgun array would need to approach in order to elicit TTS, one would (as a minimum) need to allow for the sequence of distances at which airgun shots would occur, and for the dependence of received SEL on distance in the region of the seismic operation (e.g., Erbe and King 2009; Breitzke and Bohlen 2010; Laws 2012).

There are empirical data on the sound exposures that elicit onset of TTS in captive bottlenose dolphins, belugas and porpoise (e.g., Finneran et al. 2005; Lucke et al. 2009; Mooney et al. 2009a; Popov et al. 2011). The majority of these data concern non-impulse sound, but there are some limited published data concerning TTS onset upon exposure to a single pulse of sound from a watergun (Finneran et al. 2002). A detailed review of all TTS data from marine mammals can be found in Southall et al. (2007). For toothed whales exposed to single short pulses, the TTS threshold appears to

be, to a first approximation, a function of the energy content of the pulse (Finneran et al. 2002, 2005). Given the available data, the received sound energy level of a single seismic pulse (with no frequency weighting) might need to be approximately 186 dB re 1 $\mu Pa^2 \cdot s$ (i.e., 186 dB SEL or approximately 221 to 226 dB peak-peak) in order to produce brief, mild TTS (Southall et al. 2007). Exposure to several strong seismic pulses that each have received levels near 175 to 180 dB SEL might result in slight TTS in a small odontocete. However, additional data are needed to determine the received sound levels at which small odontocetes would start to incur TTS upon exposure to repeated, LF pulses of airgun sound with variable received levels. The assumption that, in marine mammals, the occurrence and magnitude of TTS is a function of cumulative acoustic energy (SEL) is probably an oversimplification (Finneran 2012). TTS and presumably PTS thresholds may depend somewhat on the duration over which sound energy is accumulated, the frequency of the sound, whether or not there are gaps and probably other factors (Ketten 1994, 2012). Recent data have shown that the SEL required for TTS onset to occur increases with intermittent exposures, with some auditory recovery during silent periods between signals (Finneran et al. 2010b; Finneran and Schlundt 2011).

The above TTS information for odontocetes is derived from studies on the bottlenose dolphin and beluga. For the one harbour porpoise tested, the received level of airgun sound that elicited onset of TTS was lower. The animal was exposed to single pulses from a small (20 $in^3$) airgun, and auditory evoked potential methods were used to test the animal's hearing sensitivity at frequencies of 4, 32, or 100 kHz after each exposure (Lucke et al. 2009). Based on the measurements at 4 kHz, TTS occurred upon exposure to one airgun pulse with received level of approximately 200 dB re 1 µPa (peak-peak), or an SEL of 164.3 dB re 1 $\mu Pa^2 \cdot s$. If these results from a single animal are representative, it is inappropriate to assume that onset of TTS occurs at similar received levels in all odontocetes (cf. Southall et al. 2007). Some cetaceans may incur TTS at lower sound exposures than are necessary to elicit TTS in the beluga or bottlenose dolphin.

TTS thresholds for pinnipeds exposed to brief pulses (either single or multiple) of underwater sound have not been measured (Finneran et al. 2003). However, initial evident from more prolonged (non-pulse and pulse) exposures suggested that some pinnipeds (harbour seals in particular) incur TTS at somewhat lower received levels than do small odontocetes exposed for similar durations (Kastak et al. 1999, 2005; Ketten et al. 2001; Kastelein et al. 2011). At least for non-impulse sound, TTS onset in the California sea lion and northern elephant seal occurs at a similar SEL level as in odontocetes (Kastak et al. 2005).

There is no specific evidence that exposure to pulses of airgun sound can cause PTS in any marine mammal, even with large arrays of airguns. However, given the likelihood that some mammals close to an airgun array might incur at least mild TTS (see Finneran et al. 2002), there has been speculation about the possibility that some individuals occurring very close to airguns might incur PTS (Richardson et al. 1995, p. 372). The specific difference between the PTS and TTS thresholds has not been measured for marine mammals exposed to any sound type. When exposure is measured in SEL units, Southall et al. (2007) conclude the PTS-onset to TTS-onset difference for marine mammal exposure to impulse sound is at least 15 dB. Based on data from terrestrial mammals, a precautionary assumption is that the PTS threshold for impulse sounds (such as airgun pulses as received close to the source) is at least 6 dB higher than the TTS threshold on a peak-pressure basis, and probably more than 6 dB.

There have been few studies that have directly investigated hearing or noise-induced hearing loss in sea turtles, and these limited numbers of studies have used net-enclosure experiments. The apparent occurrence of TTS in loggerhead turtles exposed to many pulses from a single airgun less than or equal to 65 m away (Moein et al. 1994) suggests that sounds from an airgun array could cause at least temporary hearing impairment in sea turtles if they do not avoid the (unknown) radius where TTS occurs. Similarly, Lenhardt (2002) reported a TTS of greater than 15 dB for a loggerhead turtle, with recovery occurring in two weeks. Turtles in the open sea might have moved away from an airgun operating at a fixed location, and in the more typical case of a towed airgun or airgun array, very few shots would occur at or around one location. Thus, exposure to underwater sound during net-enclosure experiments was not typical of that expected during an operational seismic survey. There are no data to indicate whether or not there are any plausible situations in which exposure to repeated airgun pulses at close range could cause permanent hearing impairment in sea turtles.

***Non-auditory Physiological***

There is no specific evidence that airgun pulses can cause serious injury, death, or stranding even in the case of large airgun arrays. However, the association of strandings of beaked whales with naval exercises (e.g., Simmonds and Lopez-Jurado 1991; Frantzis 1998; NOAA and USN 2001; Jepson et al. 2003; Barlow and Gisiner 2006; D'Amico et al. 2009; Filadelfo et al. 2009) and, in one case, a seismic survey (Malakoff 2002; Cox et al. 2006), has raised the possibility that beaked whales exposed to strong pulsed sounds may be especially susceptible to injury and/or behavioural reactions that can lead to stranding (e.g., Hildebrand 2005; Southall et al. 2007). These strandings are apparently at least in part a disturbance response, although auditory or other injuries or other physiological effects may also be a factor. Hildebrand (2005) reviewed the association of cetacean strandings with high-intensity sound events and found that deep-diving odontocetes, primarily beaked whales, were by far the predominant (95 percent) cetaceans associated with these events, with 2 percent mysticete whales (minke). However, as summarized below, there is no definitive evidence that airguns can lead to injury, strandings, or mortality even for marine mammals in close proximity to large airgun arrays.

Specific sound-related processes that lead to strandings and mortality are not well documented, but may include: (1) swimming in avoidance of a sound into shallow water; (2) a change in behaviour (such as a change in diving behaviour that might contribute to tissue damage, gas bubble formation, hypoxia, cardiac arrhythmia, hypertensive hemorrhage or other forms of trauma; (3) a physiological change such as a vestibular response leading to a behavioural change or stress-induced hemorrhagic diathesis, leading in turn to tissue damage; and (4) tissue damage directly from sound exposure, such as through acoustically mediated bubble formation and growth or acoustic resonance of tissues. Some of these mechanisms are unlikely to apply in the case of impulse sounds from airguns. For example, resonance effects (Gentry 2002) and acoustically-mediated bubble-growth (Crum et al. 2005) are implausible in the case of exposure to an impulsive broadband source like an airgun array.

Seismic pulses and mid-frequency sonar signals are quite different, and some mechanisms by which sonar sounds have been hypothesized to affect beaked whales are unlikely to apply to airgun pulses. Sounds produced by airgun arrays are broadband impulses with most of the energy below 1 kHz. Typical military mid-frequency sonars

emit non-impulse sounds at frequencies of 2 to 10 kHz, generally with a relatively narrow bandwidth at any one time (though the frequency may change over time). Thus, it is not appropriate to assume that the effects of seismic surveys on beaked whales or other species would be the same as the apparent effects of military sonar. Nonetheless, evidence that sonar signals can, in special circumstances, lead (at least indirectly) to physical damage and mortality (e.g., Balcomb and Claridge 2001; NOAA and USN 2001; Jepson et al. 2003; Fernández et al. 2004, 2005; Hildebrand 2005; Cox et al. 2006) suggests that caution is warranted when dealing with exposure of marine mammals to any high-intensity pulsed sound.

Although there is no conclusive evidence of cetacean strandings or deaths at sea as a result of exposure to seismic surveys, Gray and Van Waerebeek (2011) have suggested a cause-effect relationship between a seismic survey off Liberia in 2009 and the erratic movement, postural instability and akinesia (loss of control of voluntary muscle movements) in a pantropical spotted dolphin based on spatially and temporally close association with the airgun array. Additionally, a few cases of strandings in the general area where a seismic survey was ongoing have led to speculation concerning a possible link between seismic surveys and strandings. However, suggestions that there was a link between seismic surveys and strandings of humpback whales in Brazil (Engel et al. 2004) were not well founded (IAGC 2004; IWC 2007). In September 2002, there was a stranding of two Cuvier's beaked whales in the Gulf of California, Mexico, when the R/V *Maurice Ewing* was operating a 20 airgun, 8,490 $in^3$ airgun array in the general area. The evidence linking the stranding to the seismic survey was inconclusive and not based on any physical evidence (Hogarth 2002; Yoder 2002). The ship was also operating its multibeam echosounder at the same time, but this had much less potential than the aforementioned naval sonars to affect beaked whales, given its downward-directed beams, much shorter pulse durations, and lower duty cycle. Nonetheless, the Gulf of California incident plus the beaked whale strandings near naval exercises involving use of MF sonar suggest a need for caution in conducting seismic surveys in areas occupied by beaked whales until more is known about effects of seismic surveys on those species (Hildebrand 2005).

Sea turtle mortality or injury has not been documented to occur as a result of exposure to sounds from seismic surveys. However, entanglement of sea turtles in seismic gear is also a concern; there have been reports of turtles being trapped and killed between the gaps in tail-buoys offshore of West Africa (Weir 2007). The probability of entanglements will be a function of turtle density in the study area, which is expected to be low.

#### 11.4.2.2 Operation and Maintenance

During the operations and maintenance phase in the Offshore Study Area, underwater noise can result from activities such as drilling operations from the WHP and from a MODU, production operations, helicopter overflights, vessel traffic, and geophysical and seismic surveys. In addition to activities that will produce noise, other activities that may affect habitat quality and habitat use include discharges (e.g., cooling water, drill cuttings and muds discharges) and presence of structures (e.g., subsea equipment in drill centres, WHP). In addition, there is limited potential for direct mortality of marine mammals and sea turtles via collisions with vessels.

This section summarizes the possible environmental effects of drilling on marine mammals and sea turtles. The possible effects of geophysical surveys, vessel traffic and

helicopter overflights on marine mammals and sea turtles have already been discussed in previous sections. The possible effects of activities that are not associated with sound production are discussed later in Section 11.5.2.

**Effects of Drilling**

Drilling may occur from the WHP (and/or from MODUs). Of note, dynamically-positioned drill ships are typically noisier than semi-submersibles which, in turn, are noisier than jackups (Richardson et al. 1995). However, no underwater sound level measurements are currently available for a WHP, but a WHP would presumably be quieter given the concrete surrounding the drill string in the water column, and the wellhead being above water.

Kapel (1979) reported numerous baleen whales – mainly fin, minke and humpback whales – within visual range of active drillships off West Greenland. In more formal studies, bowhead whales reacted to drillship sounds within 4 to 8 km of a drillship when received levels were 20 dB above ambient or approximately 118 dB re 1 µPa (Greene 1985, 1987; Richardson et al. 1985b, 1990). Reaction was greater at the onset of the sound (Richardson et al. 1995). Thus, bowhead whales migrating in the Beaufort Sea avoided an area with a 10 km radius around a drillship, which corresponded to received sound levels of 115 dB re 1 µPa (Richardson et al. 1990). Some whales were less responsive and habituation may occur, so that in time, bowheads may be seen within 4 to 8 km of a drillship (Richardson et al. 1985a, 1990). Sound attenuates less rapidly in the shallow Beaufort Sea, where these experiments were conducted, than in temperate waters with greater depths. Off California, the reaction zone around a semi-submersible drilling unit was much less than 1 km for gray whales (Malme et al. 1983, 1984). Humpback whales showed no clear avoidance response to received drillship broadband sounds of 116 dB re 1 µPa (Malme et al. 1985).

The proximal part of the migration corridor of bowhead whales in the Alaskan Beaufort Sea has been monitored during construction, drilling and production activities at an artificial island (Northstar) just inshore of the migration corridor (Richardson and Williams 2004). The primary objective of the monitoring program was to determine if, at high-noise times, underwater sound propagating from Northstar and its support vessels deflected the southern part of the bowhead migration corridor. An acoustical localization method was used to determine the locations of calling bowhead whales (Greene et al. 2004). Overall, the results showed evidence consistent with slight offshore displacement of the proximal edge of the bowhead migration corridor at some times when levels of underwater sound were unusually high (Green et al. 2004; McDonald et al. 2010). These high-noise occasions were attributable to support vessels operating near the production facility rather than to the island-based operation itself.

Beluga whales were exposed to playback sounds from a semi-submersible drill rig in an Alaskan river (Stewart et al. 1982). During the two tests, belugas swimming toward the sound source did not react overtly until they were within 50 to 75 m and 300 to 500 m, respectively; some belugas altered course to swim around the source, some increased swimming speed, and one reversed direction of travel. Reactions to sound from the semi-submersible drill unit were less severe than were reactions to motorboats with outboards (Stewart et al. 1982). Dolphins and other toothed whales show considerable tolerance of drill rigs and their support vessels, particularly when there are not negative consequences from close approach to the activities (Richardson et al. 1995).

Ringed seals were often seen near drill ships drilling in the Arctic in summer and fall (several reports summarized by Richardson et al. 1995). Ringed seals and bearded seals approached and dove within 50 m of a projector transmitting drilling sound into the water (received sound levels were 130 dB re 1 µPa). Other studies of seals near active seismic vessels (Harris et al. 2001; Moulton and Lawson 2002) confirm that seals are tolerant of offshore industrial activities.

There are currently no available systematic data on sea turtle reactions to noise from drilling rigs.

#### 11.4.2.3 Decommissioning and Abandonment

During the decommissioning and abandonment phase in the Offshore Study Area, vessel traffic, helicopter overflights and geophysical surveys could produce underwater noise which may affect marine mammals and sea turtles. These activities, as well as those that do not produce sound (e.g., air emissions), could affect habitat quality and habitat use. Also, there is some potential for direct mortality as a result of collisions with vessels. The possible effects of geophysical surveys, vessel traffic and helicopter overflights have been discussed previously within Section 11.4. All of the activities during this phase of the WREP are expected to have no more than short-term and localized effects on marine mammals and sea turtles in the Offshore Study Area. In addition, collisions, although possible, are expected to be unlikely given the wide distribution of marine mammals and sea turtles in the Offshore Study Area and the relatively slow vessel speeds.

#### 11.4.2.4 Potential Future Activities

Future activities in the Offshore Study Area may include, but are not limited to, geophysical surveys, dredging, flowline and subsea equipment installation, drilling, vessel traffic and helicopter overflights. All of these activities will introduce sound into the water, which in turn may affect marine mammals and sea turtles. These activities, as well as those that do not produce sound (e.g., chemical use and management, cuttings), could affect habitat quality and habitat use. Also, there is some potential for direct mortality as a result of collisions with vessels. The possible effects of these activities have been discussed previously within Section 11.4. All of the activities during this phase of the WREP are expected to have no more than short-term and localized effects on marine mammals and sea turtles in the Offshore Study Area. In addition, collisions are considered unlikely.

### 11.4.3 Accidental Events

There is a possibility of fuel and oil spills in the Nearshore and Offshore Study Areas. There are several physical and internal functions that may be affected by oil fouling of marine mammals and sea turtles. Hydrocarbons can be inhaled or ingested, and may cause behavioural changes, inflammation of mucous membranes, pneumonia and neurological damage (see Geraci and St. Aubin 1990). However, many marine mammals seem to show a relatively high tolerance level to oil spills (see Geraci and St. Aubin 1990). Whales and seals rely on a layer of blubber for insulation, and so oil has little effect on thermoregulation. In baleen whales, crude oil could coat the baleen and reduce filtration efficiency, but these effects are considered to be reversible (Geraci 1990). Seals fouled externally with heavy oil may also encounter problems with

locomotion, with flippers becoming stuck to their sides (Seargent 1991). If oil contacted the eyes, effects would likely be similar to that observed in ringed seals (conjunctivitis, corneal abrasion and swollen nictitating membranes), and that continued exposure to eyes could cause permanent damage (St. Aubin 1990). Damage to the visual system would likely limit foraging abilities, as vision is an important sensory modality used to locate and capture prey.

Several species of cetaceans and seals have been documented behaving normally in the presence of oil (St. Aubin 1990; Harvey and Dahlheim 1994; Matkin et al. 1994, 1999). Studies of both captive and wild cetaceans indicate that they can detect oil spills. Captive bottlenose dolphins avoided most oil conditions during daylight and darkness, but had difficulty detecting a thin sheen of oil (St. Aubin et al. 1985). Wild bottlenose dolphins exposed to the *Mega Borg* oil spill in 1990 appeared to detect, but did not consistently avoid contact with, most oil types (Smultea and Würsig 1995). This is consistent with other cetaceans behaving normally in the presence of oil (Harvey and Dahlheim 1994; Matkin et al. 1994). It is possible that cetaceans swim through oil because of an overriding behavioural motivation (for example, feeding). Some evidence exists that indicates dolphins attempt to minimize contact with surface oil by decreasing their respiration rate and increasing dive duration (Smultea and Würsig 1995). Based on a comparison of sperm whale acoustic activity from pre-spill (2007) and post-spill (2010) conditions, Ackleh et al. (2012) suggested that sperm whales may have relocated farther away from the Deepwater Horizon oil spill site in the Gulf of Mexico, as there was a statistically significant reduction in acoustic activity and abundance at a site 40 km (25 miles) compared with 14.5 km (9 miles) from the spill in 2010. Humpback whales may have shown temporary avoidance during the *Exxon Valdez* spill in Prince William Sound (von Ziegesar et al. 1994).

There is conflicting evidence on whether seals detect and avoid spilled oil. Some oiled seals hauled out on land are reluctant to enter the water, even when disturbances from intense cleanup activities occur nearby (St. Aubin 1990; Lowry et al. 1994). In contrast, several thousand grey and harbour seals apparently left Chedabucto Bay, Nova Scotia, after the grounding of the *Arrow* (Mansfield 1970, in St. Aubin 1990), although this movement may have been caused by the increased human disturbance during cleanup activities rather than by the presence of oil (St. Aubin 1990). Harbour seals observed immediately after oiling appeared lethargic and disoriented, which may be attributed to lesions observed in the thalamus of the brain (Spraker et al. 1994). Other seals have been observed swimming in the midst of oil spills (St. Aubin 1990). Oiling of both mother and pups does not appear to interfere with nursing (Lowry et al. 1994).

Hydrocarbons from an oil spill could reach the shore where seals are hauled out. During the *Exxon Valdez* oil spill, approximately 2,000 km of shoreline were oiled, and the direct mortality as a result of the spill was estimated at 300 harbour seals (*Exxon Valdez* Oil Spill Trustee Council 2012). However, Hoover-Miller et al. (2001) reported that 14 harbour seals were found dead and that the cause of death could not be determined; they suggested that the other seals that were assumed to have died likely moved out of the area, partially due to disturbance by clean-up crews. At haulout sites in Prince William Sound, seal numbers in oiled areas declined by 43 percent and seal numbers in un-oiled areas dropped by 11 percent (*Exxon Valdez* Oil Spill Trustee Council 2012). Although it is uncertain what caused the initial declines, declines were more pronounced initially in oiled areas, but numbers have since stabilized.

The release of fuel oil from the *Arrow* into Chedabucto Bay, Nova Scotia, in 1970 resulted in the fouling of 500 seals within the bay and 50 to 60 harbour and 200 grey seals on Sable Island (200 km south of the spill). Twenty-four seals were found dead and some had oil in their mouths and stomachs (Anon 1970, 1971, in St. Aubin 1990). Oiled grey and harbour seals were found on the coast of Nova Scotia and Sable Island again in 1979 when the oil tanker *Kurdistan* sank in Cabot Strait. No causal relationship between oiling and death was determined (Parsons et al. 1980, in St. Aubin 1990). No mortalities were reported after a well blowout near Sable Island in 1984 and only two oiled grey seals were observed (St. Aubin 1990). Jenssen (1996) reported that oil has produced little visible disturbance to grey seal behaviour and there has been little mortality despite the fact that approximately 50 percent of grey seal pups at Norway's largest breeding colony are polluted each year by oil.

River otters may have shown a delayed reaction to oil exposure from the *Exxon Valdez* oil spill as they were found to abandon latrine sites three times more often in oiled compared with non-oiled areas two years after the spill (Duffy et al. 1994a). Bowyer et al. (1995) also noted that the use of latrine sites in heavily oiled areas was substantially less than for non-oiled sites several months after the spill. Bowyer et al. (1995) suggested that sea otters made fine-scale habitat selection as a result of a reduction of habitat availability caused by the oil spill, but this suggestion was later discounted (Bowyer et al. 2003). However, there was a significant increase in home-range size (Bowyer et al. 1995). Changes in the diets of river otters, including prey species richness and diversity, were observed between oiled and non-oiled areas more than a year after the spill, but not during the year of the spill (Bowyer et al. 1994). None of these differences were apparent during 1996 to 1999, and densities of otters were similar in oiled and non-oiled areas (Bowyer et al. 2003).

Animals could ingest oil with water, contaminated food, or oil could be absorbed through the respiratory tract; absorbed oil could cause toxic effects (Geraci 1990). Species like the humpback whale, right whale, beluga and harbour porpoise that feed in restricted areas (for example, bays such as the Nearshore Study Area) may be at greater risk of ingesting oil (Würsig 1990). Some of the ingested oil is voided in vomit or feces, but some is absorbed and could cause toxic effects (Geraci 1990). When returned to clean water, contaminated animals can depurate this internal oil (Engelhardt 1978, 1982). Whales exposed to an oil spill are unlikely to ingest enough oil to cause serious internal damage (Geraci and St. Aubin 1980, 1982). Only small traces of oil were found in the blubber of a gray whale and liver of a killer whale exposed to *Exxon Valdez* oil (Bence and Burns 1995). River otters may ingest oil while grooming the coat after swimming through an oil slick or ingesting prey (fish) that has oil in its tissues. The extent of uptake via the latter method depends on the fish's ability to metabolize hydrocarbons. Ormseth and Ben-David (2000) showed that river otters ingesting oil via grooming had an increased passage rate of digesta and reduced assimilation of hydrocarbons.

Inhalation of vapours from volatile fractions of oil from a spill or blowout could potentially irritate respiratory membranes and hydrocarbons could be absorbed into the bloodstream (Geraci 1990). Grey seals that presumably inhaled volatile hydrocarbons from the *Braer* oil spill exhibited a discharge of nasal mucous, but no causal relationship with the oil was determined (Hall et al. 1996). Absorbed oil can cause toxic effects such as minor kidney, liver and brain lesions (Geraci and Smith 1976; Spraker et al. 1994), but contaminated animals could depurate this oil when returned to clean water (Engelhardt 1982). Petroleum and polycyclic aromatic hydrocarbons from oil spills can

also affect the immune system of aquatic organisms, including marine mammals and sea turtles, but effects on the immune system are variable and likely exposure dependent (Barron 2011). NOAA (2012) reports that 32 bottlenose dolphins in Barataria Bay, Louisiana, an area that received heavy and prolonged exposure to oil during the Deepwater Horizon spill, are showing signs of poor health (e.g., underweight, anemic, liver and lung disease) and may not survive.

Direct evidence of long-term effects from chronic exposure to hydrocarbons, either through surface contact or ingestion, is lacking for both pinnipeds and cetaceans. However, Spraker et al. (1994) did find lesions characteristic of hydrocarbon toxicity in the brains of oiled seals collected several months after the *Exxon Valdez* spill. Killer whales have been shown to be susceptible to accumulating high concentrations of persistent organic pollutants, as they are long lived and are top predators (Ross et al. 2000, 2002).

In laboratory conditions, chronic exposure to low doses of weathered crude oil, resulted in physiological damage to river otters, notably a reduction in hemoglobin and white blood cells and an increase in several liver enzymes (Ben-David et al. 2000). This damage, particularly the reduction in hemoglobin led to a decrease in aerobic dive limit and a potential increase in foraging time. Also, there was an increase in energetic costs of terrestrial locomotion. These chronic physiological effects could result in a decrease in body condition of free-ranging river otters. This is supported by an observed reduction of body mass of otters at oiled vs. non-oiled sites after the *Exxon Valdez* oil spill.

Duffy et al. (1993, 1994a, 1994b) reported that blood and enzyme chemistry of river otters showed chronic effects from the 1989 *Exxon Valdez* oil spill, but these effects were no longer evident in 1992. In addition, body mass differed between oiled and non-oiled areas from 1990 to 1992 (Duffy et al. 1993), but this difference was nearly undetectable in May and June 1992 (Duffy et al. 1994b). Although analyses showed that otters were still exposed to oil in Prince William Sound from 1996 to 1999, the effects on blood and enzyme chemistry as well as body mass were nearly undetectable (Bowyer et al. 2003).

Most marine mammals, with the exception of fur seals, polar bears and sea otters (none of these species are expected to occur in either the Nearshore or Offshore Study Areas), are considered to be not directly susceptible to deleterious effects of oil. However, newborn hair seal pups and weak or stressed animals may also be vulnerable to oiling. It is uncertain how susceptible river otters are to oil spills; coastal river otters in the Placentia Bay feed on intertidal and subtidal fish and invertebrates and thus have an increased likelihood of exposure to residual oil.

Although there has not yet been any clear evidence implicating oil spills with the mortality of cetaceans (Geraci 1990), dead cetaceans have been found stranded after spills. Several dead gray whales were found during the year of the *Exxon Valdez* spill; however, a causal link could not be established (Loughlin 1994; *Exxon Valdez* Oil Spill Trustee Council 2012). Numerous dead oiled cetaceans have also been found in association with the Deepwater Horizon oil spill in the Gulf of Mexico; NMFS (2011) documented at least 10 dead, visibly oiled dolphins. Twelve dead river otters were found following the *Exxon Valdez* spill (*Exxon Valdez* Oil Spill Trustee Council 2012). Bowyer et al. (2003) state that the "*…number of carcasses of river otters counted immediately following EVOS are a gross underestimate of the actual mortality…*" as beach surveys

would not have detected most dead otters. Toxicological analyses of several of the carcasses indicated river otters died from acute effects of oiling. The magnitude of mortalities is uncertain but it is thought that high rates of mortality did not occur immediately following the *Exxon Valdez* spill (Testa et al. 1994).

There was a substantial decrease and lack of recovery in the population size of a fish-eating killer whale pod that uses the area of the *Exxon Valdez* oil spill (Dahlheim and Matkin 1994). Continued monitoring over 16 years indicates that the killer whale pod had still not returned to its pre-spill population abundance, and the population's rate of increase was substantially less than other fish-eating pods in the area (Matkin et al. 2008). Another mammal eating killer whale pod declined substantially following the spill and is now listed as "Depleted" under the *US Marine Mammal Protection Act*, although there may have been other contributing factors in the decline (Matkin et al. 2008). This group may even be at risk of extinction (Matkin et al. 2008). Harwell and Gentile (2006) recognize the continued effect to single pods of orcas, but not for the Prince William Sound population as a whole. They believe that this continuing effect relates to the altered social structure (loss of key matriarchs), which was partly a result of the oil spill and partly a result from preceding mortality from human conflicts over fish. In contrast to Harwell and Gentile (2006), Matkin et al. (2008) suggest that *Exxon Valdez* spill did and still does have a substantial effect on the lack of recovery of these groups. Several dead gray whales were found during the year of the *Exxon Valdez* spill; however, a causal link could not be established (Loughlin 1994; *Exxon Valdez* Oil Spill Trustee Council 2012).

It is unknown whether sea turtles can detect and avoid oil slicks. Gramentz (1988) reported that sea turtles did not avoid oil at sea, and sea turtles experimentally exposed to oil showed a limited ability to avoid oil (Vargo et al. 1986). According to Milton et al. (2003), sea turtles appear to be at particular risk to oil spills, because they do not respond with avoidance behaviour, they exhibit indiscriminate feeding in convergence zones and they take large pre-dive inhalations. The ingestion of tar or oil by sea turtles has been documented by numerous studies (e.g., Hall et al. 1983; Balazs 1985; Gramentz 1988; Loehefener et al. 1989; Witherington 1994; Lutz 1989; Bugoni et al. 2001; Torrent et al. 2002).

Sea turtles are often found heavily oiled after a spill. In the US, approximately 1 percent of sea turtle strandings are associated with oil (Lutcavage et al. 1997, in Milton et al. 2003). NMFS (2011) documented 609 dead sea turtles in 2010 after the Deepwater Horizon spill in the Gulf of Mexico. This total included loggerhead turtles; at least 18 of the dead turtles were visibly oiled. Hall et al. (1983) observed seven live and three dead sea turtles following an oil well blowout in 1979; two of the carcasses had oil in the gut but no lesions, and there was no evidence of aspirated oil in the lungs. However, hydrocarbon residues were found in kidney, liver and muscle tissue of all three dead turtles, and prolonged exposure to oil may have disrupted feeding behaviour and weakened the turtles. Gross histologic lesions developed in loggerhead sea turtles experimentally exposed to oil, but most effects were apparently reversed by the tenth day after exposure (Bossart et al. 1995). Similarly, Lutcavage et al. (1995) found that juvenile loggerhead turtles exposed to weathered crude oil exhibited gross and histologic changes in the skin and mucosal surfaces, but that the turtles recovered with 21 days. Oil may also reduce lung diffusion capacity, decrease oxygen consumption or digestion efficiency, or damage nasal and eyelid tissue (Lutz et al. 1989), as well it can have negative effects on the skin, blood, digestive and immune systems and salt glands

(Milton et al. 2003). Exposure to oil can also increase egg mortality and cause developmental defects (as summarized by Milton et al. 2003).

### 11.4.4 Summary

A summary of the potential environmental effects resulting from WREP-VEC interactions, including those of accidental events and past, present, and likely future projects, is provided in Table 11-9.

**Table 11-9 Potential White Rose Extension Project-related Interactions: Marine Mammals and Sea Turtles**

| Potential WREP Activities, Physical Works, Discharges and Emissions | Change in Habitat Quality | Change in Habitat Quantity | Potential Mortality |
|---|---|---|---|
| **Nearshore** | | | |
| ***Pre-construction and Installation*** | | | |
| Construction of Graving Dock (include sheet pile/driving, potential grouting) | x | | |
| Air Emissions | x | | |
| Water discharge from The Pond/Dewater graving dock | x | | |
| ***CGS Construction and Installation*** | | | |
| *Marine (Argentia and Deep-water Mating Site)* | | | |
| Additional Nearshore Surveys (e.g., geotechnical, geophysical, environmental) | x | | |
| Dredging | x | | x |
| CGS Solid Ballasting (which may include disposal of water containing fine material) | x | | |
| CGS Water Ballasting and De-ballasting | x | | |
| CGS Towing to Deep-water mating site | x | | |
| Noise from Topsides Mating | x | | |
| Air Emissions | x | | |
| Additional Hook-up and Commissioning of Topsides | x | | |
| Operation of Helicopters, Supply, Support, Standby, Mooring and Tow Vessels/ Barges/ROVs | x | | x |
| ***Offshore*** | | | |
| ***Wellhead Platform Installation/Commissioning*** | | | |
| Clearance Surveys (e.g., sidescan sonar) Prior to Installation of WHP or Pipelines/Flowlines | x | | |
| Tow-out/offshore Installation | x | | |
| Operation of Helicopters and Vessels/Barges | x | | x |
| Diving Activities/Operation of ROVs | x | | |
| Installation of Flowlines and Pipelines between WHP, Subsea Drill Centre(s) and Existing Infrastructure | x | | |
| Potential Rock Berms for Flowline Protection | x | | |
| Additional Hook-up, Production Testing and Commissioning | x | | |
| Air Emissions | x | | |
| Hydrostatic Test Fluid (flowlines) | x | | |
| Possible Use of Corrosion Inhibitors or Biocides (flowlines) [(A)] | x | | |
| Waste Generated (domestic waste, construction waste, hazardous waste, sanitary waste) | x | | |
| Drilling-associated Seismic (VSPs and wellsite surveys) | x | | |
| ***Subsea Drill Centre Excavation/Installation (previously assessed by LGL 2007a)*** | | | |
| Dredging and Disposal of Dredge Material | x | | |
| Clearance Surveys (e.g., sidescan sonar) Prior to Installation of Pipelines/Flowlines | x | | |
| Operation of Helicopters and Supply, Support, Standby and Tow Vessels/Barges | x | | x |
| Diving Activities / Operation of ROVs | x | | |
| Air Emissions | x | | |

| Potential WREP Activities, Physical Works, Discharges and Emissions | Change in Habitat Quality | Change in Habitat Quantity | Potential Mortality |
|---|---|---|---|
| Installation of Subsea Equipment, Flowlines and tie-in Modules to Existing Subsea Infrastructure | x | | |
| Hydrostatic Test Fluid (flowlines) | x | | |
| Possible Use of Corrosion Inhibitors or Biocides (flowlines) [A] | x | | |
| Waste Generated (domestic waste, construction waste, hazardous waste, sanitary waste) | x | | |
| Drilling-associated Seismic (VSPs and wellsite surveys) | x | | |
| ***Production/Operation and Maintenance*** | | | |
| Presence of Structure | x | x | |
| Noise from Drilling from a MODU and WHP | x | | |
| WBM (from either WHP or MODU) and SBM (from MODU only) cuttings [B] | x | | |
| Air emissions | x | | |
| Chemical Use and Management (e.g. BOP fluids, fuel, well treatment fluids, corrosion inhibitors) | x | | |
| Waste Generated (domestic waste, construction waste, hazardous, sanitary waste) | x | | |
| Operation of Helicopters, Supply, Support, Standby and Tow Vessels/Barges/ROVs | x | | x |
| Surveys (geotechnical, geophysical and environmental) | x | | |
| Oily Water Treatment [C] | x | | |
| Diving Activities / Operation of ROVs | x | | |
| ***Decommissioning and Abandonment*** | | | |
| Removal of WHP | x | x | |
| Plugging and Abandoning Wells | x | | |
| Operation of Helicopters | x | | |
| Operation of Vessels (supply/support/standby/tow vessels/barges/diving/ROVs) | x | | x |
| Air Emissions | x | | |
| Surveys (geotechnical, geophysical and environmental) | x | | |
| **Potential Future Activities** | | | |
| Surveys (e.g., geophysical, geological, geotechnical, environmental, ROV, diving) | x | | |
| Excavation of Drill Centres (including disposal of dredge spoils) | x | | |
| Noise from Drilling Operations from MODU at Potential Future Drilling Centres | x | | |
| WBM and SBM Cuttings | x | | |
| Hook-Up And Commissioning of Drill Centres | x | | |
| Installation of Pipeline(s)/Flowline(s) and Testing from Drill Centres to FPSO, including Flowline Protection | x | | |
| Chemical Use and Management (e.g., BOP fluids, fuels, well treatment fluids, corrosion inhibitors) | x | | |
| **Accidental Events** | | | |
| Marine Diesel Fuel Spill from Support Vessel | x | | x |
| Graving Dock Breach | x | | |
| SBM Whole Mud Spill | x | | |
| Subsea Hydrocarbon Blowout | x | | x |
| Hydrocarbon Surface Spill | x | | x |
| Other Spills (e.g., fuel, waste materials) | x | | x |
| Marine Vessel Incident (including collisions) (i.e., marine diesel fuel spill) | x | | x |
| **Cumulative Environmental Effects** | | | |
| Commercial Fisheries (nearshore and offshore) | x | | x |
| Marine Traffic (nearshore and offshore) | x | | x |
| White Rose Oilfield Development (including North Amethyst and South White Rose extension drill centre) | x | | |
| Terra Nova Development | x | | |
| Hibernia Oil Development | x | | |
| Hibernia Southern Extension Project | x | | |

| Potential WREP Activities, Physical Works, Discharges and Emissions | Change in Habitat Quality | Change in Habitat Quantity | Potential Mortality |
|---|---|---|---|
| Hebron Oil Development | x | | |
| Offshore Exploration Seismic Activity | x | | |
| Offshore Exploration Drilling Activity | x | | |

Notes:
(A) Husky will evaluate the use of biocides other than chlorine. The discharge from the hypochlorite system will be treated to meet a limit approved by the C-NLOPB's Chief Conservation Officer.
(B) Water-based drilling fluids and cuttings will be discharged overboard. Husky will evaluate best available cuttings management technology and practices to identify a waste management strategy for spent non-aqueous fluid and non-aqueous fluid cuttings from the semi-submersible drilling rig. Synthetic-based mud cuttings will be re-injected into a dedicated well from the WHP, pending confirmation of a suitable disposal formation.
(C) Water (including from open drains) will be treated prior to being discharged to the sea in accordance with OWTG

## 11.5 Environmental Effects Analysis, Monitoring, and Mitigation Measures

As shown in Table 11-9, WREP activities can interact with marine mammals and sea turtles to create the following potential environmental effects:

- Change in Habitat Quantity: includes interactions that limit habitat availability to marine mammals and sea turtles
- Change in Habitat Quality: includes interactions that may result in physical/ physiological/behavioural effects that occur as a result of a change in habitat quality
- Potential Mortality: includes interactions that may cause the mortality of a marine mammal or sea turtle

The following sections describe how WREP interactions with marine mammals (and marine-related mammals like the river otter) and sea turtles may contribute to these potential environmental effects. In addition, proposed monitoring and mitigation measures as outlined are designed to minimize the potential environmental effects and risk of injury to marine mammals and sea turtles. For all WREP phases in both the Nearshore and Offshore Project Areas, the activities that are most likely to interact with marine mammals and sea turtles are those that introduce strong sounds into the water, but collisions with vessels could also have direct effects.

To aid in the assessment of potential environmental effects of noise from WREP activities on marine mammals and sea turtles, a description of the hearing abilities of marine mammals and sea turtles, a review of noise criteria for assessing effects, and a review of known physical effects of relevant noise sources were provided in Section 11.4. Also discussed in this section are acoustic modelling efforts that were undertaken by JASCO (2012) to estimate received sound levels for dredging in the WREP Nearshore and Offshore Study Areas, and how they pertain to sound thresholds that are known or expected to cause environmental effects in marine mammals (and sea turtles). Pile driving was not modelled, as this activity will take place onshore and it is expected that transfer of pile driving sounds to the water will be negligible.

### 11.5.1 Nearshore

Marine mammal species most likely to be affected include those predicted to be common within the Nearshore Study Area, including humpback whales, possibly minke and fin whales, harbour porpoise, and several delphinid species. The large baleen whales are particularly common in the area during summer. Sea turtles are uncommon within the Nearshore Study Area, particularly at times other than late summer and early fall.

Given that WREP activities are mostly localized, of low to medium magnitude, and reversible at the population level, there are not likely to be significant residual adverse environmental effects on marine mammals and sea turtles from nearshore activities.

The environmental effects of WREP nearshore construction and installation activities on marine mammals and sea turtles are summarized in Table 11-10.

#### 11.5.1.1 Graving Dock Construction

Underwater noise could result from WREP activities such as possible pile driving. However, pile driving during this phase would occur on shore and underwater noise from pile driving is expected to be minimal.

**Change in Habitat Quantity**

No change in habitat quantity is expected for marine mammals or sea turtles during the pre-construction and installation phase of the WREP. All of these activities will occur onshore, thus the only possible effect may be a loss of potential habitat to river otters due to grading of the site and construction of new buildings and structures. However, river otters are not known to use the proposed construction area, as it is a brownfield location.

**Table 11-10 Environmental Effects Assessment: Construction and Installation**

| WREP Activity | Potential Positive (P) or Negative (N) Environmental Effect | Mitigation Measure | Evaluation Criteria for Assessing Environmental Effects [A] | | | | | | Significance Rating | Level of Confidence |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | Magnitude | Geographic Extent | Frequency | Duration | Reversibility | Ecological / Socio-cultural / Economic Significance | | |
| **Nearshore** | | | | | | | | | | |
| Bund Wall Construction (e.g., sheet/pile driving) | Change in Habitat Quality (N) | • Equipment design | M | 3 | 1 | 3 | R | 2 | NS | H |
| Dredging of Bund Wall and Tow-out Route | Change in Habitat Quality (N) | • Planning<br>• Equipment design | M | 3 | 1 | 3 | R | 2 | NS | H |
| Air Emissions | Change in Habitat Quality (N) | • Adhere to NL *Air Pollution Control Regulations, 2004* and CEPA *National Ambient Air Quality Objectives* | N | 4 | 6 | 3 | R | 2 | NS | H |
| Water Discharges from the Pond/Dewater Graving Dock | Change in Habitat Quality (N) | • Compliance monitoring and treatment as required before discharge | L | 1 | 1 | 3 | R | 2 | NS | H |
| CGS Solid and/or Water Ballasting/ Deballasting | Change in Habitat Quality (N) | | L | 1 | 1 | 3 | R | 2 | NS | H |
| Nearshore Geophysical Surveys | Change in Habitat Quality (N) | • Avoid mammal concentration when possible<br>• Maintain steady course and safe speed when possible | L | 3 | 1 | 3 | R | 2 | NS | H |
| CGS Tow-out | Change in Habitat Quality (N) | | L | 3 | 1 | 1 | R | 2 | NS | H |
| Noise from Topside Mating | Change in Habitat Quality (N) | | L | 1 | 1 | 1 | R | 2 | NS | H |
| Additional Hook-up and Commissioning of Topsides | Change in Habitat Quality (N) | | L | 1 | 1 | 1 | R | 2 | NS | H |
| Vessel Traffic (e.g., supply, tug, barge) | Change in Habitat Quality (N)<br>Potential Mortality (N) | • Avoid mammal concentrations when possible<br>• Maintain steady course and safe speed when possible<br>• Deviate course to avoid animals | L | 3 | 6 | 3 | R [B] | 2 | NS | H |
| Helicopter Overflights | Change in Habitat Quality | • Avoid low altitudes when possible | L | 2 | 6 | 3 | R | 2 | NS | H |
| **Offshore (WHP and Subsea Drill Centre)** | | | | | | | | | | |
| WHP Tow-out and Installation | Change in Habitat Quality (N) | | L | 3 | 1 | 2 | R | 2 | NS | H |
| Dredging | Change in Habitat Quality (N) | • Planning<br>• Equipment design | M | 3 | 1 | 2 | R | 2 | NS | H |

| WREP Activity | Potential Positive (P) or Negative (N) Environmental Effect | Mitigation Measure | Evaluation Criteria for Assessing Environmental Effects [A] | | | | | | Significance Rating | Level of Confidence |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | Magnitude | Geographic Extent | Frequency | Duration | Reversibility | Ecological / Socio-cultural / Economic Significance | | |
| Diving Activities / Operation of ROVs | Change in Habitat Quality (N) | | L | 2 | 1 | 2 | R | 2 | NS | H |
| Installation of Flowlines and Pipelines | Change in Habitat Quality (N) | | L | 2 | 1 | 2 | R | 2 | NS | H |
| Potential Rock Berms for Flowines Protection | Change in Habitat Quality (N) | | L | 2 | 1 | 2 | R | 2 | NS | H |
| Additional Hook-up, Production Testing and Commissioning | Change in Habitat Quality (N) | | L | 2 | 1 | 2 | R | 2 | NS | H |
| Geophysical Surveys (e.g., VSP, geohazard, sidescan sonar) | Change in Habitat Quality (N) | • Adherence to the *Geophysical, Geological, Environmental and Geotechnical Program Guidelines* (C-NLOPB 2012d) | L | 3 | 1 | 2 | R | 2 | NS | H |
| Vessel Traffic (e.g., supply, tug, barge) | Change in Habitat Quality (N)<br>Potential Mortality (N) | • Avoid animal concentrations when possible<br>• Maintain steady course and safe speed when possible<br>• Deviate course to avoid animals | L | 3 | 6 | 2 | R [B] | 2 | NS | H |
| Helicopter Overflights | Change in Habitat Quality (N) | • Avoid low altitudes when possible | L | 3 | 6 | 2 | R | 2 | NS | H |
| Air Emissions | Change in Habitat Quality (N) | • Adhere to NL *Air Pollution Control Regulations, 2004* and CEPA *National Ambient Air Quality Objectives* | N | 5 | 6 | 2 | R | 2 | NS | H |
| Hydrostatic Test Fluid | Change in Habitat Quality (N) | • Adhere to OWTG | L | 1 | 1 | 2 | R | 2 | NS | H |
| Waste Generated | Change in Habitat Quality (N) | • Adhere to OWTG | L | 1 | 1 | 2 | R | 2 | NS | H |

| WREP Activity | Potential Positive (P) or Negative (N) Environmental Effect | Mitigation Measure | Evaluation Criteria for Assessing Environmental Effects (A) | | | | | | Significance Rating | Level of Confidence |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | Magnitude | Geographic Extent | Frequency | Duration | Reversibility | Ecological / Socio-cultural / Economic Significance | | |

Key:

**Magnitude:**
N = Negligible (essentially no effect)
L = Low: <10 percent of the population or habitat in the Study Area will be affected
M = Medium: 11 to 25 percent of the population or habitat in the Study Area will be affected
H = High: >25 percent of the population or habitat in the Study Area will be affected

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

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

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

**Reversibility (population level):**
R = Reversible
I = Irreversible

**Ecological / Socio-cultural / Economic Significance:**
1 = Relatively pristine area not affected by human activity
2 = Evidence of existing adverse activity
3 = High level of existing adverse activity

**Significance Rating:**
S = Significant
NS = Not Significant
P = Positive

**Level of Confidence:**
L = Low level of confidence
M = Medium level of confidence
H = High level of confidence

(A) Where there is more than one potential environmental effect, the evaluation criteria rating is assigned to the environmental effect with the greatest potential for harm
(B) Reversible at the population level but irreversible at the individual level

### Change in Habitat Quality

This environmental effect category includes interactions that may result in physical/ physiological/behavioural effects which occur as a result of a change in habitat quality. Activities that are most likely to affect marine mammals and sea turtles during the pre-construction and installation phase are possible on-land pile driving, which produce sound levels high enough to cause physical/physiological/behavioural effects in marine mammals (and sea turtles). Sound levels thought to be high enough to cause a "change in habitat quality" typically occur close to the sound source. The effects of sounds on marine mammals (and sea turtles) could include one or more of the following: tolerance; masking; behavioural disturbance; and, at least in theory, temporary or permanent hearing impairment, or non-auditory physical or physiological effects (Richardson et al. 1995; Gordon et al. 2004; Nowacek et al. 2007; Southall et al. 2007).

#### *Pile Driving*

To the best of the study team's knowledge, there is no evidence that marine mammals or sea turtles have experienced injury as a result of exposure to pile driving sounds, although behavioural responses have been observed in harbour porpoise, beluga and harbour seals (see Section 11.4.1). Based on this limited information and the literature for marine mammal response to LF impulsive sounds (like airgun pulses - see Richardson et al. 1995; Nowacek et al. 2007), cetaceans could exhibit at least localized avoidance of the pile driving site. There is some evidence to suggest that harbour porpoise echolocation activity may decline, at least temporarily, and that harbour seals may exhibit short-term avoidance of the area. However, any behavioural disturbance is expected to be short-term and localized. If a marine mammal or sea turtle did react to pile driving sounds by changing its behaviour or moving a small distance, the effects of the change are unlikely to be critical to the individual, let alone the stock or population.

It is very unlikely that the on-land pile driving activities associated with the WREP would result in any cases of temporary or especially permanent hearing impairment, or any substantial non-auditory physical or physiological effects (see Section 11.4.1). Monitoring and mitigation measures for marine mammals may be implemented during pile driving activities, although minimal sound energy from onshore pile driving activity is expected to transfer to the water.

#### *Other Activities*

Other activities during graving dock construction are expected to have negligible environmental effects on the habitat quality of marine mammals and sea turtles. It is expected that air emissions will be minimized, when possible, and water discharges will meet compliance monitoring requirements and treated as required before being released into the marine environment.

### Summary

Given that WREP activities are mostly localized, of low to medium magnitude, and reversible at the population level, there are not likely to be significant residual adverse environmental effects on marine mammals and sea turtles from the WHP graving dock pre-construction and installation.

#### 11.5.1.2 Concrete Gravity Structure Construction and Installation

Underwater noise will be produced during WREP activities associated with the construction, tow-out and installation of the CGS. Underwater sounds will be produced by dredging of the bund wall and sections of the tow-out route to the deep-water mating site, vessels, helicopters, and geophysical surveys (i.e., side scan sonar and geohazard surveys). The activities associated with the CGS construction, tow-out and installation could affect the habitat quality for marine mammals and sea turtles. Vessel traffic could also affect marine mammals and sea turtles through direct mortality. The potential effects from vessels and helicopters were summarized in Section 11.4.1.2, and the possible effects of geophysical surveys were discussed in terms of seismic surveys in Section 11.4.2.1.

**Change in Habitat Quantity**

No changes in habitat quantity directly affecting marine mammals or sea turtles are expected during this phase. However, dredging may change the habitat quantity for marine mammal and sea turtle prey items. However, since most marine mammals and sea turtles occurring in the area do not feed off the bottom, change in habitat quantity due to dredging is expected to have negligible effect on these species.

**Change in Habitat Quality**

This effect category includes interactions that may result in physical/physiological/ behavioural effects which occur as a result of a change in habitat quality. Activities that are most likely to affect marine mammals and sea turtles during construction and installation of the CGS are dredging, which produce sound levels high enough to cause physical/physiological/behavioural effects in marine mammals and sea turtles. Sound levels thought to be high enough to cause a “change in habitat quality” typically occur close to the sound source. Dredging would also affect the habitat quality by increasing turbidity. Sea turtles in particular use visual cues to evade vessels and predators, which could be affected by water clarity. However, sediment suspension modelling by AMEC (2012a) showed that suspended sediment levels will not exceed the thresholds for total particular matter given in the *Canadian Water Quality Guidelines for the Protection of Aquatic Life* (CCME 2002). According to AMEC (2012a), maximum plume concentrations above 25 mg/L are expected to persist for no more than 4 hours for an average dredging operation for all wind scenarios. Concentrations above 10 mg/L would persist for approximately 6 hours, and levels above 5 mg/L would last for about 10 hours for a single dredging operation. Plume concentrations above 25 mg/L are expected to occur within limited areas of approximately 0.7 $km^2$. The only significant difference between the wind scenarios is observed in the extent and persistence of plume concentrations above 1 mg/L (but below 5 mg/L), where the southwesterly winds are about twice as efficient at dispersing these low levels of suspended sediment (within 21.9 hours) compared to the northwesterly winds (37.8 hours), and the most frequent, westerly wind conditions (32.6 hours). In addition, sea turtles are uncommon in the Nearshore Study Area. Thus, it is expected that increased turbidity associated with dredging would have negligible effects on marine mammals and sea turtles.

### *Dredging*

In nearshore shallow water regions, dredges can be strong sources of LF underwater noise (Richardson et al. 1995). Because LF attenuates rapidly in shallow water, underwater sound produced by dredging is normally undetectable at ranges beyond 25 km (Richardson et al. 1995). Dredging that occurs consistently over long periods can create a higher potential for disturbance, which could result in changes in habitat use for marine mammals and sea turtles. Acoustic modelling was undertaken by JASCO (2012) to provide estimates of received sound levels for dredging in the Nearshore Study Area. Dredging can have a source level as high as 195.4 dB re µPa at 1 m (JASCO 2012). Results of acoustic modelling (JASCO 2012) for two different types of dredgers (a cutter suction dredge and a trailing suction hopper dredge) indicated that sound levels greater or equal to 180 dB re 1 µPa (rms) (un-weighted) occur at $R_{95\%}$ distances of 7 m or less. Because the peak in source spectrum occurs at LF, the application of M-weighting generally results in smaller distances for MF and HF cetaceans. Thus, it is very unlikely that dredging operations would cause TTS, let alone PTS, in any marine mammal or sea turtle.

The criteria proposed by Southall et al. (2007) were not examined for dredging. However, sound levels of 160 dB re 1 µPa (rms) occur within 248 m ($R_{95\%}$) of the dredging site, depending on dredge type and season. Thus, it is possible that marine mammals and sea turtles may show behavioural changes from dredging activities within at least 248 m of the dredging site. Based on the limited data available, long-term dredging operations may cause prolonged avoidance of an area by marine mammals. However, cetaceans have been reported to continue using habitats near short-term dredging operations and any behavioural responses are expected to be short-term and localized. Dredging operations during the WREP will be temporary and of limited duration. Dredging to remove the shoreline berm is estimated to take approximately six to eight weeks during the late winter/early spring of 2016. Dredging of the tow-out channels will take approximately four to six weeks, during winter 2015/ 2016. Winter is a time of year when marine mammal abundance is expected to be lowest in Placentia Bay. Proper planning and equipment design will reduce the duration of dredging activities and hence the environmental effect on marine mammals and sea turtles.

### *Vessel Traffic*

Sound levels from vessel traffic associated with the WREP are not expected to be high enough to cause physical or physiological effects on marine mammals or sea turtles (see Richardson et al. 1995). The CGS tow-out to the deep-water mating site will employ four tugs and take approximately two to four days. The WHP will be at the deep-water mating site for six to eight weeks. During the topsides mating, there will be an accommodation vessel, a tug and supply vessel. A logistics vessel will transit between the deep-water mating site and the Port of Argentia three to four times per week.

It is expected that the greatest vessel noise source during this phase of the WREP would result from tugs (see Blackwell and Greene 2006). Sound levels that have the potential to induce hearing impairment in marine mammals and sea turtles have been modelled to occur less than 5 m from a tug (JASCO 2012). Thus, potential for TTS and PTS are very low. However, increased noise levels would result in changes in habitat quality that are likely to elicit behavioural responses by marine mammals and sea turtles and may cause masking (see Section 11.4.1.2).

Sound source levels for most small ships, including tugs and barges, are above the 160 dB re 1 µPa (rms) criterion considered for behavioural disturbance (Richardson et al. 1995). Relative to other sources of construction noise, estimated sound levels from a single tug are much lower relative to other sources. Sound levels of 160 dB re 1 µPa (rms) were estimated to occur within 22 m of a tug (JASCO 2012). Behavioural responses by marine mammals to vessels are variable and may include approach or avoidance, or changes in diving, feeding, or vocalizations (see Section 11.4.1.2). Sea turtles are uncommon in the Nearshore Study Area and only occasionally occur in the Offshore Study Area, typically only during late summer or early fall. Generally, sea turtles flee or dive when approached closely by a vessel. Vessel traffic is expected to have a short-term and localized effect on marine mammals and sea turtles.

WREP activities involving vessel traffic will avoid spatial and temporal concentrations of marine mammals and sea turtles whenever possible. Additionally, vessels will maintain a steady course and safe vessel speed whenever possible, as sudden changes in these factors are known to increase behavioural responses in marine mammals.

***Helicopter Overflights***

Helicopter traffic in the Nearshore Study Area is expected to be minimal. Nonetheless, flights over water will introduce some sound to the surrounding marine environment. JASCO (2012) described the sound levels of a helicopter at an altitude of 91 m hovering over water and found that received levels did not exceed 157 dB re 1 µPa at depths greater than 3 m. Although transfer of sound from helicopters to the water is likely minimal, marine mammals have shown variable reactions to aircraft, often startling or diving during low-altitude overflights (see Richardson et al. 1995). Baleen whales often react to aircraft overflights by hasty dives, turns, or other changes in behaviour. Whales actively feeding or socializing often seem rather non-responsive, whereas whales in confined waters or with calves sometimes seem more responsive. Odontocetes reacting to aircraft may dive, slap the water with flippers or flukes, or swim away.

Generally, pinnipeds exhibit a greater response to disturbance when on land than in the water, although overflights at low altitudes may cause some animals in the water to dive (Richardson et al. 1995). Helicopter overflights in the Nearshore Study Area may disturb hauled out seals. Hauled out pinnipeds often become alert during an overflight and in many cases, rush into the water (Richardson et al. 1995). Disturbance during the spring pupping season may have the most substantial effects, as mothers could abandon their pups. However, relatively little is known about breeding activity of harbour seals within the Nearshore Study Area. Sea turtles are uncommon in the Nearshore and Offshore Study Areas, generally only occurring in the area during late summer or early fall.

Thus, helicopter overflights are expected to have short-term and localized effects on marine mammals and sea turtles. Single or occasional overflights by helicopters would likely only elicit a brief behavioural response by most marine mammals and sea turtles. Helicopters will typically only reduce altitude on approach for landing.

***Geophysical Surveys***

The geophysical surveys that may take place along the tow-out route include side scan sonar and geohazard surveys. These surveys produce noise at lower source levels than those of airgun pulses from seismic surveys (described in Section 11.4.2.1). Sounds are

also typically emitted in a narrow beam, short duration and sometimes at frequencies outside the range of marine mammal and sea turtle hearing abilities. Therefore, geohazard surveys and side scan sonar are less likely to affect marine mammals and sea turtles than seismic surveys. However, they may cause short-term, localized avoidance of the area or other brief behavioural responses.

Very little is known about the potential for geohazard survey sounds to cause either auditory impairment or other non-auditory physical effects in marine mammals or sea turtles. Available data suggest that such effects, if they occur at all, would be limited to short distances. However, the available data do not allow for meaningful quantitative predictions of the numbers (if any) of marine mammals that might be affected in these ways.

Geophysical surveys will also increase the presence of vessels along the tow-out route, increasing the potential environmental effects of vessel traffic. However, survey effort will be limited, when possible.

***Other Activities***

Other activities associated with the CGS construction and installation (see Table 11-9) are expected to have negligible effects on the habitat quality of marine mammals and sea turtles. It is expected that air emissions will be minimized, when possible, and water discharges will meet compliance monitoring requirements and treatment as required before being released into the marine environment.

**Potential Risk of Mortality**

To the best of the study team's knowledge, there is no evidence that marine mammals or sea turtles have experienced injury, fatal or otherwise, during dredging activities (Section 11.4).

The presence of vessels during various WREP activities can also increase the risk of direct mortality via vessel collisions with marine mammals. Large species of whales and sea turtles that spend extended periods near the surface would be particularly susceptible to ship strikes. Fin whales are the most commonly reported whale to be struck by vessels, followed by humpback whales (Jensen and Silber 2003; Vanderlaan and Taggart 2007); both of these species are expected to be common in the Nearshore Study Area, less so in the Offshore Study Area (at least for humpbacks), particularly during the summer. Evidence suggests that a greater rate of mortality and serious injury to large whales is correlated with a greater vessel speed at the time of a ship strike (Laist et al. 2001; Vanderlaan and Taggart 2007). Most lethal and severe injuries to large whales have occurred when vessels greater than 80 m in length were travelling at 26 km/hr (14 knots) or more (Laist et al. 2001).

For sea turtles, the risk of collision with vessels also increases with vessel speed, particularly when vessels travel at speeds greater than 4 km/h (Hazel et al. 2007). However, sea turtles are uncommon within the Nearshore Study Area and not abundant in the Offshore Study Area, particularly at times other than late summer and early fall.

WREP activities involving vessel traffic will avoid spatial and temporal concentrations of marine mammals and sea turtles whenever possible, and vessels will maintain a safe speed, or deviate from their course to avoid potentially fatal collisions. Particularly in the Nearshore Study Area, smaller vessels (less than 80 m long) associated with the WREP will typically be engaged in activities that require a slow speed or maintenance of a stationary position, which will also reduce the risk of a collision.

**Summary**

Given that WREP activities are mostly localized, of low to medium magnitude, and reversible at the population level, there are not likely to be significant residual adverse environmental effects on marine mammals and sea turtles from the CGS construction and installation.

#### 11.5.1.3 Accidental Events in the Nearshore

The effect of an accidental release of hydrocarbons (i.e., fuel) in the Nearshore Study Area is assessed below (Table 11-11). Spills in the Nearshore Study Area would be attributable to vessel malfunctions. The type and probability of spills are discussed in Section 3.6. A detailed analysis can be found in SL Ross (2012).

**Table 11-11 Environmental Effects Assessment: Accidental Events in the Nearshore**

| WREP Activity | Potential Positive (P) or Negative (N) Environmental Effect | Mitigation Measure | Evaluation Criteria for Assessing Environmental Effects (A) | | | | | | Significance Rating | Level of Confidence |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | Magnitude | Geographic Extent | Frequency | Duration | Reversibility | Ecological / Socio-cultural / Economic Significance | | |
| Nearshore Fuel Spill | Change in Habitat Quality (N)<br>Potential Mortality (N) | • Training, preparation, equipment inventory, prevention, and emergency response drills<br>• Oil spill response plan | M | 4-5 | 1 | 2 | R (B) | 2 | NS | H |

Key:
Magnitude:
N = Negligible (essentially no effect)
L = Low: <10 percent of the population or habitat in the Study Area will be affected
M = Medium: 11 to 25 percent of the population or habitat in the Study Area will be affected
H = High: >25 percent of the population or habitat in the Study Area will be affected

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

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

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

Reversibility (population level):
R = Reversible
I = Irreversible

Ecological / Socio-cultural / Economic Significance:
1 = Relatively pristine area not affected by human activity
2 = Evidence of existing adverse activity
3 = High level of existing adverse activity

Significance Rating:
S = Significant
NS = Not Significant
P = Positive

Level of Confidence:
L = Low level of confidence
M = Medium level of confidence
H = High level of confidence

(A) Where there is more than one potential environmental effect, the evaluation criteria rating is assigned to the environmental effect with the greatest potential for harm
(B) Reversible at the population level but irreversible at the individual level

Oil spill response is included as part of the contingency planning undertaken for the WREP (Section 16.9). Chapter 16 describes the WREP overall environmental management process.

Spill modelling based on the accidental release of fuel in Placentia Bay predicts that a 100 $m^3$ and 350 $m^3$ spill that does not reach shore would evaporate from the surface within approximately 52 and 67 hours, respectively (SL Ross 2012). The slick width was estimated to be up to 440 m, with the loss of the slick at distances of up to 53 km. However, a spill in Placentia Bay could reach shore prior to evaporation under certain wind conditions and currents (SL Ross 2012). When wind conditions were included in the model, a 350 $m^3$ slick during March-July reached the shore within 2 to 159 hr, but was most likely to do so within 6 to 48 hr (SL Ross 2012). The maximum slick life for a spill that did not reach shore was eight days. Weathering processes (photolysis and biodegradation) would reduce the amount of oil potentially reaching shorelines.

**Change in Habitat Quantity**

No direct changes in habitat quantity are expected during accidental events. However, a change in habitat quality because of a hydrocarbon spill may indirectly reduce the amount of habitat available to a marine mammal, river otter, or sea turtle by rendering it unsuitable for foraging and other activities.

**Change in Habitat Quality**

The accidental release of fuel may affect several physical and internal functions of marine mammals and sea turtles. Hydrocarbons can be inhaled or ingested, and may cause behavioural changes, inflammation of mucous membranes, pneumonia and neurological damage (see Geraci and St. Aubin 1990). However, most marine mammals, with the exception of fur seals, polar bears and sea otters (none of these species are expected to occur in the Nearshore Study Area), are considered to be not directly susceptible to deleterious effects of oil (see Geraci and St. Aubin 1990). However, newborn hair seal pups and weak or stressed animals may also be vulnerable to oils spills. Less information is known about the effects of fuel oil on marine mammals. A fuel spill in Placentia Bay was estimated to evaporate or disperse within a maximum eight days, limiting the exposure time of the animals to the fuel.

Hydrocarbons from a spill could reach the shore, which may result in oiling and degradation of habitat for river otters and hauled out harbour seals. Harbour seals may be particularly at risk because they exhibit site fidelity (Boulva and McLaren 1979; Yochem et al. 1987). However, harbour seals are considered uncommon in the Nearshore Study Area and grey seals are expected to be rare.

It is uncertain how susceptible river otters are to hydrocarbon spills. Coastal river otters in the Placentia Bay feed on intertidal and subtidal fish and invertebrates and thus have an increased likelihood of exposure to residual hydrocarbons.

### Potential Risk of Mortality

Marine mammals are not considered to be at high risk from the effects of oil exposure, but some evidence implicates oil spills with seal mortality, particularly young seals, and river otters. Sea turtle carcasses are also often found after a spill. However, harbour seals and sea turtles are expected to be uncommon in the Nearshore Study Area, and grey seals are considered rare. River otters may be able to avoid fouled areas, and use other areas within the Nearshore Study Area that are not affected.

Baleen whales appear to be less susceptible to spills than delphinids, as dolphins are often found stranded after an oil spill. Thus, the delphinids that occur in the Nearshore Study Area at the time of the spill are most susceptible to fouling. Although effects of the *Exxon Valdez* oil spill were substantial on killer whales, killer whales are uncommon in Placentia Bay, and no population-level effects would be expected. Toxicological analyses have shown that river otter have died from acute effects of oiling. Thus, it is possible that there could be some mortality of river otters associated with a hydrocarbon spill in the Nearshore Study Area. Sea turtles are unlikely to be affected in a great degree as they are uncommon in the Nearshore Study Area, especially outside of summer or fall.

Animals exposed to heavy doses of hydrocarbon for prolonged periods could experience mortality. Chronic exposure to hydrocarbons, either through surface contact or ingestion, may occur in cetaceans, seals, river otters, or sea turtles. Hydrocarbon toxicity could result in physiological damage, such as lesions and effects on blood and enzyme chemistry.

For marine mammals and sea turtles, it is probable that only small proportions of populations are at risk at any one time in the Nearshore Study Area. Oil spill prevention measures, along with typical oil spill countermeasures (creating an oil spill response plan, training, preparation, an equipment inventory and conducting emergency response drills) will serve to reduce the number of animals exposed to hydrocarbons.

### Summary

Depending on the time of year, location of animals within the affected area and type of oil spill, the effects of an oil release on the health of cetaceans is predicted to range from negligible to low magnitude over varying geographic extents. Based on present knowledge of Placentia Bay and the modelling exercises, it can be predicted that a hydrocarbon spill associated with the WREP will not result in any significant residual environmental effects to marine mammals or sea turtles in the Nearshore Study Area.

Mitigation measures will likely reduce effects of potential hydrocarbon spills on marine mammals, sea turtles and river otters in the Nearshore Study Area.

## 11.5.2 Offshore

During the installation phase in the Offshore Study Area, underwater noise will result from activities such as (possible) clearance dredging, helicopter overflights, operation of vessels, wellsite and VSP surveys, other geophysical and geotechnical surveys, installation of the flowlines, pipelines and the WHP or subsea drill centre and subsea equipment and hook-up to WHP or subsea drill centre and commissioning. During

production and operation, drilling will be taking place. During decommissioning and abandonment vessel noise also will be present. These activities could affect habitat quality for marine mammals and sea turtles. In addition, operation of vessels could lead to direct mortality of individuals via collisions. The possible environmental effects of subsea drill centre excavation/installation on marine mammals and sea turtles were analyzed previously by LGL (2007a).

#### 11.5.2.1 Wellhead Platform or Subsea Drill Centre Installation/Commissioning

During the installation phase in the Offshore Study Area, underwater noise will result from activities such as dredging, operation of vessels (including tow-out), geophysical surveys and helicopter overflights. Helicopters will be used to transfer personnel to the WHP, drilling units and possibly seismic vessels. These activities could affect habitat quantity and quality for marine mammals and sea turtles. In addition, operation of vessels could lead to direct mortality of individuals via collisions.

The environmental effects of WREP offshore construction activities on marine mammals and sea turtles are summarized in Table 11-9.

**Change in Habitat Quantity**

The footprint of the WHP or subsea drill centre in the Offshore Project Area would occupy a very limited area that may reduce the habitat quantity for pelagic and migratory marine mammals and sea turtles. However, this reduction in habitat quantity is expected to result in minimal habitat loss for marine mammals and sea turtles.

**Change in Habitat Quality**

This effect category includes interactions that may result in physical/physiological/ behavioural effects that occur as a result of a change in habitat quality. Activities that are most likely to affect marine mammals and sea turtles during the WHP installation and commissioning are wellsite and VSP surveys, which produce sound levels high enough to cause physical/physiological/behavioural effects in marine mammals (and sea turtles). However, sounds from dredging, vessel traffic and helicopters could also affect the habitat quality. Sound levels thought to be high enough to cause a “change in habitat quality” typically occur very close to the sound source. Dredging may occur over a limited area in the Offshore Study Area that may be used by pelagic and migratory marine mammals and sea turtles. Species that are primarily benthic foragers (e.g., some phocids) would be most affected by a disruption in benthic habitat. However, dredging will likely result in minimal effects on prey and habitat quality for marine mammals and sea turtles.

**Wellsite and Vertical Seismic Profile Surveys**

In the Offshore Study Area, geophysical surveys will include VSP as well as geohazard surveys. Similar to seismic surveys, both VSP and geohazard surveys use air guns, but a key difference is the larger array size and longer duration required during seismic surveys. The potential physical and physiological effects of noise from the geohazards equipment are of less concern than air gun pulses from 2-D and 3-D surveys given their relatively lower source levels, emission in a narrow beam, short duration of the geohazards program, and that some equipment operates at frequencies outside the

range of marine mammal and sea turtle hearing abilities. The potential effects of air guns sounds may include one or more of the following: tolerance, masking of natural sounds, behavioural disturbance and, at least in theory, temporary or permanent hearing impairment, or non-auditory physical or physiological effects (Richardson et al. 1995; Gordon et al. 2004; Nowacek et al. 2007; Southall et al. 2007). Many cetaceans tend to avoid operating air guns, but only slight (if any) avoidance has been shown by pinnipeds and sea turtles.

As summarized in Section 11.4.2.1, data now available imply that TTS is unlikely to occur in various odontocetes (and probably mysticetes as well), unless they are exposed to a sequence of several air gun pulses in which the strongest pulse has a received level substantially exceeding 190 dB re 1 $\mu Pa_{rms}$. On the other hand, for the harbour seal, harbour porpoise and perhaps some other species, TTS may occur upon exposure to one or more air gun pulses whose received level equals the NMFS "do not exceed" value of 190 dB re 1 $\mu Pa_{rms}$. That criterion corresponds to a single pulse with a SEL of 175 to 180 dB re 1 $\mu Pa^2$ s in typical conditions, whereas TTS is suspected to be possible in harbour seals and harbour porpoises with a cumulative SEL of approximately 171 and approximately 164 dB re 1 $\mu Pa^2$ s, respectively. Although the possibility of hearing impairment cannot be entirely excluded, it is unlikely that the WREP would result in any cases of temporary or especially permanent hearing impairment, or any significant non-auditory physical or physiological effects.

Although it is unlikely that air gun operations during most wellsite and VSP surveys would cause PTS in marine mammals, caution is warranted given the limited knowledge about noise-induced hearing damage in marine mammals, particularly baleen whales. Commonly-applied monitoring and mitigation measures, including visual monitoring, ramp-ups, and power-downs of the air guns when mammals are seen within the "safety radii", are expected to minimize the already-low probability of exposure of marine mammals to sounds strong enough to potentially induce PTS.

Some behavioural disturbance is expected, but this would be localized and short-term. However, short term avoidance behaviour does not necessarily provide information about long-term effects, such as reproductive rate or distribution and habitat use in subsequent days or years. Additionally, effects likely vary between species, location and past exposure to seismic sounds. Wellsite and VSP operations in or near areas where marine mammals or turtles concentrate are likely to have the greatest effect. However, marine mammals are expected to be widely distributed throughout the Jeanne d'Arc Basin, and the Offshore Study Area is not a breeding area for sea turtles and there are no known feeding areas or sensitive areas; thus, concentrations of marine mammals, especially sea turtles, are unlikely.

As indicated in the *Geophysical, Geological, Environmental and Geotechnical Program Guidelines* (C-NLOPB 2012d), mitigation measures will be implemented consistent with those provided for in the *Statement of Canadian Practice with respect to the Mitigation of Seismic Sound in the Marine Environment*, including, but not limited to:

- Ramp-up of the air gun array over a minimum of 20 minutes
- Monitoring by a trained marine mammal observer

- Shutdown of the air gun array when a Schedule 1 endangered or threatened marine mammal or sea turtle is sighted within the 500 m safety zone

- Delay of ramp-up if any marine mammal or sea turtle is sighted within the 500 m safety zone

Considering the seismic survey mitigation measures, there will likely be minimal effects of seismic surveys on marine mammals and sea turtles.

***Vessel Traffic***

As stated earlier, sound levels from vessel traffic associated with the WREP are not expected to be high enough to cause physical or physiological effects on marine mammals or sea turtles (see Richardson et al. 1995). It is expected that the greatest and most continuous vessel noise source during this phase of the WREP would result from tugs and barges (see Blackwell and Greene 2006). Sound levels that have the potential to induce hearing impairment in marine mammals and sea turtles have been modelled to occur less than 5 m from a tug (JASCO 2012). Thus, potential for TTS and PTS are very low. However, increased noise levels would result in changes in habitat quality that are likely to elicit behavioural responses by marine mammals and sea turtles and may possibly cause masking (see Section 11.4.1.2).

Sound source levels for most small ships, including tugs and barges, are above the 160 dB re 1 µPa (rms) criterion considered for behavioural disturbance (Richardson et al. 1995). Relative to other sources of installation noise, estimated sound levels from a single tug are much lower relative to other sources of installation noise. Sound levels of 160 dB re 1 µPa (rms) were estimated to occur within 22 m of a tug (JASCO 2012). Behavioural responses by marine mammals to vessels are variable and may include approach or avoidance, changes in diving, feeding, or vocalizations by cetaceans include changes in diving and feeding as well as avoidance (see Section 11.4.1.2). Sea turtles are not found in high densities in the Offshore Study Area and typically occur only during late summer or early fall. Generally, sea turtles flee or dive when approached closely by a vessel. Vessel traffic is expected to have a short-term and localized effect on marine mammals and sea turtles. Marine mammals occurring in the Offshore Study Area during periods of increased vessel traffic are more likely to be affected.

WREP activities involving vessel traffic will avoid spatial and temporal concentrations of marine mammals and sea turtles whenever possible. Additionally, vessels will maintain a steady course and safe vessel speed whenever possible, as sudden changes in these factors are known to increase behavioural effects in marine mammals.

***Helicopter Overflights***

Helicopter flights over water will introduce some sound to the surrounding marine environment. JASCO (2012) described the sound levels of a helicopter at an altitude of 91 m hovering over water and found that received levels did not exceed 157 dB re 1 µPa at depths greater than 3 m. Although transfer of sound from helicopters to the water is likely minimal, marine mammals have shown variable reactions to aircraft, often startling or diving during low-altitude overflights (see Richardson et al. 1995). Baleen whales often react to aircraft overflights by hasty dives, turns, or other changes in behaviour. Whales actively feeding or socializing often seem rather non-responsive, whereas

whales in confined waters or with calves sometimes seem more responsive. Odontocetes reacting to aircraft may dive, slap the water with flippers or flukes, or swim away. Generally, pinnipeds exhibit a greater response to disturbance when on land than in the water, although overflights at low altitudes may cause some animals in the water to dive (Richardson et al. 1995).

Thus, helicopter overflights are expected to have short-term and localized effects on marine mammals and sea turtles. Single or occasional overflights by helicopters would likely only elicit a brief behavioural response by most marine mammals and sea turtles. It is unlikely that large numbers of marine mammals will be overflown, especially at low altitude.

Helicopters will typically only reduce altitude on approach for landing. Helicopter landings at offshore platforms would probably affect a very small area with a radius less than 500 m.

### *Dredging*

Results of acoustic modelling (JASCO 2012) for a trailing suction hopper dredge indicated that sound levels greater or equal to 180 dB re 1 µPa (rms) (un-weighted) occur at $R_{95\%}$ distances of 7 m or less. Because the peak in source spectrum occurs at LF, the application of M-weighting generally results in smaller distances for MF and HF cetaceans. Thus, it is very unlikely that dredging operations would cause TTS let alone PTS in any marine mammal or sea turtle.

Sound levels of 160 dB re 1 µPa (rms) occur within 90 m ($R_{95\%}$) of the dredging site. Thus, it is possible that marine mammals and sea turtles may show behavioural changes from dredging activities. Based on the limited data available, long-term dredging operations may cause prolonged avoidance of an area by marine mammals. However, cetaceans have been reported to continue using habitats near short-term dredging operations and any behavioural responses are expected to be short-term and localized. Dredging that occurs consistently over long periods can create a higher potential for disturbance, which could result in changes in habitat use for marine mammals and sea turtles.

Dredging operations during the WREP will be temporary and of limited duration. Proper planning and equipment design will reduce the duration of dredging activities and hence the environmental effect on marine mammals and sea turtles. Marine mammals common within the Offshore Study Area during dredging activities, particularly those present for extended periods, are most likely to be affected.

### *Other Activities*

Other activities associated with the WHP installation and commissioning (see Table 11-9) are expected to have negligible environmental effects on the habitat quality of marine mammals and sea turtles. It is expected that air emissions will be minimized, when possible. Any waste or fluids to be discharged into the marine environment will adhere to regulatory requirements. The main environmental effect from some other activities is the operation of vessels (described above). Artificial light might attract prey species of marine mammals and sea turtles, but this potential positive environmental effect is also considered negligible.

**Potential Risk of Mortality**

As discussed for mortality associated with vessel traffic in the Nearshore Study Area, there is a risk of vessel collision with marine mammals and sea turtles resulting in serious injury or mortality. Large species of whales and sea turtles that spend extended periods near the surface would be particularly susceptible to ship strikes. Fin and humpback whales are the most commonly reported whale to be struck by vessels and are expected to be common in the Offshore Study Area. However, sea turtles are uncommon within the Offshore Study Area, particularly at times other than late summer and early fall.

WREP activities involving vessel traffic will avoid spatial and temporal concentrations of marine mammals and sea turtles whenever possible, and vessels will maintain a steady course and safe speed, reduce speed, or deviate from their course in order to avoid potentially fatal collisions with marine mammals or sea turtles.

**Summary**

The *Geophysical, Geological, Environmental and Geotechnical Program Guidelines* (C-NLOPB 2012d) will be followed to minimize environmental effects on Marine Mammals and Sea Turtles. Given that WREP activities are mostly localized, of low to medium magnitude, and reversible at the population level, there are not likely to be significant residual adverse environmental effects on marine mammals and sea turtles from the WHP or subsea drill centre installation and commissioning.

### 11.5.2.2 Production/Operations and Maintenance

During the operations and maintenance phase in the Offshore Study Area, underwater noise can result from activities such as drilling operations from the WHP and from a MODU, helicopter overflights, vessel traffic, and geophysical and wellsite and VSP surveys. The changes in habitat quality associated with wellsite and VSP surveys, vessel traffic and helicopters were discussed in Section 11.5.2.1. The environmental effects of drilling on the habitat quality of marine mammals and sea turtles are discussed in this section. In addition, there is limited potential for direct mortality of marine mammals and sea turtles via collisions with vessels.

The environmental effects of WREP operations and maintenance activities on marine mammals and sea turtles are summarized in Table 11-12.

**Change in Habitat Quantity**

The footprint of the WHP or subsea drill centre in the Offshore Project Area would occupy a very limited area that may be used by pelagic and migratory marine mammal and sea turtle species. Thus, the installation of the WHP or subsea drill centre at the offshore site location will result in minimal habitat loss for marine mammals and sea turtles.

**Table 11-12 Environmental Effects Assessment Matrix: Operations and Maintenance**

| Project Activity | Potential Positive (P) or Negative (N) Environmental Effect | Mitigation Measure | Evaluation Criteria for Assessing Environmental Effects [A] | | | | | | Significance Rating | Level of Confidence |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | Magnitude | Geographic Extent | Frequency | Duration | Reversibility | Ecological / Socio-cultural / Economic Significance | | |
| Presence of Structure | Change in Habitat Quantity (P)<br>Change in Habitat Quality (N) | | L | 1 | 6 | 5 | R | 2 | NS | H |
| Noise from Drilling | Change in Habitat Quality (N) | | L | 3 | 6 | 5 | R | 2 | NS | H |
| WBM and SBM Cuttings | Change in Habitat Quality (N) | • Re-use of drill mud<br>• Adhere to OWTG<br>• SBM cuttings re-injection from the WHP | L | 2 | 2 | 5 | R | 2 | NS | H |
| Geophysical Surveys (e.g., VSP, geohazard) | Change in Habitat Quality (N) | • Adherence to the *Geophysical, Geological, Environmental and Geotechnical Program Guidelines* (C-NLOPB 2012d) | L | 3 | 2 | 5 | R | 2 | NS | H |
| Vessel Traffic (e.g., supply, tug, barge) | Change in Habitat Quality (N)<br>Potential Mortality (N) | • Avoid animal concentrations when possible<br>• Maintain steady course and safe speed when possible | L | 3 | 6 | 5 | R [B] | 2 | NS | H |
| Helicopter Overflights | Change in Habitat Quality (N) | • Avoid low altitudes when possible | L | 2 | 6 | 5 | R | 2 | NS | H |
| Air Emissions | Change in Habitat Quality (N) | • Adhere to NL *Air Pollution Control Regulations, 2004* and CEPA *National Ambient Air Quality Objectives* | N | 5 | 6 | 5 | R | 2 | NS | H |
| Chemical Use and Management (BOP fluids, corrosion inhibitors) | Change in Habitat Quality (N) | • Adhere to OWTG | L | 1 | 6 | 5 | R | 2 | NS | H |
| Waste Generated | Change in Habitat Quality (N) | • Adhere to OWTG | L | 1 | 6 | 5 | R | 2 | NS | H |
| Oily Water Treatment | Change in Habitat Quality (N) | • Adhere to OWTG | L | 1 | 6 | 5 | R | 2 | NS | H |
| Diving Activities / Operation of ROVs | Change in Habitat Quality (N) | | L | 2 | 3 | 5 | R | 2 | NS | H |

| Project Activity | Potential Positive (P) or Negative (N) Environmental Effect | Mitigation Measure | Evaluation Criteria for Assessing Environmental Effects (A) | | | | | | Significance Rating | Level of Confidence |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | Magnitude | Geographic Extent | Frequency | Duration | Reversibility | Ecological / Socio-cultural / Economic Significance | | |

Key:

**Magnitude:**
N = Negligible (essentially no effect)
L = Low: <10 percent of the population or habitat in the Study Area will be affected
M = Medium: 11 to 25 percent of the population or habitat in the Study Area will be affected
H = High: >25 percent of the population or habitat in the Study Area will be affected

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

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

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

**Reversibility (population level):**
R = Reversible
I = Irreversible

**Ecological / Socio-cultural / Economic Significance:**
1 = Relatively pristine area not affected by human activity
2 = Evidence of existing adverse activity
3 = High level of existing adverse activity

**Significance Rating:**
S = Significant
NS = Not Significant
P = Positive

**Level of Confidence:**
L = Low level of confidence
M = Medium level of confidence
H = High level of confidence

(A) Where there is more than one potential environmental effect, the evaluation criteria rating is assigned to the environmental effect with the greatest potential for harm
(B) Reversible at the population level but irreversible at the individual level

### Change in Habitat Quality

As discussed previously, potential changes in habitat quality of the Offshore Study Area may result from wellsite and VSP and other geophysical surveys, vessel traffic, helicopter overflights, and drilling. These changes may have physical/physiological/ behavioural effects on marine mammals and sea turtles. The focus of this section is how drilling activities may affect habitat quality in the Offshore Study area in terms of marine mammals and sea turtles.

#### *Drilling*

Drilling may occur from either the WHP or from a MODU, if the subsea drill centre option is selected (and from MODUs at future subsea drill centres). Of note, dynamically-positioned drill ships are typically noisier than semi-submersibles which, in turn, are noisier than jackups (Richardson et al. 1995). However, no sound level measurements are currently available for a platform. Modelling results by JASCO (2012) showed that sound levels of 160 dB re 1 µPa (rms) or greater occur within 5 m ($R_{95\%}$) of the drilling activity. Thus, there is nearly no risk of TTS or PTS to any marine mammal or sea turtle, and the behavioural disturbance zone around drill operations is very small. Some cetaceans are known to react to drillships and may show slight, but temporary avoidance, whereas seals are very tolerant of drill operations (reviewed by Richardson et al. 1995).

#### *Other Activities*

Other activities associated with production and operations (see Table 11-11) are expected to have negligible environmental effects on the habitat quality of marine mammals and sea turtles. It is expected that air emissions will be minimized, when possible. Any waste or fluids to be discharged into the marine environment will adhere to regulatory requirements. The discharge of any blowout preventer fluid from an offshore platform will not affect marine mammals because glycol-water mixes will be used and the blowout preventer (BOP) fluid will have a low toxicity. Sanitary and domestic waste water will be discharged during drilling and production operations. Organic matter from sanitary wastes will be quickly dispersed (after maceration) and degraded by bacteria, and food waste may be shipped ashore. The environmental effects on marine mammals and sea turtles swimming in the receiving waters containing small amounts of organic matter and nutrients will be minimal.

Water-based cuttings and operational fluids will be discharged overboard in accordance with the *Offshore Waste Treatment Guidelines* (National Energy Board (NEB) et al. 2010). Water-based cuttings will be discharged overboard regardless of development option selected. Synthetic-based cuttings will be re-injected into the subsurface if the WHP option is selected and will be treated and discharged overboard if the subsea drill centre option is selected. Drilling activities are unlikely to produce concentrations of heavy metals in muds and cuttings that are harmful to marine mammals (Neff et al. 1980, in Hinwood et al. 1994). In addition, none of the marine mammals that regularly occur in the Offshore Study Area are known to feed on benthos in the area. The bearded seal, which is considered a benthic feeder, may occasionally occur in the Offshore Study Area, but typically occurs much farther north near ice. These activities are expected to have minimal environmental effect on marine mammals and sea turtles.

The main environmental effect from some other activities is the operation of vessels (described above). Artificial light might attract prey species of marine mammals and sea turtles, but this potential positive environmental effect is also considered negligible.

**Potential Risk of Mortality**

As discussed for mortality associated with vessel traffic in the Nearshore Study Area, there is a risk of vessel collision with marine mammals and sea turtles resulting in serious injury or mortality. Large species of whales and sea turtles that spend extended periods near the surface would be particularly susceptible to ship strikes. Fin and humpback whales are the most commonly reported whale to be struck by vessels and are expected to be common in the Offshore Study Area. However, sea turtles are uncommon within the Offshore Study Area, particularly at times other than late summer and early fall.

WREP activities involving vessel traffic will avoid spatial and temporal concentrations of marine mammals and sea turtles whenever possible, and vessels will maintain a steady course and safe speed, reduce speed, or deviate from their course in order to avoid potentially fatal collisions with marine mammals or sea turtles.

**Summary**

The *Geophysical, Geological, Environmental and Geotechnical Program Guidelines* (C-NLOPB 2012d) will be followed to minimize environmental effects on marine mammals and sea turtles. Given that WREP activities are mostly localized, of low to medium magnitude, and reversible at the population level, there are not likely to be significant residual adverse environmental effects on marine mammals and sea turtles from WREP operation and maintenance activities.

### 11.5.2.3 Offshore Decommissioning and Abandonment

The environmental effects of WREP offshore decommissioning and abandonment activities on marine mammals and sea turtles are summarized in Table 11-13.

**Table 11-13 Environmental Effects Assessment Matrix: Decommissioning and Abandonment**

| Project Activity | Potential Positive (P) or Negative (N) Environmental Effect | Mitigation Measure | Evaluation Criteria for Assessing Environmental Effects [A] | | | | | | Significance Rating | Level of Confidence |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | Magnitude | Geographic Extent | Frequency | Duration | Reversibility | Ecological / Socio-cultural / Economic Significance | | |
| Removal of WHP | Change in Habitat Quantity (P)<br>Change in Habitat Quality (N) | | L | 2 | 1 | 2 | R | 2 | NS | H |
| Plugging and Abandoning Wells | Change in Habitat Quality (N) | | L | 2 | 1 | 2 | R | 2 | NS | H |
| Geophysical Surveys (e.g., VSP, geohazard) | Change in Habitat Quality (N) | • Adherence to the *Geophysical, Geological, Environmental and Geotechnical Program Guidelines* (C-NLOPB 2012d) | L | 2 | 2 | 3 | R | 2 | NS | H |
| Vessel Traffic (e.g., supply, tug, barge) | Change in Habitat Quality (N)<br>Potential mortality (N) | • Avoid mammal concentrations when possible<br>• Maintain steady course and safe speed when possible | L | 3 | 6 | 3 | R [B] | 2 | NS | H |
| Helicopter Overflights | Change in Habitat Quality (N) | • Avoid low altitudes when possible | L | 2 | 6 | 3 | R | 2 | NS | H |
| Air Emissions | Change in Habitat Quality (N) | • Adhere to NL *Air Pollution Control Regulations, 2004* and CEPA *National Ambient Air Quality Objectives* | N | 5 | 6 | 3 | R | 2 | NS | H |

Key:

**Magnitude:**
N = Negligible (essentially no effect)
L = Low: <10 percent of the population or habitat in the Study Area will be affected
M = Medium: 11 to 25 percent of the population or habitat in the Study Area will be affected
H = High: >25 percent of the population or habitat in the Study Area will be affected

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

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

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

**Reversibility (population level):**
R = Reversible
I = Irreversible

**Ecological / Socio-cultural / Economic Significance:**
1 = Relatively pristine area not affected by human activity
2 = Evidence of existing adverse activity
3 = High level of existing adverse activity

**Significance Rating:**
S = Significant
NS = Not Significant
P = Positive

**Level of Confidence:**
L = Low level of confidence
M = Medium level of confidence
H = High level of confidence

(A) Where there is more than one potential environmental effect, the evaluation criteria rating is assigned to the environmental effect with the greatest potential for harm
(B) Reversible at the population level but irreversible at the individual level

**Change in Habitat Quantity**

The removal of structures (WHP) will make minimal habitat available to marine mammals and sea turtles. This will have negligible effects on marine mammals and sea turtles in the Offshore Study Area.

**Change in Habitat Quality**

Environmental effects of removing structures (WHP), vessel traffic, helicopter traffic and geophysical surveys are decommissioning activities which could affect habitat quality. These activities, as well as those that do not produce sound (e.g., air emissions), could affect habitat quality. The potential environmental effects of these activities are expected to be similar to (or less than) those of installation or operation (assessed previously in Sections 11.5.2.1 and 11.5.2.2); therefore, no significant adverse environmental effects are predicted.

**Potential Risk of Mortality**

As discussed for mortality associated with vessel traffic in the Nearshore Study Area, there is a risk of vessel collision with marine mammals and sea turtles resulting in serious injury or mortality. Project activities involving vessel traffic will avoid spatial and temporal concentrations of marine mammals and sea turtles whenever possible, and vessels will maintain a steady course and safe speed in order to avoid potentially fatal collisions with the VEC. Vessels will reduce speed whenever possible and deviate their course to avoid marine animals.

**Summary**

The *Geophysical, Geological, Environmental and Geotechnical Program Guidelines* (C-NLOPB 2012d) will be followed to minimize environmental effects on marine mammals and sea turtles. Given that WREP activities are mostly localized, of low to medium magnitude, and reversible at the population level, there are not likely to be significant residual adverse environmental effects on marine mammals and sea turtles from WREP decommissioning and abandonment activities.

### 11.5.2.4 Potential Future Activities

**Change in Habitat Quantity**

No changes in habitat quantity for marine mammals or sea turtles are expected during potential future activities.

**Change in Habitat Quality**

Future activities in the Offshore Study Area that could potentially affect habitat quality may include, but are not limited to, geophysical surveys, dredging, flowline and subsea equipment installation, drilling, vessel traffic and helicopter overflights (see Table 11-9). All of these activities will introduce sound into the water, which in turn may affect marine mammals and sea turtles. These activities, as well as those that do not produce sound (e.g., chemical use and management, cuttings), could affect habitat quality. The potential environmental effects of these activities are expected to be similar to (or less than) those

of installation or operation (assessed previously in Sections 11.5.2.1 and 11.5.2.2); therefore, no significant adverse environmental effects are predicted.

**Potential Risk of Mortality**

As discussed for mortality associated with vessel traffic in the Nearshore Study Area, there is a risk of vessel collision with marine mammals and sea turtles resulting in serious injury or mortality. Large species of whales and sea turtles that spend extended periods near the surface would be particularly susceptible to ship strikes. Fin and humpback whales are the most commonly reported whale to be struck by vessels and are expected to be common in the Offshore Study Area. However, sea turtles are uncommon within the Offshore Study Area, particularly at times other than late summer and early fall. The potential environmental effects of vessel traffic associated with potential future activities are expected to be similar (or less than) those of installation or operation (assessed previously in Sections 11.5.2.1 and 11.5.2.2);

**Summary**

The *Geophysical, Geological, Environmental and Geotechnical Program Guidelines* (C-NLOPB 2012d) will be followed to minimize environmental effects on marine mammals and sea turtles. Given that WREP activities are mostly localized, of low to medium magnitude, and reversible at the population level, there are not likely to be significant residual adverse environmental effects on marine mammals and sea turtles from WREP potential future activities.

### 11.5.2.5 Accidental Events

Spills in the Offshore Study Area could be associated with a subsea hydrocarbon blowout, surface oil spills, or fuel spills from vessels. The effects of an accidental release of oil from a blowout or surface spill are assessed below (see Table 11-14). A diesel fuel spill was estimated to have a slick survival time of 48 hours (SL Ross 2012) and would thus have reduced effects on marine mammals and sea turtles compared to a crude oil spill. The different types and probability of spills are discussed in Section 3.6. A detailed analysis can be found in SL Ross (2012).

**Table 11-14 Environmental Effects Assessment: Accidental Events**

| WREP Activity | Potential Positive (P) or Negative (N) Environmental Effect | Mitigation Measure | Evaluation Criteria for Assessing Environmental Effects [A] | | | | | | Significance Rating | Level of Confidence |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | Magnitude | Geographic Extent | Frequency | Duration | Reversibility | Ecological / Socio-cultural / Economic Significance | | |
| Subsea blowout, or crude oil surface spill | Change in Habitat Quality (N)<br>Potential Mortality (N) | • Training, preparation, equipment inventory, prevention, and emergency response drills<br>• Oil spill response plan | L | 6 | 1 | 2 | R [B] | 2 | NS | H |
| Other Spills (fuel, chemicals, drilling muds) | Change in Habitat Quality (N)<br>Potential Mortality (N) | • Training, preparation, equipment inventory, prevention, and emergency response drills<br>• Oil spill response plan | L | 1 | 1 | 2 | R [B] | 2 | NS | H |
| Marine Vessel Incident (including collisions) (fuel spills) | Change in Habitat Quality (N)<br>Potential Mortality (N) | • Training, preparation, equipment inventory, prevention, and emergency response drills<br>• Oil spill response plan | L | 5 | 1 | 2 | R [B] | 2 | NS | H |

Key:

**Magnitude:**
N = Negligible (essentially no effect)
L = Low: <10 percent of the population or habitat in the Study Area will be affected
M = Medium: 11 to 25 percent of the population or habitat in the Study Area will be affected
H = High: >25 percent of the population or habitat in the Study Area will be affected

**Geographic Extent:**
1 = <1 km radius
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**Frequency:**
1 = <11 events/year
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**Duration:**
1 = <1 month
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**Reversibility (population level):**
R = Reversible
I = Irreversible

**Ecological / Socio-cultural / Economic Significance:**
1 = Relatively pristine area not affected by human activity
2 = Evidence of existing adverse activity
3 = High level of existing adverse activity

**Significance Rating:**
S = Significant
NS = Not Significant
P = Positive

**Level of Confidence:**
L = Low level of confidence
M = Medium level of confidence
H = High level of confidence

(A) Where there is more than one potential environmental effect, the evaluation criteria rating is assigned to the environmental effect with the greatest potential for harm
(B) Reversible at the population level but irreversible at the individual level

Oil spill response is included as part of the contingency planning undertaken for the WREP (Section 16.9). Chapter 16 describes the WREP overall environmental management process.

A crude oil blowout of 3,963 to 6,435 $m^3$/day would have a slick survival time of more than 30 days; a subsea blowout would have a thinner, but wider slick (up to 2.8 km) than a surface blowout (up to 3.4 mm thick and 160 m wide) (SL Ross 2012). The spill would most likely be dispersed to a southeasterly direction, away from the shore. According to the spill modelling (SL Ross 2012), oil is highly unlikely to reach the shore if a spill occurs in the Offshore Study Area. The probability of a crude oil spill reaching shore was zero for December through February and April through September, and less than 1 percent for March, October and November (SL Ross 2012).

**Change in Habitat Quantity**

No direct changes in habitat quantity are expected during accidental events. However, a change in habitat quality because of a hydrocarbon spill may indirectly reduce the amount of habitat available to marine mammals or sea turtles by rendering it unsuitable for foraging and other activities.

**Change in Habitat Quality**

The accidental release of hydrocarbons may affect several physical and internal functions of marine mammals and sea turtles. Hydrocarbons can be inhaled or ingested, and may cause behavioural changes, inflammation of mucous membranes, pneumonia and neurological damage (see Geraci and St. Aubin 1990). Most marine mammals, with the exception of fur seals, polar bears and sea otters (none of these species are expected to occur in the Offshore Study Area), are considered to be not directly susceptible to deleterious effects of oil (see Geraci and St. Aubin 1990). However, weak or stressed animals may also be vulnerable to oils spills.

According to the spill modelling (SL Ross 2012), oil is not expected to reach the shore if a spill occurs in the Offshore Study Area. Thus, hauled out seals are not expected to be effected. Therefore, the effects are considered less for seals in the Offshore Study Area compared with the Nearshore Study Area.

It is difficult to predict with precision the effects of accidental events on biota, especially as they relate to the geographic extent of the effects. Numerous parameters (e.g., chemical composition of the hydrocarbon, behaviour of spilled substance at different times of year) influence hydrocarbon spill characteristics and there are many unknowns concerning specific effects on different marine mammal and sea turtle groups. It may be possible under calm conditions to clean up a large proportion of spilled petroleum hydrocarbons; however, only a small percentage offshore can be retrieved under typical wind and wave conditions, especially in winter. Therefore, there will be an emphasis on accident prevention at all phases of the WREP.

### Potential Risk of Mortality

Marine mammals and sea turtles are not considered to be at high risk from the effects of oil exposure, but some evidence implicates oil spills with seal mortality, particularly young seals. Sea turtle carcasses are also often found after a spill. However, harbour seals are considered rare in the Offshore Study Area, and grey seals as well as sea turtles are expected to be uncommon. Baleen whales appear to be less susceptible to spills than delphinids, as dolphins are often found stranded after an oil spill. Thus, delphinids that occur in the Offshore Study Area at the time of the spill are most susceptible to fouling. Although effects of the *Exxon Valdez* oil spill were substantial on killer whales, killer whales are uncommon in the Offshore Study Area, and no population-level effects would be expected.

Animals exposed to heavy doses of hydrocarbon for prolonged periods could experience mortality. Chronic exposure to hydrocarbons, either through surface contact or ingestion, may occur in cetaceans, seals and sea turtles. Hydrocarbon toxicity could result in physiological damage, such as lesions and effects on blood and enzyme chemistry.

For marine mammals and sea turtles, it is probable that only small proportions of populations are at risk at any one time in the Offshore Study Area. Oil spill prevention measures, along with typical oil spill countermeasures (creating an oil spill response plan, training, preparation, an equipment inventory, and conducting emergency response drills) will serve to reduce the number of animals exposed to oil.

### Summary

Depending on the time of year, location of animals within the affected area, and type of oil spill or blow-out, the effects of an offshore oil release on the health of cetaceans is predicted to range from negligible to low magnitude over varying geographic extents. Based on present knowledge of Jeanne d'Arc Basin, the modelling exercises, and on past monitoring experience with large spills (*e.g.*, *Exxon Valdez*, *Arrow* and others), it can be predicted that an oil spill associated with the WREP will not result in any significant residual environmental effects to marine mammals or sea turtles in the Offshore Study Area.

## 11.5.3 Cumulative Environmental Effects

Marine exploration, commercial fishery activity, marine transportation and existing and planned production activity (e.g., White Rose, Hibernia, Terra Nova and Hebron) all have the potential to interact with marine mammals and sea turtles (see Table 11-9). Hunting of marine mammals and sea turtles does not occur inside the Nearshore or Offshore Study Areas, other than a relatively small harp seal harvest. Most, if not all, commercial seal hunting occurs outside the Nearshore and Offshore Study Areas in southern Labrador and northeast Newfoundland. It is very unlikely that routine activities associated with other marine exploration, existing production areas, marine transportation and commercial fisheries have much environmental effect on Marine Mammals and Sea Turtles.

#### 11.5.3.1 Nearshore

Cumulative environmental effects in the Nearshore Study Area are expected to be of a lower magnitude than those of the Offshore Study Area, as fewer activities have the potential to interact with the WREP (see Section 11.5.3.2 for cumulative environmental effects assessment of the Offshore Study Area).

Underwater sound will likely have the greatest effect on marine mammals and sea turtles, particularly cetaceans, during WREP activities. Most species will be able to hear sounds, if they are close enough, and will be able to avoid them if they so choose. Individuals near WREP activities and other activities in the Nearshore Study Area (e.g., other vessel traffic) may be subject to cumulative environmental effects. However, these effects would most likely be limited to behavioural effects (i.e., localized avoidance). Cumulative environmental effects of activities producing underwater noise in Placentia Bay are predicted to be not significant.

A hydrocarbon spill in Placentia Bay could affect marine mammals and sea turtles to varying degrees depending upon type, size, timing, and species and life stages involved. A fuel spill is very unlikely to coincide among multiple users in Placentia Bay. Overall, the effects of accidental events on marine mammals and sea turtles are predicted to be not significant, and thus, the overall cumulative environmental effects on marine mammals and sea turtles are also likely to be not significant.

#### 11.5.3.2 Offshore

Commercial fishing activities may cause incidental mortalities or disturbance to marine mammals and sea turtles. It is predicted that the WREP will not cause any mortality to marine mammals and sea turtles and thus, there will be no or negligible cumulative environmental effect from commercial fishing activities. Major shipping routes pass in proximity to the Offshore Study Area, and additional marine traffic (e.g., cruise ships) typically occur inshore of the Offshore Study Area. Supply vessels and tankers are also associated with other developments in Jeanne d'Arc Basin. As assessed above, the most likely effect of vessel traffic on marine mammals and sea turtles is disturbance. It is predicted that WREP activities are very unlikely to cause any mortality and, thus, the cumulative environmental effects of marine transportation are predicted to be not significant.

Underwater sound associated with WREP activities will likely have the greatest effect on marine mammals and sea turtles, particularly cetaceans. Most species will be able to hear sounds, if they are close enough, and will be able to avoid them if they so choose. Mitigation measures associated with wellsite and VSP surveys are designed to prevent harm to marine mammals or sea turtles. Individuals travelling near one or more of the offshore developments or in proximity to other offshore exploration activities may be subject to cumulative environmental effects. However, these effects would most likely be limited to behavioural effects (i.e., localized avoidance). Cumulative environmental effects of other developments and exploration activities on the Jeanne d'Arc Basin are predicted to be not significant.

A major hydrocarbon spill or blowout in Jeanne d'Arc Basin could affect marine mammals and sea turtles to varying degrees depending upon type, size, location, timing, and species and life stages involved. A major spill is statistically very unlikely to coincide

among multiple developments in the Jeanne d'Arc Basin. Nonetheless, cumulative environmental effects could occur from chronic discharge of oil bilges at sea by ships transiting the area or from other activities that could affect marine mammals and sea turtles. Overall, the effects of accidental events on marine mammals and sea turtles were predicted to be not significant, and thus, the overall cumulative environmental effects on marine mammals and sea turtles are also likely to be not significant.

**Summary**

Given the predicted minimal environmental effects of other projects/activities, the large size of the Offshore Study Area and the prediction that the residual environmental effects of WREP's routine activities on marine mammals and sea turtles through the difference phases are not significant in the Nearshore and Offshore Study Areas (see Sections 11.5.1 and 11.5.2, respectively), the cumulative environmental effects on marine mammals and sea turtles are also predicted to be not significant. This is consistent with the predicted significance of between project cumulative environmental effects on marine mammals and sea turtles in the Husky Delineation/Exploration Drilling Program for Jeanne d'Arc Basin Area 2008-2017 (LGL 2007b) and Petro-Canada Exploration Drilling Program for Jeanne d'Arc Basin 2009-2017 environmental assessments (Christian 2008).

### 11.5.4 Determination of Significance

The determination of significance is based on the definition provided in Section 11.2. It considers the magnitude, geographic extent, duration, frequency, reversibility and ecological context of each environmental effect within the Study Areas, and their interactions, as presented in the preceding analysis. Significance is determined at the population level within the Study Areas.

The significance of potential residual environmental effects, including cumulative environmental effects, resulting from the interaction between WREP-related activities and marine mammals and sea turtles, after taking into account any proposed mitigation, is summarized in Table 11-15).

The environmental effects of routine activities associated with the construction, installation, operations/maintenance and decommissioning/abandonment phases of the WREP on marine mammals and sea turtles are predicted to be not significant (Table 11-15).

The environmental effects associated with accidental events associated with the WREP on marine mammals and sea turtles are also predicted to be not significant (Table 11-15).

As required by *CEAA*, an analysis of potential environmental effects to the sustainable use of renewable resources associated with marine mammals and sea turtles has been considered. No significant adverse residual environmental effects on marine mammals and sea turtles are predicted that could affect renewable resource use.

**Table 11-15 Residual Environmental Effects Summary: Marine Mammals and Sea Turtles**

| Phase | Residual Adverse Environmental Effect Rating [A] | Level of Confidence | Probability of Occurrence (Likelihood) [C] |
|---|---|---|---|
| Construction [B] | NS | H | NA |
| Installation of WHP or Subsea Drill Centre | NS | H | NA |
| Operation and Maintenance | NS | H | NA |
| Decommissioning and Abandonment [D] | NS | H | NA |
| Accidental Events | NS | H | NA |
| Cumulative Environmental Effects | NS | H | NA |

Key:

**Residual Environmental Effects Rating:**
S = Significant Adverse Environmental Effect
NS = Not Significant Adverse Environmental Effect
P = Positive Environmental Effect

**Level of Confidence in the Effect Rating:**
L = Low level of Confidence
M = Medium Level of Confidence
H = High level of Confidence

**Probability of Occurrence of Significant Effect:**
L = Low Probability of Occurrence
M = Medium Probability of Occurrence
H = High Probability of Occurrence

NA = Not Applicable
(A) As determined in consideration of established residual environmental effects rating criteria
(B) Includes all Argentia activities (engineering, construction, tow-out) of the WHP option only(
(C) (Effects are not predicted to be significant, therefore the probability of occurrence rating is not required under CEAA.
(D) Includes decommissioning and abandonment of the WHP and offshore site

### 11.5.5 Follow-up and Monitoring

The *CEAA* definition of "follow-up program" is "a program for (a) verifying the accuracy of the environmental assessment of a project, and (b) determining the effectiveness of any measures taken to mitigate the adverse environmental effects of the project". Follow-up programs serve as the primary means to determine and quantify change from routine operations on the receiving environment. Compliance monitoring on its own, does not satisfy the requirements for a follow-up program. Compliance monitoring is conducted to ensure that a project and its activities are meeting the relevant environmental standards, guidelines and regulations. Compliance monitoring will be conducted for the WREP in accordance with regulatory requirements.

Specific EEM programs to verify the accuracy of assessment predictions and the efficacy of mitigation measures are not planned for marine mammals and sea turtles.

For WREP activities such as wellsite and VSP activities, Husky will implement a marine mammal and sea turtle observation program consistent with the requirements outlined in the *Geophysical, Geological, Environmental and Geotechnical Program Guidelines* (C-NLOPB 2012d). Data on marine mammal and sea turtle observations will be provided to DFO and the C-NLOPB where applicable.