4.0 Biological Environment

4.1 Study Area Ecosystem

An ecosystem is an inter-related complex of physical, chemical, geological, and biological components that can be defined at many different scales, including a Project Area level (i.e., a deep ocean basin ecosystem) to a Regional Area ecosystem that is topographically and oceanographically complicated with shelves, slopes, and valleys and several major water masses and currents. Many important components of the ecosystem, such as certain species and life stages of fish, seabirds and marine mammals that are ecologically, economically, and/or socially important, may be affected by the Project. Information concerning biological characteristics of these species is discussed in the following sections.

4.2 Fish and Fish Habitat

This section provides a description of the existing fish and fish habitat in the Study Area. Fish habitat is considered first, followed by a discussion of macro-invertebrates and fishes in the Study Area.

4.2.1 Fish Habitat

In this EA, 'fish habitat' includes physical and biological aspects of the marine environment used by macro-invertebrate and fish species in the Study Area. The physical and chemical nature of the water column (i.e., water temperature, depth, salinity) and bottom substrate (i.e., surficial sediment) are critical factors affecting the characterization of associated marine biological communities. The biological component of fish habitat refers to phytoplankton, zooplankton, and benthos (i.e., infaunal and epibenthic invertebrates not typically harvested during commercial fisheries in the Study Area [e.g., polychaetes, echinoderms]).

4.2.1.1 Bathymetry

The bathymetry within the Study Area ranges from just under 100 m to >5,000 m (see Figure 1.1). More than half of the Study Area is characterized by water depths exceeding 500 m. A substantial portion of the Study Area contains a grouping of banks that includes the Grand Bank, Whale Bank, Green Bank, and St. Pierre Bank, collectively known as the Grand Banks of Newfoundland. The majority of these banks have water depths ranging from 50 to 100 m depths with the exception of portions of the St. Pierre Bank and the Southeast Shoal of the Grand Bank where water depths <50 m. The continental slope in the southern and eastern regions of the Grand Banks reaches depths >1,000 m over a relatively short distance. The Grand Bank is deeply incised with submarine canyons along the southern and southeast areas (e.g., Carson Canyon, Lilly Canyon). The Study Area also includes the southern portions of the nose of the Grand Bank, the Flemish Pass, and the Flemish Cap. The most westerly part of the Study Area is adjacent to the Laurentian Channel. Two smaller channels, Halibut Channel situated between St. Pierre Bank and Green Bank, and Haddock Channel situated between Green Bank and Whale Bank occur in the northwestern part of the Study Area. The Study Area extends slightly into both Nova Scotia and St. Pierre et Miquelon waters. Most of the Study Area is located outside of Canada's Exclusive Economic Zone (EEZ) (200 nm limit).

4.2.1.2 Surficial Sediment

The surficial geology of portions of the Study Area was discussed in LGL (2003a, 2009a,b), and subsequently summarized in the Southern Newfoundland SEA (LGL 2010a). The following information was obtained from the Southern Newfoundland SEA (LGL 2010a).

Unconsolidated Quaternary sediments deposited during and subsequent to the Wisconsinian glaciations lie above the Tertiary and older bedrock. Five surficial sedimentary formations are recognized within the SEA Area: (1) Grand Banks Drift; (2) Downing Silt; (3) Adolphus Sand; (4) Placentia Clay; and (5) Grand Banks Sand and Gravel. These formations consist of glacial tills, proglacial silts, sublittoral sands, recent mud, and basal transgressive sand and gravel. Descriptions of these sediment types are provided below (from Fader et al. 1982; Piper et al. 1990; and Brown 1990).

Grand Banks Drift

This formation consists of till deposited at the base of a grounded ice sheet, generally in contact with bedrock surfaces. This unit is <60 m thick and found at water depths up to 500 m (i.e., the upper continental slope). It is an olive-grey to reddish-brown, poorly sorted till, composed of sand, silt, and clay with various amounts of pebbles, cobbles, and boulders. Where this formation is exposed at the seabed, it appears as protruding cobbles and boulders within a matrix of sandy mud. It occurs as a thin veneer or ground moraine, as infillings in old subaerial erosional channels in underlying bedrock, and in thick morainal ridges.

Downing Silt

This formation overlies and locally intertwines with the Grand Banks Drift. It is typically <90 m thick and is interpreted to have been deposited at the front of a grounded ice sheet, beneath an ice shelf, or as a proglacial deposit. Downing Silt is a dark greyish-brown to greenish-brown, clayey and sandy silt that locally grades to silty and clayey sand with minor angular gravel. In the SEA Area, Downing Silt is exposed primarily at the base of the Laurentian Channel and in isolated depressions of the Halibut Channel. Below the seabed, this unit occurs in the northeastern St. Pierre Bank and over most of the Laurentian Channel. Where exposed, the surface of this formation is smooth with gentle undulations. In areas where this formation is thin and overlies rough glacial till, its surface mimics that of the underlying till. This formation is extensively furrowed by icebergs, some as deep as 10 m.

Adolphus Sand

This formation is found below the post-Wisconsinian low sea level at 115 to 120 m water depths. It is a dark, greyish-brown, fine to coarse-grained sand containing some silt and clay-sized fractions and gravel that generally is found as a thin veneer <10 m thick. Foraminiferal tests, sponge spicules, radiolaria, and broken shell fragments occur in abundance within this formation. In the SEA Area, this unit is found along the flanks of the Laurentian Channel and at the base of the Halibut Channel. Iceberg furrows occur across many areas of Adolphus Sand, particularly along the edges of the Laurentian Channel. In the Halibut Channel, the seabed is characterized by numerous sand waves with maximum heights of 8 m and wavelengths of 305 m.

Placentia Clay

This formation is a dark greyish-brown to dark olive, homogeneous silty clay to clayey silt. It is <30 m thick and its generally flat surface comprises most of the seabed of the Laurentian Channel within the SEA Area. This unit originates primarily from reworking of Downing Silt and glacial tills during the marine transgression of the Holocene.

Grand Banks Sand and Gravel

This formation is a basal marine transgressive sand and gravel deposit that occurs in water depths <115 to 120 m and is generally <20 m thick. This unit consists of reddish to greyish-brown, fine to coarse grained, well sorted sand that grades locally to coarse, well rounded gravel with large boulders. The fine silt and clay-sized fraction characteristic of the Adolphus Sand is absent in this formation. Grand Banks Sand and Gravel is exposed at the seabed over most of St. Pierre Bank as sand waves and megaripples with wavelengths ranging from one to 200 m.

4.2.1.3 Plankton

Plankton is composed of free-floating organisms that form the basis of the pelagic ecosystem. It includes bacteria, fungi, phytoplankton, zooplankton and ichthyoplankton (i.e., fish eggs and larvae). In simplest terms, phytoplankton (e.g., diatoms) produce carbon compounds through the utilization of sunlight, carbon dioxide, and nutrients (e.g., nitrogen, phosphorus, and silicon), a process called primary production. Herbaceous zooplankton (e.g., calanoid copepods, the dominant component of NW Atlantic zooplankton) feed on phytoplankton, a process called secondary production. The herbivores in turn are fed upon by predators (i.e., tertiary production) such as predacious zooplankton (e.g., chaetognaths, jellyfish, etc.), all of which may be grazed by higher predators including invertebrates, fishes, seabirds, sea turtles and marine mammals. This food web also links to the benthic ecosystem through bacterial degradation processes, dissolved and particulate carbon, and direct predation. An understanding of plankton production is important because areas of enhanced production and/or biomass are areas where marine biota tend to congregate for feeding.

Production is enhanced in areas of bottom upwelling where nutrient-rich bottom water is brought to the surface by a combination of bottom topography, wind and currents. Frontal areas are where two differing water masses meet to create lines of convergence and often concentrate plankton and predators alike. An example of this phenomenon is the semi-permanent front between waters of Gulf Stream origin and waters of Labrador Current origin.

Seasonal fluctuations in phytoplankton biomass into the Newfoundland and Labrador region are dominated by changes in the abundance of diatoms (DFO 2007a). The spring bloom trends to be dominated by diatoms while the fall bloom dominant species are flagellates and dinoflagellates (Buchanan and Foy 1980a,b; DFO 2007a). Zooplankton comprise the main link between primary production and higher-level organisms in the marine ecosystem. They transfer organic carbon from phytoplankton to fish, marine mammals, and birds higher in the food chain. Zooplankton is a food source for a broad spectrum of species and they contribute faecal matter and dead zooplankton to the benthic communities. Zooplankton reproduction is tied to the phytoplankton bloom, which either coincides with or immediately follows the brief but intense phytoplankton blooms in the high latitudes (Huntley et al. 1983; Head et al. 2000; Head and Pepin 2008).

The information on plankton of the southern Grand Banks area has been reviewed extensively in the Southern Newfoundland SEA (LGL 2010a) and is summarized briefly in the current section. Some of the key points concerning the various components of planktonic communities for the southern Grand Banks area are highlighted below:

- In the North Atlantic, there is strong seasonal variability in primary production, typically characterized by a peak in the spring (March-June) known as the spring bloom. Increased light during the spring warms the upper 10 to 20 m of the water column which creates a thermocline. This in combination with intense grazing by zooplankton and a depletion of nutrients results in a mid-summer primary production low. As the thermocline weakens and upwelling increases in the fall, another lesser primary production peak typically occurs.

- The areas within the SEA Area where primary production was highest at certain times during 2008, based on chlorophyll-a concentration, included the coastal region of the southwest coast of Newfoundland, the western edge of St. Pierre Bank/Laurentian Channel, and both the shelf edge/slope and shelf of the southwest Grand Bank.

- Zooplankton within the Laurentian Channel are dominated by euphausiids (*Meganyctiphanes norvegica* and *Thysanoessa* spp.), and calanoid copepods (*Calanus* spp.). Euphausiids and calanoid copepods are important prey for whales in this area.

- Calanoid copepods dominate the zooplankton that typically occur on St. Pierre Bank and serve as important prey for resident fish larvae (e.g., redfishes (*Sebastes* spp.)). Hyperiid amphipods and chaetognaths are also important components of the zooplankton occurring within the SEA Area.

- The vertical distributions of many zooplankton species exhibit diurnal variability, whereby concentrations in the surface waters are greater during the day.

The Atlantic Zone Monitoring program (AZMP) was implemented by DFO in 1998 in an attempt to better understand, describe and forecast the state of the marine ecosystem. A critical element of the AZMP is an observation program designed to assess the variability in nutrients, phytoplankton and zooplankton (DFO 2013a). The AZMP findings in relation to oceanographic conditions in the Study Area for 2012 are summarized below.

- Sea-surface temperatures were at record or near-record highs during ice-free months, most notably in the Southern areas of Newfoundland. Bottom temperatures were above normal in the Atlantic region with the exception of NAFO Div. 3LNO in the fall.

- Nitrate inventories in both surface and near bottom waters remained below normal on the Newfoundland and Labrador Shelf with the exception of a few distinct areas, such as the Southeast Shoal within the Study Area.

- Overall abundance of phytoplankton has been strongly below normal across much of the Newfoundland and Labrador Self in 2011 and 2012.

- High abundance levels of non-copepod zooplankton (e.g., larval stages of benthic invertebrates and carnivores that feed on other zooplankton) were observed on the Grand Banks in 2012.

- The abundance levels of zooplankton species *Pseudocalanus* spp. and *Calanus finmarchicus* have demonstrated above normal levels since 2009.

- Overall, the southern Grand Banks have demonstrated above normal nutrient inventories and near normal phytoplankton abundance while conditions across much of the Newfoundland-Labrador Shelf have been below average.

Similarly, in another paper which used information from the AZMP, Pepin et al. (2013) concluded that the abundance of *C. finmarchicus* has increased in recent years with the highest levels being recorded along the southern Grand Bank section in 2011 and the Flemish Cap section in 2012. The abundance of two other *Calanus* spp., *C. glacialis* and *C. hyperboreus* however have shown long-term declines in abundance on the Flemish Cap and southeast Grand Bank from 2001 to present.

Plankton communities of the Southeast Shoal region of the Grand Banks were described by Anderson and Gardner (1986). They identified 56 separate taxonomic groupings which included 35 species in this highly productive region within the Study Area (See Table 2 of Anderson and Gardner (1986) for complete list of taxa). The most abundant species encountered were *Pseudocalanus* spp. and *C. finmarchicus.*

The pattern and scale of long-term variability among NW Atlantic plankton communities based on continuous plankton recorder (CPR) data collected between 1958 and 2006 were recently investigated (Head and Pepin 2010; Pershing et al. 2010). A portion of the area considered overlaps with the proposed Study Area. It was concluded that changes in the plankton community corresponded to changes in the physical environment suggesting that physical conditions are strong drivers of interannual variability in NW Atlantic Shelf ecosystems (Pershing et al. 2010). Head and Pepin (2010) showed that the increases in phytoplankton abundances in the shelf region in the early 1990s, primarily in winter, occurred along with increased contribution of Arctic-derived freshwater to the Newfoundland and Labrador Shelves. It is thought that increased melting of sea ice from ocean warming will increase overall plankton productivity and alter plankton community composition in Newfoundland and Labrador Shelves in the future (Harrison et al. 2013).

Planktonic organisms are so ubiquitous and abundant, and many have such rapid generation times that there will be essentially no effect on planktonic communities from the seismic program. Planktonic stages of commercial invertebrates (e.g., crab) and fishes (e.g., cod) that occur in the Study Area are described in the Southern Grand Banks SEA (LGL 2010a) and in Section 4.2.2.2 of this EA related to reproduction in macro-invertebrates and fishes.

4.2.1.4 Benthos

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

Benthic invertebrate communities can be spatially variable because of physical habitat characteristics such as water depth, substrate type, currents, and sedimentation. The primary factors affecting the structure and function of such communities in high latitude communities are water mass differences, sediment characteristics, and ice scour (Carey 1991). The wide range of these characteristics within the Study Area ensures a variety of benthic communities. The structure and metabolism of benthic communities can also be directly affected by the rate of sedimentation of organic detritus in shelf and deeper waters (Desrosiers et al. 2000). The seasonality of phytoplankton can influence production in benthic communities, adding temporal variability to a highly heterogeneous community. The benthic environment in the Study Area can be broken into two distributional zones (Carey 1991):

1. Continental shelf where the biomass is higher at the shelf edge; and
2. Upper Slopes where the biomass begins to decrease.

The benthic invertebrate communities of portions of the Study Area have been described extensively in the Southern Newfoundland SEA (LGL 2010a) and are briefly summarized below. It is important to note that beyond the Canadian 200 nm limit, excluding the Nose and Tail of the Grand Banks, the Flemish Pass and the Flemish Cap, there is a substantial deficiency in data relating to the benthos. The information presented in this section pertains to studies completed on the continental shelf and slope of the Study Area.

- Characteristic deep subtidal invertebrate species in the Southern Grand Banks area include lobster (*Homarus americanus*), snow crab (*Chionoecetes opilio*), toad crab (*Hyas* sp.), rock crab (*Cancer* sp.), Iceland scallops (*Chlamys islandica*), sea scallops (*Placopecten magellanicus*), northern shrimp (*Pandalus borealis*), Stimpson's surf clams (*Mactromeris polynyma*), propeller clams (*Cyrtodaria siliqua*), ocean quahogs (*Arctica islandica*) and sea urchins.

- The Sydney Basin SEA and the Laurentian Sub-basin SEA both described benthic invertebrate communities reported by Hutcheson et al. (1981) and Nesis (1965) in deep subtidal areas of the Grand Banks. Reported invertebrate groups included echinoderms, polychaetes, crustaceans, bivalve molluscs and benthic colonial organisms such as bryozoans, hydrozoans, sponges and corals.

- Infaunal invertebrates collected at Lewis Hill (southwestern Grand Banks) in recent years were dominated by polychaetes, followed by nemertean worms, amphipods and sea cucumbers. The invertebrate community found at Lewis Hill was very similar to those found in similar surficial sediment types elsewhere on the Grand Banks (Husky 2003a,b).

- The Laurentian Sub-basin Exploration Drilling Program EA (Buchanan et al. 2006) provided some information on deepwater benthos sampling on the Nova Scotian continental rise. The most abundant invertebrate groups found during sampling included polychaetes, bivalves, isopods and tanaids.

Gilkinson (2013) provides summary data related to benthos caught during DFO research survey vessel trawling in NAFO Divisions 3LNO between 2006 and 2010. Figure 1 in Gilkinson (2013) indicates that the trawl-caught benthos biomass was dominated by snow crab and echinoderms. Catches of sponges and shrimp in 3L were larger than those in 3NO. During the DFO NEREUS grab sampling program, 2008 to 2010, a total of 455 benthic macrofaunal taxa were identified from 22,000 specimens representing 12 phyla. The average sampling depth was 92 m (range 58-157 m). Overall, 51% of samples collected were composed of pure sand. The majority (77%) of samples were collected from the mid-depth zone (>50-100 m) of which 46% contained pure sand. This increased to 61% in the deep zone. The three phyla that dominated the grab samples included Annelida, Arthropoda, and Mollusca. These three phyla comprised 86% of all recorded taxa. Annelida was the most species rich phylum (39% of all species) with polychaetes accounting for 99% of all annelid taxa. Amphipods accounted for 60% of arthropod taxa, while gastropods and bivalves accounted for 51% and 43% of mollusc taxa, respectively. Dominance in species richness by these three phyla is typical of northwest Atlantic continental shelves that are composed primarily of sandy seabeds (Gilkinson et al. 2005, Kenchington et al. 2001 in Gilkinson 2013). Some of the main species collected in grab samples included the annelids *Glycera capitata, Prionospio steenstrupi, Terebellides stroemi, Nothria conchylega, Nothria conchylega,* and *Pectinaria granulate*, the arthropods *Hyas coarctatus, Unciola irrorata,* and *Unciola leucopis*, and the molluscs *Antalis entails, Crenella decussate, Arctica islandica, Liocyma fluctuosa,* and *Chlamys islandicus*.

LGL analysis of DFO RV data for 2007-2011 also indicated that sponges were the benthos group accounting for highest catch weight. Other invertebrate benthos with relatively high catch weights included snow crab, sea anemones, basket stars, corals, basket stars and sea urchins, confirmation of what was reported in Gilkinson (2013).

Deep-water Corals and Sponges

A variety of coral groups occur in Newfoundland and Labrador waters. These include scleractinians (solitary stony corals), antipatharians (black wire corals), alcyonaceans (large and small gorgonians, soft corals), and pennatulaceans (sea pens) (Wareham and Edinger 2007; Wareham 2009). Corals are largely distributed along the edge of the continental shelf and slope off Newfoundland and Labrador (Edinger et al. 2007; Wareham and Edinger 2007). Typically, they are found in canyons and along the edges of channels (Breeze et al. 1997), at depths greater than 200 m. Soft corals are distributed in both shallow and deep waters, while horny and stony corals (hard corals) are restricted to deep water only in this region. Dense congregations of coral off Labrador are referred to as coral "forests" or "fields". Most grow on hard substrate (Gass 2003), such as large gorgonian corals (Breeze et al. 1997). Others, such as small gorgonians, cup corals, and sea pens, prefer sand or mud substrates (Edinger et al. 2007). The distribution of various corals along the continental shelf and slope regions of the Grand Banks, Flemish Pass, and Flemish Cap, based on data collected by fisheries observers, are provided in Figure 3 of Wareham and Edinger (2007) and Map 1 of Wareham (2009). In total, thirty species of corals were documented, including two antipatharians (black wire corals), 13 alcyonaceans (large gorgonians, small gorgonians, and soft corals), four scleractinians (solitary stony corals), and 11 pennatulaceans (sea pens). The authors noted that corals were more widely distributed on the continental edge and slope, most found deeper than 200 m.

Several recently published reports present information on the ecology of deep cold-water corals of Newfoundland and Labrador waters, including information on biogeography, life history, biochemistry, and relation to fishes (e.g., Gilkinson and Edinger 2009; Kenchington et al. 2010a,b; Baillon et al. 2012; Baker et al. 2012). Wareham (2009) updated deep-sea coral distribution data for the Newfoundland and Labrador and Arctic Regions to partially fill information gaps previously identified by Wareham and Edinger (2007). Their study area encompassed the continental shelf, edge, and slope ranging from Baffin Bay to the Grand Banks. Distributional maps were compiled by Wareham (2009) using DFO Newfoundland and Labrador Region Multispecies Surveys (2000 to 2007), DFO Arctic Multispecies Surveys (2006 to 2007), Northern Shrimp Survey (2005), and from Fisheries Observers aboard commercial fishing vessels (2004 to 2007). The maps provided by Wareham (2009) show the distribution of several coral groups occurring along the continental edge and slope from Baffin Bay to the Grand Banks. The groups profiled include antipatharians, alcyonaceans, scleractinians, and pennatulaceans. Six previously undocumented coral species, composed of one alcyonacean, two scleractinians, and three pennatulaceans, were identified in the Newfoundland and Labrador and Arctic Regions (Wareham 2009).

According to distribution maps included in Wareham (2009), there are numerous species of corals occurring within or adjacent to the Study Area. The species identified include large gorgonians (*Keratoisis ornata*, *Paragorgia arborea*, and *Paramuricea* spp.), small gorgonians (*Acanthogorgia armata*, *Acanella arbuscula, Radicipes gracilis*, and *Anthothela grandiflora*), and soft corals (*Anthomastus grandiflorus*, *Duva florida*, *Gersemia rubiformis*, and *Nephtheid* spp.). Also noted were scleractinian species (*Flabellum alabastrum*, *Flabellum macandrewi, Desmophyllum dianthus*, and *Javania cailleti*) and several pennatulacean species (*Anthoptilum grandiflorum, Protoptilum carpentry, Halipteris finmarchica, Pennatula grandis, Umbellula encrinus, Pennatula phosporea, Kophobelemnon stelliferum,* and unspecified sea pen species). Antipatharian species were also observed within the Study Area along the Flemish Pass and the southwest slope of the tail of the Grand Banks. The majority of coral species observed occurred on the continental slope, with the exception of several soft corals (*Gersemia rubiformis* and *Nephtheid* spp.) found distributed on the shelf. Map 1 in Wareham (2009) indicates a continuous coral distribution within the Study Area primarily on the edges of the continental shelf and slope of the Grand Banks. Corals have been observed as far west as 3Pn, bordering the Laurentian Channel. The area beyond the continental slope of the tail of the Grand Banks was not sampled during the RV surveys. In another deep-water coral distribution study within the Study Area, it was determined that the Flemish Cap supported the greatest species diversity of deep-water corals Murillo et al. (2011). They observed 34 species on the Flemish Cap, followed by 22 species in the Flemish Pass and on the Nose of the Grand Banks, and 17 species southeast of the Grand Banks.

The patterns of association between deep-sea corals, fish, and invertebrate species, based on DFO scientific surveys and ROV surveys, are discussed by Edinger et al. (2009). Although there were no dramatic relationships between corals and abundance of the ten groundfish species studied, there was a weak but statistically significant positive correlation between coral species richness and fish species richness. For various sample segment lengths and depth ranges in the southern Grand Banks, Baker et al. (2012) found significant positive relationships between the presence and/or abundance of roundnose grenadier (*Coryphaenoides rupestris*) with that of large skeletal corals and cup corals, of roughhead grenadier (*Macrourus berglax*) with large gorgonians/antipatharians and soft corals, and of marlin-spike grenadier (*Nezumia bairdii*) with small gorgonians. Baillon et al. (2012) determined that several types of coral, particularly sea pens (e.g., *Anthoptilum grandiflorum*) were hosts to eggs and/or larvae of two redfish species (*Sebastes fasciatus* and *S. mentella*), lantern fish (*Benthosema glaciale*) and greater eelpout (*Lycodes esmarkii*) in the Laurentian Channel and southern Grand Banks. This suggests that habitats that support diverse corals may also support diverse assemblages of fishes. Although relationships between corals and groundfish or invertebrates are not obligate and may result from coincidence, conservation areas established for corals may effectively protect populations of groundfish, including some commercial species (Edinger et al. 2009). By increasing the spatial and hydrodynamic complexity of habitats, deep-sea corals may provide important, but probably not critical, habitat for a wide variety of fishes. Effects of deep-sea corals on fish habitat and communities may include higher prey abundance, greater water turbulence, and resting places for a wide variety of fish size classes (Auster et al. 2005, Costello et al. 2005 *in* Edinger et al. 2009).

Sponges also provide significant deep-sea habitat, enhance species richness and diversity, and cause clear ecological effects on other local fauna. Sponge grounds and reefs support increased biodiversity compared to structurally-complex abiotic habitats or habitats that do not contain these organisms (Beazley et al. 2013). Kenchington et al. (2013) noted the association of several demersal fish taxa with Geodia-dominated sponge grounds on the Grand Banks and Flemish Cap. Beazley et al. (2013) determined that deep-water sponge grounds in the Northwest Atlantic contained a significantly higher biodiversity and abundance of associated megafauna compared to non-sponge habitat.

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

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

The North Atlantic Fisheries Organization (NAFO) Scientific Council has recently identified areas of significant coral and sponge concentrations within the NAFO Regulatory Area. These areas that have been deemed closed to fishing with bottom gear are shown in Section 4.7 on Sensitive Areas (DFO 2010a).

As indicated by data collected during DFO RV surveys during 2007-2011, the highest coral catches in the Study Area occurred along the slopes of the Southern Grand Bank and St. Pierre Bank, and in the Laurentian Channel (see Figure 4.40 in Section 4.3.7). Smaller coral catches were also reported on the shelf of the Southern Grand Bank. During the same surveys, sponges were caught at locations distributed throughout the shelf and upper slope region of the Study Area, with highest catches occurring along the slope, particularly the northeastern slope region outside of the 200 nm limit (see Figure 4.39 in Section 4.3.7).

4.2.2 Fish

For the purposes of this EA, 'fish' includes macro-invertebrates that are targeted in the commercial fisheries and all fishes, targeted in the commercial fisheries or otherwise.

4.2.2.1 Macro-invertebrate and Fish Species Harvested during Commercial Fisheries

This section describes the principal macroinvertebrate and fish species that are typically harvested in the Study Area during commercial fisheries. These include both targeted species (e.g., snow crab, yellowtail flounder (*Limanda ferruginea*), redfish (*Sebastes* spp.), whelk (*Buccinum* spp.)) and other species caught incidentally (e.g., wolffishes (*Anarhichas* spp.), Atlantic cod (*Gadus morhua*), American plaice (*Hippoglossoides platessoides*))

Snow crab, yellowtail flounder, redfish, and whelks have dominated directed commercial fishery landings for the Study Area in recent years. Species are discussed in decreasing order of catch weight for the 2005 to 2010 period (see Section 4.3). Some of the 'incidental catch' species are also discussed in this section.

Snow Crab

The snow crab, a decapod crustacean, occurs over a broad depth range in the NW Atlantic from Greenland south to the Gulf of Maine (DFO 2013b). Snow crab distribution is widespread and continuous in waters off Newfoundland and southern Labrador. Generally, snow crabs undertake a migration from shallow cold areas with hard substrates to warmer deeper areas with soft substrates as they develop. Large males are most commonly found on mud or mud/sand, while smaller crabs are more common on harder substrates (DFO 2013b).

After spring hatching, snow crab undergo a multi-stage life cycle including a 12 to 15 week planktonic larval period before settlement. Benthic juveniles of both sexes molt frequently, becoming sexually mature at about 40 mm CW (~ 4 years of age). Female crabs carry fertilized eggs for about two years (DFO 2013b). Snow crab are believed to be recruited to the fishery at approximately 10 years of age in warmer areas (e.g., Div. 2J3K) while those in colder areas (e.g., Subdiv. 3LNOPs) are recruited at higher ages owing to less frequent molting in colder temperatures (Dawe et al. 2010 in DFO 2013b).

Snow crab typically feed on fish, clams, benthic worms, brittle stars, shrimps and crustaceans, including smaller snow crabs. Their predators include various groundfish, other snow crabs, and seals (DFO 2013b).

Snow crab landings in NAFO Div. 3LNO (offshore) between 2009 and 2012 have increased by 20% while landings in NAFO Div. 3Ps (offshore) declined by 14% between 2011 and 2012 (DFO 2013b). Long-term recruitment prospects in these NAFO Divisions are considered unfavourable due to a recent warm oceanic regime (DFO 2013b).

In the commercial fishery conducted within the Study Area between 2005 and 2010, snow crab catches between 2005-2012 were most concentrated along the eastern/southern shelf edge of the Southern Grand Bank (NAFO UAs 3Lt, 3Nb, 3Nd, 3Ne and 3Nf), and in the northwestern part of the Study Area in the Halibut and Haddock Channels (UAs 3 Oa and 3PSf) and at two locations of the inner shelf of the Southern Grand Banks (UA 3Ob). Most of the snow crab catches in the Study Area during 2005-2012 occurred at locations with water depths <200 m (see Figures 4.10 to 4.12 in Section 4.3.3.2).

Yellowtail Flounder

Yellowtail flounder inhabit the continental shelf of the northwest Atlantic from Labrador to Chesapeake Bay at depths ranging from 37 to 91 m (DFO 2013c). The northern limit of commercial concentrations extends to the Grand Banks off the east coast of Newfoundland. Mark and recapture data indicates that yellowtail flounder make daily vertical migrations as well as seasonal migrations to warmer and deeper waters in winter (Kearley 2012). Yellowtail spawning on the Grand Banks generally occurs between May and September with peaks during the latter part of June. They tend to occur at depths <100 m and in water temperatures exceeding 2ºC (LGL 2006a). The eggs, larvae and early juvenile stages of yellowtail are pelagic. Growth rates of flounder are slower in the northern range (i.e., Grand Banks and Gulf of St. Lawrence) in comparison to those in its southern range (i.e., Georges Bank). Consequently, sexual maturation for those further north is also slower with maturity occurring by age 4-6 compared to age 2-3 in the southern range (DFO 2013c).

Because of its small mouth size, this flounder is restricted in its choice of prey. The most common prey of yellowtail flounder includes polychaetes, amphipods, shrimp, cumaceans, molluscs, isopods, and small fish. The most common predators of yellowtail flounder include cod and spiny dogfish. They are also prey to skates, monkfish, bluefish, Atlantic halibut, fourspot flounder and seals (DFO 2013c).

Juvenile and adult yellowtail are generally concentrated on the southern Grand Banks, on or near the Southeast Shoal where the substrate consists primarily of sand (primarily Unit Area 3Nc) (Walsh et al. 2001 *in* LGL 2006a). Maddock Parsons (2013) discussed the distribution and abundance of yellowtail flounder on the Grand Banks based on spring and fall trawl surveys. She indicated that the greatest concentrations of yellowtail flounder are in Div. 3N, the bordering areas of Div. 3O and, to a lesser extent, the border of Div. 3LN which occurs in the central part of the Study Area. Most of the catches made by the Canadian fleet in 2011 and 2012 were taken from April to June (Maddock Parsons et al. 2013).

As indicated by data collected during DFO RV surveys during 2007-2011, the highest yellowtail flounder catches in the Study Area occurred in the eastern part of the Southern Grand Bank shelf and on St. Pierre Bank (see Figure 4.36 in Section 4.3.7).

In the commercial fishery conducted within the Study Area from May to November between 2005 and 2012, yellowtail flounder catches were most concentrated in the central part of the Southern Grand Bank in NAFO UAs 3Na, 3Nc, 3Ob and 3Od. Catches were also made on St. Pierre Bank in NAFO Div. 3PS. Most of the yellowtail flounder catches in the Study Area during the eight-year period occurred at locations with water depths <100 m (see Figures 4.15 to 4.17 in Section 4.3.3.2).

Redfish

The NW Atlantic redfish consist of a complex of three species identified as Acadian redfish (*Sebastes fasciatus*), golden redfish (*S. marinus*), and deepwater redfish (*S. mentella*) (DFO 2012a). Acadian redfish and deepwater redfish both have *threatened* status under COSEWIC but no status under Schedule 1 of *SARA*. The redfish distribution in the NW Atlantic ranges from the Gulf of Maine, northwards off Nova Scotia and southern Newfoundland banks, in the Gulf of St. Lawrence, and along the continental slope and deep channels from the southwestern Grand Bank to areas as far north as Baffin Island. Redfish are also present in the area of Flemish Cap and west of Greenland.

Redfish typically inhabit cool waters (3 to 8°C) along the slopes of banks and deep channels in depths of 100 to 700 m (Scott and Scott 1988; DFO 2012a). Although generally found near the bottom, redfish are known to undertake diel vertical migrations, moving off the bottom at night to follow the migration of their prey (DFO 2012a). Redfish are pelagic or bathypelagic feeders, feeding primarily on zooplankton such as copepods, amphipods and euphausiids. Fishes and crustaceans become more important in the diet of larger redfish (Scott and Scott 1988). Greenland halibut and skate are the primary predators of redfish on the Labrador shelf (DFO 2012a).

The deepwater redfish and Acadian redfish, the two most important commercially-targeted species, are distributed according to a gradient in the NW Atlantic (DFO 2012a). The deepwater redfish is the dominant species in northern areas, such as Baffin Island and in Labrador waters, whereas Acadian redfish dominates in the Gulf of Maine and the basins and continental slope of the western Scotian Shelf (the latter known collectively as Unit 3). Their distributions overlap in the Gulf of St. Lawrence (Unit 1), the Laurentian Channel (Unit 2), off Newfoundland (3LN, 3M, 3O), and south of the Labrador Sea (2J, 3K). In areas of distributional overlap, deepwater redfish generally occur in deeper water (350 – 500 m) than Acadian redfish (150 – 300 m).

Redfish are generally slow growing and long-lived fishes (DFO 2012a). Maturation in redfish occurs between 8-10 years of age with Acadian redfish maturing, on average, 1-2 years earlier than deepwater redfish. Males also mature, on average, 1-2 years earlier than females within the same species. The reproductive cycle of redfish is quite different than those of most other fish species. Redfish are ovoviviparous, meaning fertilization is internal and females bear live young. Mating takes place in the fall, most likely between September and December, and females carry the developing embryos until they are extruded as free swimming larvae in spring. Larval extrusion takes place from April to July, the timing being dependent on location and species. Mating and larval extrusion do not necessarily occur in the same locations.

Two species of redfish have been fished in NAFO Div. 3NO: (1) the deepwater redfish; and (2) the Acadian redfish. These species have been collectively reported as "redfish" in commercial fishery statistics. There was a redfish fishery moratorium in 3N from 1998-2009, followed by a re-opening of the fishery in 2010. The TAC in 2012 was 6,000 t. In surveys completed by NAFO, biomass has always been greater in 3N than in 3O. Since 2005, over 83% of redfish catches have occurred in 3N (González-Troncoso et al. 2013a) A fishery for redfish on the shallower region of the Flemish Cap (i.e., <300 m depth) opened in 2005, prosecuted primarily by pelagic and bottom trawl (Ávila de Melo 2013).

As indicated by data collected during DFO RV surveys during 2007-2011, the highest redfish catches in the Study Area occurred along the upper slope region of the Southern Grand Bank shelf and St. Pierre Bank (see Figure 4.35 in Section 4.3.7).

In the Study Area commercial fishery conducted from May to November between 2005 and 2010, redfish catches were incidental in the commercial fishery and most concentrated along the northwestern slope of the Southern Grand Bank (NAFO UAs 3Oc and3Oe), the slope of St. Pierre Bank (UA 3PSh) and the Laurentian Channel (UA 4VSc) where water depths range from 200 to 1,000 m (see Figures 4.20 to 4.22 in Section 4.3.3.2).

Whelks

Whelks are marine gastropods that are distributed from Newfoundland and Labrador to New Jersey, including the Gulf of St. Lawrence (DFO 2010b). Whelks reach up to 120 mm in shell height and can live over 10 years of age (DFO 2013d). An abundant and relatively inactive species, whelks are typically found partially buried in muddy or sandy substrates at a variety of depths ranging from the intertidal zone to >200 m (DFO 2003, 2010b). Generally, whelk density is highest on soft bottoms at 15-30 m depths (DFO 2013d).

Whelk sexual maturity is typically reached at ages 4-7 years, varying by gender and location. Whelks are polygamous and females are able to store sperm from several different males (DFO 2013d). Spawning takes place between late spring or summer and late autumn, depending on location (DFO 2003, DFO 2013d). Fertilization is internal and females lay their embryos inside capsules which adhere to hard surfaces such as rocks and boulders. Juvenile whelks emerge from the capsules after 3-8 months of development (DFO 2013d). Whelks have no planktonic or pelagic stage.

These gastropods feed on both live and dead animals, primarily molluscs and other invertebrates such as urchins, polychaetes, bivalves, and crustaceans (DFO 2003). Whelks are able to detect a scent trail and follow it to source, which is why they are commonly found in lobster, crab, and cod traps. Feeding activity generally decreases with the onset of spawning (DFO 2003; DFO 2013d). Whelks are preyed upon by lobster, cod, crab, starfish, dogfish, wolffish, rays, and gulls, and their empty shells often serve as habitat for organisms such as hermit crabs (DFO 2003).

Whelks are harvested offshore throughout the year using various pot designs. There fishery is prosecuted in NAFO Subdivision 3Ps on St. Pierre Bank in three distinct areas (North, West, and South grounds; see Figure 1 of DFO 2013d). The fishery runs from April 1 to September 30 (DFO 2013d). Of the 5,819 t of whelk landed in 2011, 61% of was taken from the South grounds, while the North and West grounds each contributed 29%, and 10% respectively (DFO 2013d).

There was no georeferenced commercial catch location data for whelk in the Study Area during May to November, 2005–2010.

Cockles

This bottom-dwelling bivalve occurs submerged just under the sediment surface in a variety of substrate types, ranging from soft mud to stony gravel (Franklin 1972). A non-selective filter-feeder, the cockle slightly projects two fleshy siphons through the sediment surface into the water, and directs a continuous flow of water through its body for respiration and feeding (Franklin 1972). Cockles fall prey to a variety of predators, such as various fish (including flounders and plaice), crabs, starfish, and even seabirds in shallower waters (Franklin 1972).

Cockles generally spawn in the spring, but spawning may extend into summer and fall (Franklin 1972). Eggs and sperm are shed freely into the water, and larvae are thought to remain planktonic for approximately three weeks before they settle on the sea bed.

Several species of cockle are known to occur in northwest Atlantic waters. Of these, the Greenland cockle (*Serripes groenlandicus*) occurs in and around the Study Area and is a common bycatch species in the Arctic surf clam (*Mactromeris polynyma*) commercial fishery. Greenland cockle was found distributed primarily along the eastern edge of the Grand bank during an Arctic surf clam survey in 2006-2009 (Roddick et al. 2011). As such, it is likely the cockle species in question in the georeferenced DFO commercial catch location data for 2005 to 2010 in the Study Area.

The Greenland cockle is widely distributed throughout the Arctic Ocean and southward in varying degrees (Golikov and Scarlato 1973 *in* Christian et al. 2010). In the Northwest Atlantic Ocean, this bivalve is found from Greenland to Cape Cod at subtidal depths >9 m. Barrie (1979 *in* Christian et al. 2010) found this cockle species on sandy substrates within a depth range of 6 to 18 m at various Labrador locations. It is ~100 mm in diameter at full growth (Gosner 1979 *in* Christian et al. 2010). The life history of the Greenland Cockle is poorly understood.

The Greenland cockle displays intense escape behaviour towards the sea stars *Leptasterias polaris* and *Asterias rubens,* two of its primary predators (Legault and Himmelman 1993 *in* Christian et al. 2010).

Other predators of the Greenland cockle include demersal fish (e.g., cod, haddock) (Dolgov and Yaragina 1990 *in* Christian et al. 2010) and marine mammals (Fisher and Stewart 1997, Born et al. 2003 *in* Christian et al. 2010).

In the Study Area commercial fishery conducted from May to November between 2005 and 2011, cockle catches occurred on the eastern side of the Southern Grand Bank shelf in NAFO UAs 3Na, 3Nb, 3Nc, 3Nd and 3Nf (see Figures 4.25 and 4.26 in Section 4.3.3.2).

Atlantic Cod

The NL population of Atlantic cod has *endangered* status under COSEWIC but no status under Schedule 1 of *SARA* (COSEWIC 2010a). Cod in the NL population inhabit waters ranging from immediately north of Cape Chidley on the northern tip of Labrador southeast to Grand Bank off eastern Newfoundland. For management purposes, cod in this population are treated as three separate stocks by DFO: (1) northern Labrador cod (NAFO Divisions 2GH), (2) "northern cod" i.e., those found off southeastern Labrador, the Northeast Newfoundland Shelf, and the northern half of Grand Bank (NAFO Divisions 2J3KL, and (3) southern Grand Bank cod (NAFO Divisions 3NO). Cod in the Study Area are considered to be those of the southern Grand Bank (3NO) cod stock and the 'northern cod' (3L). The following paragraphs provide an overall summary of the life history and ecology of Atlantic cod in Canadian waters, regardless of cod population or stock (Brattey et al. 2011).

The Atlantic cod is a demersal fish that inhabits cold (10 to 15°C) and very cold (<0 to 5°C) waters in coastal areas and in offshore waters overlying the continental shelf throughout the NW and NE Atlantic Ocean (COSEWIC 2010a). The species is found contiguously along the east coast of Canada from Baffin Island to Georges Bank. During the first few weeks of life, cod eggs and larvae are found in the upper 50 m of the water column. As juveniles, cod are settled on the bottom and tend to occur in nearshore habitats with vertical structure such as eelgrass (*Zostera marina*) and macroalgae. As adults, the habitat requirements of cod are increasingly diverse.

Atlantic cod typically spawn over a period of less than three months in water that may vary in depth from tens to hundreds of metres (COSEWIC 2010a). Cod are described as batch spawners because only a small percentage (5 to 25%) of the female's egg total is released at any given time during a three to six week period. After hatching, larvae obtain nourishment from a yolk sac until they have reached a length of 1.5 to 2.0 mm. During the larval stage, the young feed on phytoplankton and small zooplankton in the upper 10 to 50 m of the water column. After the larval stage, the juveniles settle to the bottom where they appear to remain for a period of 1 to 4 years. These settlement areas are known to range from very shallow (<10 to 30 m) coastal waters to moderately deep (50 to 150 m) waters on offshore banks. After this settlement period, it is believed that the fish begin to undertake seasonal movements and migrations characteristic of adults.

Dispersal in Atlantic cod appears to be limited to the egg and larval phases of life, during which surface and near-surface water currents and turbulence are the primary determinants of horizontal and vertical displacement in the water column (COSEWIC 2010a). For some cod populations, eggs and larvae are capable of dispersing very long distances. For example, cod eggs spawned off southeastern Labrador (NAFO Division 2J) may possibly disperse as far south as Grand Bank. By contrast, eggs spawned by cod in inshore, coastal waters, especially at the heads of large bays, may experience dispersal distances of a few kilometres or less.

Long-term movements by cod take the form of seasonal migrations (COSEWIC 2010a). These migrations can be attributed to geographical and seasonal differences in water temperature, food supply, and possibly spawning grounds. At one extreme, some inshore populations are suspected to have extremely short migrations, possibly limited to tens of kilometres or less. In contrast, cod in other populations are known to move hundreds of kilometres during their seasonal migrations.

Since the early 1970s, the northern Labrador cod stock (2GH) has been managed separately from southern Labrador cod (2J) because of differing characteristics (e.g., growth rates) of the stocks (ICNAF 1973). In addition, stock separation was influenced by over-fishing experienced in the 1960s, which affected the cod stock more in northern Labrador than in southern areas (Pinhorn 1976; DFO 2013e). According to COSEWIC (2010a), cod abundance in the inshore and offshore waters of Labrador and northeastern Newfoundland have declined by 97-99% since the 1960s and are currently at historical lows. Virtually no recovery of either abundance or age structure of offshore cod has been observed since the moratoria were imposed in the early 1990s and threats to persistence include fishing, predation by fish and seals, and natural and fishing-induced ecosystem changes.

In NAFO Divs. 3NO, cod are generally distributed over the shallower parts of the bank in the summer, commonly in the Southeast Shoal region in Div. 3N, and distributed on the slopes of the bank in the winter. It is possible that seasonal mixing occurs between cod in 3O and 3Ps (Rideout et al. 2013). RV surveys from DFO have reported continuing low abundances of cod in the central and southern region of 3L (DFO 2013e).

In DFO RV surveys conducted in the Study Area between 2007 and 2011, Atlantic cod catches were distributed throughout the shelf and upper slope regions where water depths ranged from <100 to 1,000 m.

In the Study Area commercial fishery conducted from May to November during 2005 and 2012, cod catches were incidental and occurred primarily in the central and eastern parts of the Southern Grand Bank (NAFO UAs 3Na, 3Nc, 3Ob and 3Od), on St. Pierre Bank (UAs 3PSf and 3PSh), along parts of the slope (UAs 3Oc, 3Od, 3Oe and 3PSh) and in Laurentian Channel (UA 4VSc) where water depths range from <100 to 1,000 m (see Figures 4.29 to 4.31 in Section 4.3.3.2).

White Hake

White hake (*Urophycis tenuis*) inhabit the continental shelf and upper slope of the West Atlantic, ranging from southern Labrador (including the southern slope of the Grand Banks) to North Carolina and occasionally deep waters off Florida (DFO 2013f). Adults occur over a wide range of depths (50-100 m) and prefer soft-bottomed areas, with water temperatures ranging from 5 to 11ºC (DFO 2002; DFO 2013f). White hake move to shallower waters in warmer months and out into deeper areas during colder periods. This preference for warmer waters restricts their distribution on the Grand Banks to the southwestern shelf edge near the border of NAFO Div. 3Ps/3O and the Laurentian Channel year-round.

Hake are also caught more often in the bank areas of 3O in fall surveys when bottom temperatures are higher (DFO 2002). Spanish survey biomass indices in 2011 to 2012 for white hake in Div. 3NO indicate that biomass remains at very low levels (González-Troncoso et al. 2013b).

Mature female white hake are among the most fertile of the commercial demersal species in the northwest Atlantic, producing millions of eggs when they spawn in summer to early fall (DFO 2013f). On the Grand Banks, spawning occurs in mid-summer (DFO 2002). Eggs are buoyant, and larvae and juveniles are pelagic for up to three months. Young hake will descend to the bottom when they reach 8 to 13 cm in length (DFO 2002).

Young, demersal juveniles feed primarily on shrimps, polychaetes, and small crustaceans, while older juveniles also consume krill and some fish (DFO 2013f). Adult white hake consume a variety of fish species, including Atlantic herring, Atlantic cod, haddock, longfin hake, redfish, Atlantic mackerel, northern sand lance, and winter flounder (DFO 2013f). White hake are preyed upon by larger cod and hake, Atlantic puffins, Arctic terns, and grey seals (DFO 2013f). White hake are targeted in Canadian fisheries, but are also caught as bycatch in other fisheries. They are caught using gillnets, hooks and lines, bottom trawls, and seines (DFO 2013f).

American Plaice

The Newfoundland and Labrador population of American plaice currently has no status under Schedule 1 of *SARA* but it does have *threatened* status under COSEWIC (COSEWIC 2009; DFO 2012b).

The American plaice is a bottom-dwelling flatfish that resides on both sides of the Atlantic (COSEWIC 2009). American plaice that reside in the W Atlantic region range from the deep waters off Baffin Island and western Hudson's Bay southward to the Gulf of Maine and Rhode Island (Scott and Scott 1988). In Newfoundland waters, plaice occur both inshore and offshore over a wide variety of bottom types (Morgan 2000) but seem to prefer fine sand and gravel substrates (DFO 2012b). It is tolerant of a wide range of salinities and has been observed in estuaries (Scott and Scott 1988; Jury et al. 1994). Adult and juvenile plaice typically inhabit similar areas at depths ranging from 20 to 700 m but primarily at depths of 100 to 300 m (DFO 2012b). Most commercially harvested plaice are taken at depths of 125 to 200 m. It is a coldwater species, preferring water temperatures of -1.5°C to 13°C, but is most abundant at temperatures ranging from just below zero to -1.5°C (DFO 2012b). Tagging studies in Newfoundland waters suggest that, once settled, juveniles and adults are rather sedentary and do not undertake large scale migrations (DFO 2008). However, older plaice have been known to move up to 160 km (Powles 1965). Migrations have been observed in Canadian waters to deeper offshore waters in the winter, returning to shallower water in the spring (Hebert and Wearing-Wilde 2002 *in* Johnson 2004).

In Newfoundland waters, American plaice spawn during the spring (Scott and Scott 1988). Within the Study Area, there is limited data with respect to the actual spawning times. American plaice in the Newfoundland Region spawn over the entire area within which they occur (DFO 2008) with the most intense spawning coincident with areas with the highest abundance of adults (Busby et al. 2007; DFO 2012b). Limited data in southern areas (e.g., Burgeo Bank, St. Pierre Bank and along the slopes of the

Laurentian Channel and Hermitage Channel) indicate that spawning does occur in April and possibly other months (Ollerhead et al. 2004). In addition, spawning in southern areas (e.g., St. Pierre Bank) typically occurs in water temperatures of about 2.7°C (Scott and Scott 1988). American plaice are group synchronous, batch spawners that generally release eggs in batches every few days (DFO 2012b). Large quantities of eggs are released and fertilized over a period of days on the seabed (Johnson 2004). Eggs are buoyant and drift into the upper water column where they are widely dispersed. Hatching time is temperature dependent, occurring in 11 to 14 days at temperatures of 5°C (Scott and Scott 1988). Larvae are 4 to 6 mm in length at hatch and subsequent settlement to the seabed occurs when they reach 18 to 34 mm in length and their body flattens (Fahay 1983).

American plaice has been under moratorium since 1995. Biomass and spawning stock biomass remain at very low levels but have increased since the onset of the moratorium. NAFO surveys in 3L have demonstrated high occurrence of small individuals (Román 2013). However, bottom trawl surveys conducted by NAFO on the Flemish Cap have indicated poor recruitment for later year-classes (Casas and González-Troncoso 2013).

In DFO RV surveys conducted in the Study Area between 2007 and 2011, American plaice catches were distributed throughout the shelf and upper slope regions where water depths ranged from <100 to 1,000 m, particularly in the southern and eastern parts of the Southern Grand Bank (see Figure 4.37 in Section 4.3.7).

Stimpson's Surf Clam

This bivalve mollusc is a circumboreal species, inhabiting both the Atlantic and Pacific Oceans. It is the largest clam in the Northwestern Atlantic Ocean and occurs from Labrador to Rhode Island, often on medium to coarse sand substrate (Abbott 1974 *in* Christian et al. 2010). In the Canadian part of its range, this species occurs in commercial quantities in the offshore areas of the Scotian Shelf and Eastern Grand Banks, and inshore areas off southwest Nova Scotia and in the Gulf of St. Lawrence (DFO 1989a, 1999, 2004a *in* Christian et al. 2010). Atlantic populations of this species are located at water depths ranging from shallow subtidal to 110 m (DFO 2011a). The Stimpson's surf clam is a strong, active burrower that is capable of burrowing several inches below the sediment surface (DFO 2011a).

Surf clam spawning in the offshore areas typically occurs during the fall (DFO 2009 *in* Christian et al. 2010). Davis and Shumway (1996 *in* Christian et al. 2010) report that larval hatch occurs within days of spawning, and that larvae remain planktonic for 1 to 2 months before settlement to the bottom substrate. Stimpson's surf clams are filter feeders with a microalgal diet (e.g., dinoflagellates) (Smith and Wikfors 1992 *in* Christian et al. 2010). Predators of the surf clam include sea stars, whelk, crabs, and large groundfish (Himmelman and Hamel 1993, Rochette et al.1995, Morissette and Himmelman 2000 *in* Christian et al. 2010). This species is slow growing and long-lived (>40 years). If populations are depleted, it is expected that recovery would take some time (DFO 2011a).

The fishery for Stimpson's surf clam takes place on Banquereau Bank and the Grand Banks using factory freezer fishing vessels equipped with hydraulic clam dredges. The fisheries are relatively new, being established in 1986 (DFO 2011a). There are four licenses for offshore vessels in this fishery however only two vessels are currently active. The stock does not have a high exploitation rate and is believed to be relatively healthy. The fishery typically takes place in areas with water depths of 45 to 65 m (Roddick 2013).

Swordfish

Swordfish (*Xiphias gladius*) is a large migratory pelagic fish ranging throughout the Atlantic Ocean and the Mediterranean Sea. Individuals of this species typically occur in Canadian waters during the June to November period, feeding in the productive waters of the continental slope and shelf basins areas. Swordfish may occur in surface waters or as deep as 500 m, although their presence at surface tends to occur during darkness when they are feeding. Swordfish spawn in warmer tropical and subtropical waters throughout the year. While in Canadian waters, swordfish are known to feed on fish and invertebrate species that include mackerel, silver hake, redfish, herring and short-finned squid (Scott and Scott 1988 *in* Buchanan et al. 2006). They have few natural predators, the possible exceptions being some shark species and killer whales (Kearley 2012). Swordfish tagging studies have shown that they may live up to 15 years, however 10 years is considered the average maximum age (DFO 2013g).

Since it is such a highly migratory species that occurs in many different regions of the world, swordfish are managed by an international body, the International Commission for the Conservation of Atlantic Tunas (ICCAT). The ICCAT establishes quota allocations for several different countries. The Canadian harpoon fishery for swordfish received Marine Stewardship Council (MSC) certification in June 2010, while the pelagic longline fishery was awarded MSC certification in April 2012. These fisheries, although recognized for being sustainable and well-managed (DFO 2013g), still possess problems with regard to bycatch in the pelagic longline fishery.

Northern Shrimp

The primary cold-water shrimp resource in the N Atlantic, the northern shrimp is distributed from Davis Strait to the Gulf of Maine. It usually occupies areas with soft muddy substrates, depths ranging from 150 to 600 m, and water temperatures ranging from 1 to 6°C (DFO 2013h). Larger individuals generally occur in deeper waters (DFO 2013i). During the day, shrimp generally rest and feed on or near the ocean floor. They commence a diel vertical migration at night with large abundances of shrimp moving off the bottom into the water column to feed on zooplankton. Female shrimp also undergo a seasonal migration to shallower areas to spawn (DFO 2013i).

Northern shrimp are protandric hermaphrodites. They first mature as males, mate as males for one to several years and then permanently change to mature females (DFO 2013h). Eggs are typically extruded in the summer and remain attached to the female until the following spring, when the female migrates to shallow coastal waters to spawn (Nicolajsen 1994 *in* Ollerhead et al. 2004). The hatched larvae float to the surface feeding on planktonic organisms (DFO 2013i). Northern shrimp are known to live for more than eight years in some areas and are thought to begin recruitment to the fishery as early as at age three. Some northern populations exhibit slower rates of growth and maturation but greater longevity that results in larger maximum size (DFO 2013i).

As with most crustaceans, northern shrimp grow by moulting their shells. During this period, the new shell is soft, causing them to be highly vulnerable to predators such as Greenland halibut, cod, Atlantic halibut, skates, wolffishes and harp seals (*Phoca groenlandica*). Northern shrimp are vulnerable to these predators regardless of whether they have a soft shell or not (DFO 2013h).

The northern shrimp fishery in NAFO Div. 3LNO within the Study Area has seen a reduction in shrimp catch and declining TAC levels in recent years. TACs increased from 6,000 t in 2000 to 30,000 t in 2009 and 2010 but has declined to 8,600 t by 2013 due to continued declines in survey and commercial fishery indices. Small and large Canadian fishing fleets have altered their fishing patterns in response to low catch rates by fishing along the border to 3K. The number of countries fishing for shrimp in 3L has decreased, from as many as 16 in 2006 to four countries in 2013. The majority (over 92.7%) of total biomass in NAFO Div. 3LNO from either spring or fall surveys has come from 3L, while 3N accounted for only 0.2-8.1%, and 3O accounted for less than 1% (Orr and Sullivan 2013). Northern shrimp have also been declining in NAFO Div. 3M with biomass and abundance decreasing by 20% and 21% respectively in 2013 from the previous year (Casas 2013). This decline has been attributed to a lack of strong year classes and poor recruitment in recent years.

4.2.2.2 Macroinvertebrate and Fish Reproduction in the Study Area

Temporal and spatial reproduction specifics for macroinvertebrates and fishes that occur in the Study Area are provided in Table 4.1.

Table 4.1 Reproduction Specifics of Key Macro-invertebrate and Fish Species Known or Likely to Reproduce within or near the Study Area.

Species	Locations of Reproductive Events	Timing of Reproductive Events	Duration of Planktonic Stages
Northern Shrimp	On banks and in channels over the extent of its distribution	Spawning in late summer/fall Fertilized eggs carried by female for 8 to 10 months and larvae hatch in the spring	12 to 16 weeks
Snow Crab	On banks and possibly along some upper slope regions over the extent of its distribution	Mating in early spring Fertilized eggs carried by female for 2 years and larvae hatch in late spring/early summer	12 to 15 weeks
Redfish	Primarily along edge of shelf and banks, in slope waters, and in deep channels	Mating in late winter and release of young between April and July (peak in April)	No planktonic stage
Atlantic Cod	Spawn along outer slopes of the shelf in depths from tens to hundred of metres	March to June	10 to 12 weeks
American Plaice	Spawning generally occurs throughout the range the population inhabits.	April to May	12 to 16 weeks

Species	Locations of Reproductive Events	Timing of Reproductive Events	Duration of Planktonic Stages
Yellowtail Flounder	Shallower sandy areas – typically <100 m water depth – at bottom	May to September, typically peaking in June/July	Pelagic larvae are brief residents in the plankton
Swordfish	NW Atlantic population believed to spawn in the Caribbean Sea, Gulf of Mexico, and off Florida.	Year-round	Uncertain
Stimpson's Surf Clam	Eastern Grand Banks	Fall	4 to 8 weeks
Whelks	Eggs deposited in masses on bottom	May to July	No planktonic stage
Greenland Cockle	Eastern Grand Banks	Uncertain	Uncertain

4.3 Fisheries

This section provides a description of the fisheries within the Study Area. Most of this section describes the commercial fishery in the Study Area between 2005 and 2012. Figure 4.1 shows the Study and Project areas in relation to regional fisheries management areas. As the figure indicates, the Study Area comprises portions of NAFO Divisions 3L, 3M, 3N, 3O, 3Ps, and 4Vs.

This section also briefly describes any recreational fisheries, traditional fisheries, aquaculture activity, and fisheries research surveys in the Study Area. The biology and status of the principal macro-invertebrate and fish species included in this section were discussed in the preceding Section 4.2.

4.3.1 Information Sources

NAFO catch weight data are used to describe both domestic and foreign fisheries beyond the 200 nm EEZ. Most of the Study Area is located outside of the 200 nm limit (Figure 4.1). The NAFO data are derived from the STATLANT 21 data set for 2005 to 2012. The STATLANT reporting system of questionnaires is a long-standing standardized statistical inquiry for submission of national catch data to international fisheries agencies by national reporting offices. Rather than being georeferenced, these STATLANT data are geographically resolved at the NAFO Division level only. Thus the analysis of these data quantifies harvesting for portions of NAFO Divisions 3L, 3M, 3N, 3O, 3Ps, and 4Vs (Figure 4.1).

The primary fisheries data analyses use DFO Newfoundland Region (Newfoundland and Labrador), Maritimes Region (New Brunswick and Nova Scotia Atlantic coasts), Gulf Region (Prince Edward Island, and New Brunswick and Nova Scotia Gulf coasts), and Quebec Region (Gulf and St. Lawrence River) georeferenced catch and effort datasets for the 2005 to 2010 time period. The 2011 and 2012 catch data were provided as ranges of catch weight and catch value within 6 min x 6 min cells (latitude x longitude). Figures based on these 2011 and 2012 commercial fishery databases are included in the EA. The DFO datasets record domestic harvest and foreign harvest landed in Canada.

The 2005 to 2010 DFO data are georeferenced in two ways: (1) by latitude and longitude (degrees and minutes) of the gear set location; and (2) by NAFO Unit Area (UA) in which the catch was harvested. Georeferencing by latitude and longitude allows the mapping of specific harvesting locations. Areas farther from shore, fished generally by larger boats, tend to have a greater proportion of their catch georeferenced than those closer to shore. Certain inshore species (e.g., lobster) are not georeferenced. While much of the harvest carries the latitude and longitude information, virtually all the data carry a UA designation. The UA designation allows all the harvesting data to be tabulated according to these fisheries management areas. It is important to note that some of the UAs occur only partially within the boundaries of the Study Area. For these UAs, the harvesting locations occurring outside of the Study Area were excluded from analysis for the detailed overview of the 2005 to 2010 fishing seasons.

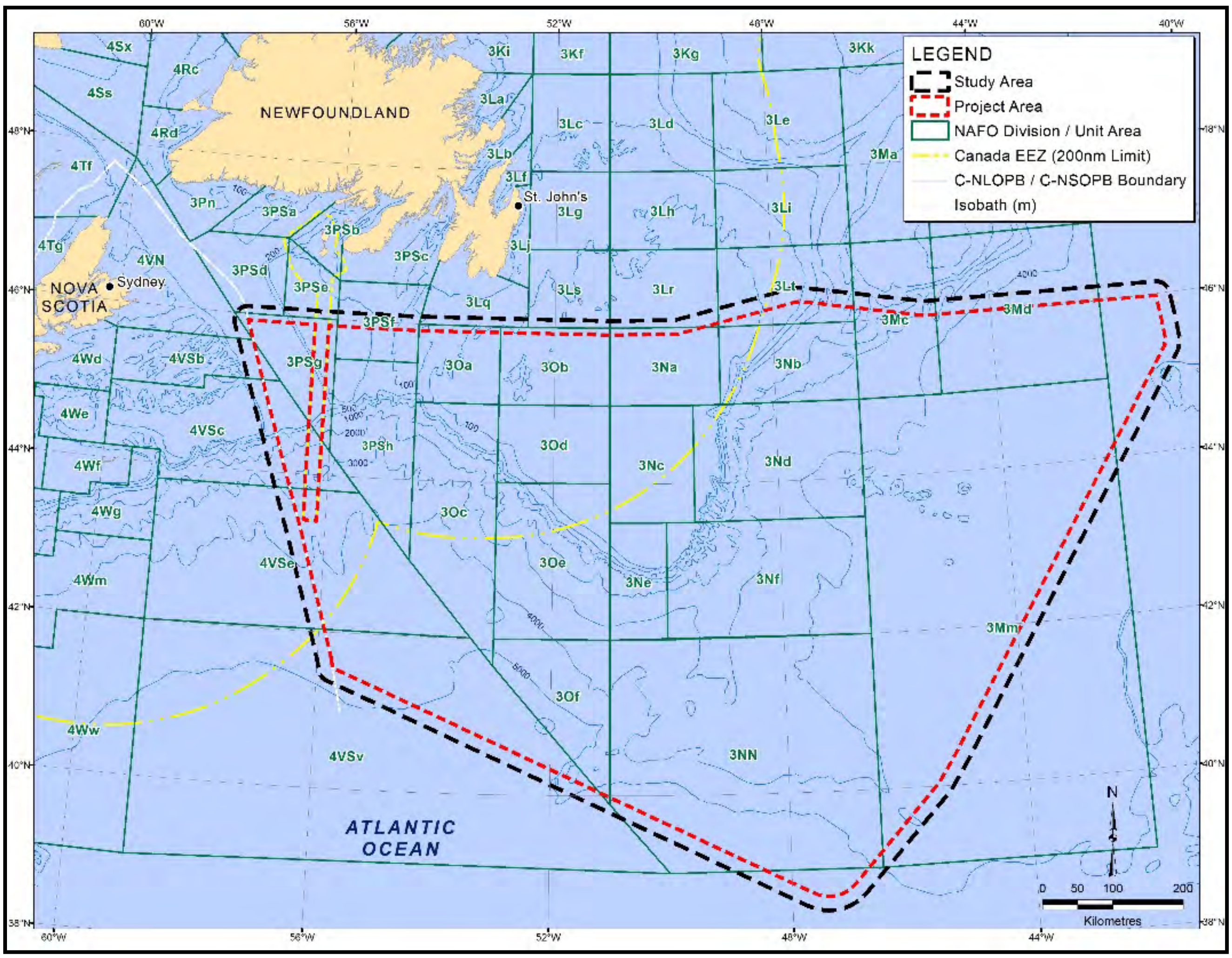


Figure 4.1 Study Area and Project Area in relation to Regional Fisheries Management Areas (NAFO Divisions and Unit Areas).

The maps in this section show harvesting locations for 2005 to 2010, based on the latitude and longitude (lat/long) data, as dark points. (The data coordinates given are those recorded in the vessel's fishing log, and is reported in the DFO datasets by degree and minute of latitude and longitude; thus the position should be accurate to within approximately 925 m (0.5 nm) of the reported coordinates.) The points are not "weighted" by quantity of harvest, but show where fishing effort was recorded. Such location data have been groundtruthed with fishers in many consultations for past assessments and for fisheries planning. They have proven to be particularly useful in understanding the likely location of gear concentrations and timing of fisheries in order to eliminate or minimize potential mutual interference. DFO catch data for 2011 and 2012, based on 6 min x 6 min cells, are displayed as uniformly coloured grid cells representing cells within which harvesting was reported. Samples of fishery harvest location maps were presented during consultations.

The data primarily used to characterize the fisheries in this EA are harvest catch weights. Catch value is used to demonstrate that some species have lower ranked catch weights but are highly ranked in terms of value. Catch values are important in the case of a gear damage incident, and would be carefully evaluated at that time, based on then-current numbers, to calculate compensation (e.g., to be used as an impact mitigation during a seismic project).

The following groups were involved in consultations that included the most discussion related to fisheries.

- Fish, Food and Allied Workers Union (FFAW);
- One Ocean;
- Fisheries and Oceans Canada;
- Newfoundland and Labrador Department of Fisheries and Aquaculture;
- Nature Newfoundland and Labrador;
- Association of Seafood Producers;
- Ocean Choice International;
- Bay Bulls Town Council;
- Burin Harbour Authority;
- Fortune Town Council;
- Grand Bank Harbour Authority;
- Grand Bank Town Council;
- Marystown Town Council;
- Placentia Harbour Authority;
- Riverhead Harbour Authority; and
- St. Bride's Community Council.

Part of the purpose of the consultations was to gather information about area fisheries and to determine any issues or concerns to be considered in the EA, as well as to discuss communications, mitigations and other solutions aimed at eliminating or minimizing potential impacts on the fisheries (see Consultation Report, Appendix 1).

Other sources used for this assessment include DFO species management plans, DFO stock status reports and other internal documents, previous EAs relevant to the Study Area, and the Southern Newfoundland Strategic Environmental Assessment (SEA) (LGL 2010a).

4.3.2 Regional NAFO Fisheries

As noted previously, most of the Study Area occurs outside of Canada's 200 nm EEZ. The Study Area overlaps portions of NAFO Divisions 3L, 3M, 3N, 3O, 3Ps, and 4Vs (see Figure 4.1). NAFO manages 19 stocks comprised of 11 species: Atlantic cod (3L, 3M, 3NO stocks), redfish (3LN, 3M, 3O, Sub-area 2 and Div. 1F+3K stocks), American plaice (3LNO, 3M stocks), witch flounder (3L, 3NO stocks), yellowtail flounder (3LNO stocks), Greenland halibut (3LMNO stock), white hake (3NO stock), skates (3LNO stock), capelin (3NO stock), squid (Sub-areas 3+4 stock), and shrimp (3L and 3NO stocks). Of the 19 stocks managed by NAFO, 16 straddle the EEZ; only the 3M cod, redfish and American plaice stocks occur entirely outside of the EEZ. Most fishing for relevant species in the NAFO Convention Regulatory Area is conducted using bottom trawlers.

During the 2005 to 2012 period, commercial harvesting beyond the 200 nm EEZ, in terms of catch weight, was dominated by snow crab (20% of total catch weight; primarily in NAFO Division 3L), northern shrimp (14%; primarily in 3L), Atlantic redfishes (10%; primarily in 3M and 3O), Stimpson's surf clam (10%; primarily in 4Vs), Atlantic cod (7%; primarily in 3Ps), capelin (7%; primarily in 3L), and Greenland halibut (6%; primarily in 3L). The highest catch weights during the eight-year period were taken in NAFO Divisions 3L (38%), 4Vs (16%), and 3Ps (15%), followed by 3M, 3N, and 3O. Canadian vessels accounted for 72% of the commercial catch weight reported for this area during 2005 to 2012. Only in Division 3M did the foreign vessels dominate catches (>99% of total catch weight in this Division). Catches in 3M were dominated by northern shrimp, Atlantic redfishes, Atlantic cod, Greenland halibut, and blue shark. Percentage catches by weight in Divisions 3N and 3O were similar for Canadian and foreign vessels (3N: ~55 and 45%; 3O: ~46 and 54%, respectively).

4.3.3 Domestic Fisheries

This section provides an overview of the commercial fisheries within and/or adjacent to the Study Area. The first part of this section provides the historical context. The second part of this overview provides recent information for the georeferenced (lat/long) data recorded specifically within the Study Area for 2005 to 2010, including harvest location distribution maps for the 2005-2012 period. Statistical summaries of the commercial catch data are provided for both the Project Area and the Study Area.

4.3.3.1 Historical Fisheries

Commercial fish harvesting in many parts of Newfoundland and Labrador has changed considerably over the last two decades, shifting from a groundfish-based industry to primarily crustacean harvesting. In the early 1990s, a harvesting moratorium was imposed on several commercially important groundfish species and directed fisheries for Atlantic cod and other groundfish were no longer permitted in most areas.

The Study Area fisheries were not exceptions to this trend (Buchanan et al. 2006; Sikumiut 2008; LGL 2009a, 2010a). After large groundfish catches in NAFO Divisions in and around the Study Area in the 1970s and 1980s, the fishery was considerably reduced in the early 1990s at the time of the moratorium. Directed fisheries for Atlantic cod and some other groundfish species were no longer permitted in most areas; 3Ps has remained one of the few directed Atlantic cod fisheries (although quotas are now lower than in previous decades) (LGL 2010a). Since the early 1990s, much lower quotas have been allowed, based on scientific advice and other considerations. Overall, the Study Area groundfish fishery has become greatly reduced while the invertebrate fisheries have grown in importance. Invertebrate catches, most notably snow crab, have become increasingly important within the Study Area, particularly since the mid-1990s. In the late 1980s, the fisheries in NAFO Divisions 3L, 3M, 3N, 3O, 3Ps and 4Vs largely targeted Atlantic cod, capelin, and American plaice. American plaice remains an important target species in 2010; however, snow crab has replaced Atlantic cod as a principal species. Today, there is limited directed fishery for Atlantic cod and only a modest by-catch is allowed.

4.3.3.2 Study Area Catch Analysis, 2005-2010

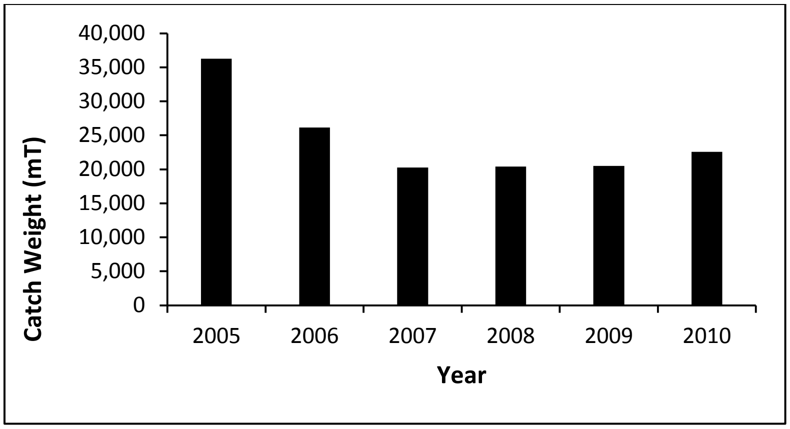
The 2005 to 2010 domestic harvests recorded from within the Study Area are shown in Table 4.2. As indicated, the principal fisheries (by catch weight) within the Study Area are for snow crab (19.9%), yellowtail flounder (18.6%), redfish (14.3%), cockles (9.0%), and Atlantic cod (9.0%), accounting for ~71% of the average annual catch weight. The total annual commercial fisheries catch weights of all species during May to November, 2005 to 2010, are indicated in Figure 4.2.

Table 4.2 Study Area Average Annual Catch Weight and Value by Species, 2005 to 2010.

Species	Quantity (mt)	% of Total	Value ($)	% of Total
Snow Crab	7,116	19.9	21,936,338	42.7
Yellowtail Flounder	6,674	18.6	3,850,840	7.5
Redfish	5,116	14.3	2,934,327	5.7
Cockles	3,220	9.0	3,387,172	6.6
Atlantic Cod	3,218	9.0	3,973,989	7.7
Whelks	2,341	6.5	2,245,838	4.4
Stimpson's Surf Clam	1,694	4.7	2,232,593	4.3
White Hake	1,373	3.8	982,942	1.9
American Plaice	1,017	2.8	565,923	1.1
Skate sp.	820	2.3	253,688	0.5
Monkfish	469	1.3	677,890	1.3
Pollock	444	1.2	267,609	0.5
Atlantic Halibut	442	1.2	3,863,189	7.5
Icelandic Scallops	356	1.0	559,261	1.1
Witch Flounder	265	0.7	177,775	0.3
Haddock	262	0.7	245,361	0.5
Swordfish	243	0.7	1,846,010	3.6
Hagfish	236	0.7	370,354	0.7
Sea Scallops	205	0.6	340,990	0.7
Greenland Halibut (Turbot)	144	0.4	311,993	0.6
Propellor Clams	60	0.2	30,447	0.1
Herring	33	0.1	7,292	0.0

Species	Quantity (mt)	% of Total	Value ($)	% of Total
Bluefin Tuna	21	0.1	214,497	0.4
Cusk	10	<0.1	8,005	<0.1
Mako Shark	8	<0.1	10,501	<0.1
Bigeye Tuna	7	<0.1	72,793	0.1
Sea Cucumber	7	<0.1	3,782	<0.1
Porbeagle Shark	6	<0.1	6,054	<0.1
Northern Shrimp	5	<0.1	5,346	<0.1
Mackerel	5	<0.1	1,470	<0.1
Catfish	3	<0.1	1,643	<0.1
Roundnose Grenadier	2	<0.1	1,868	<0.1
Flounder sp.	2	<0.1	2,683	<0.1
Roughhead Grenadier	2	<0.1	566	<0.1
Blue Shark	2	<0.1	1,930	<0.1
Albacore Tuna	1	<0.1	6,020	<0.1
Winter Flounder	1	<0.1	1,475	<0.1
Mahi mahi (Dolphinfish)	0	<0.1	1,117	<0.1
Alantic (Striped) Wolffish	0	<0.1	142	<0.1
Shark sp.	0	<0.1	189	<0.1
Argentine	0.3	<0.1	34	<0.1
Red Hake	0.3	<0.1	271	<0.1
Yellowfin Tuna	0.2	<0.1	1,192	<0.1
White Squid	0.1	<0.1	21	<0.1
Thresher Shark	0.1	<0.1	90	<0.1
Jonah Crab	0.1	<0.1	77	<0.1
Groundfish sp.	0.1	<0.1	8	<0.1
Lobster	<0.1	<0.1	319	<0.1
Dogfish	<0.1	<0.1	29	<0.1
Pelagic Fish sp.	<0.1	<0.1	38	<0.1
Squid sp.	<0.1	<0.1	6	<0.1
White Marlin	<0.1	<0.1	38	<0.1
Silver Hake	<0.1	<0.1	12	<0.1
Sculpin	<0.1	<0.1	7	<0.1
Sand Tiger Shark	<0.1	<0.1	12	<0.1
Blue Marlin	<0.1	<0.1	2	<0.1
Basking Shark	<0.1	<0.1	5	<0.1
Tuna sp.	<0.1	<0.1	7	<0.1
Illex Squid	<0.1	<0.1	1	<0.1
Totals	35,830	100.0	51,404,069	100.0

Source: DFO commercial landings database, 2005 to 2010.

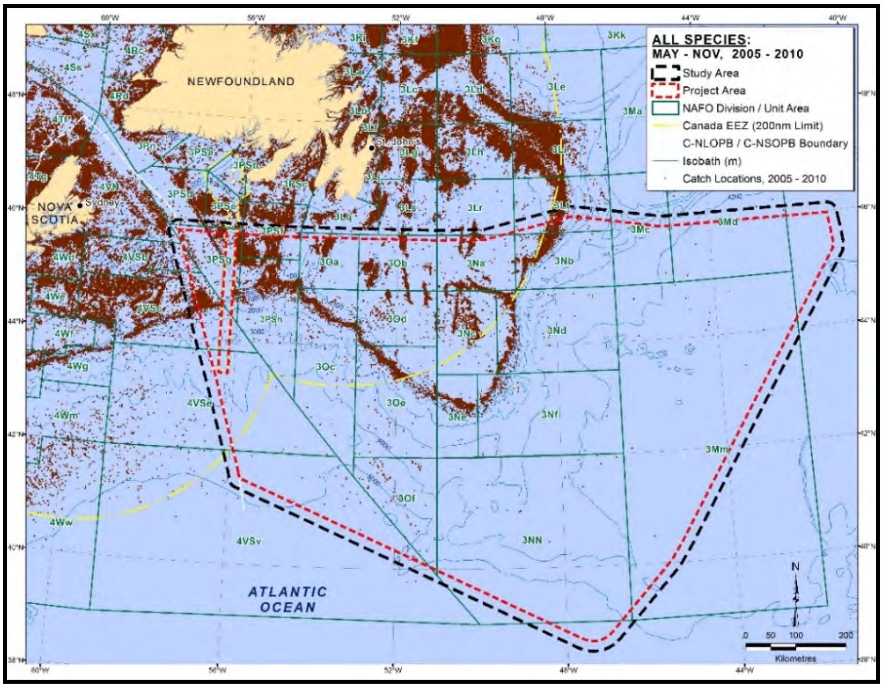


Source: DFO commercial landings database, 2005-2010.

Figure 4.2 Annual Total Catch Weight (All Species) within the Study Area, May to November, 2005 to 2010.

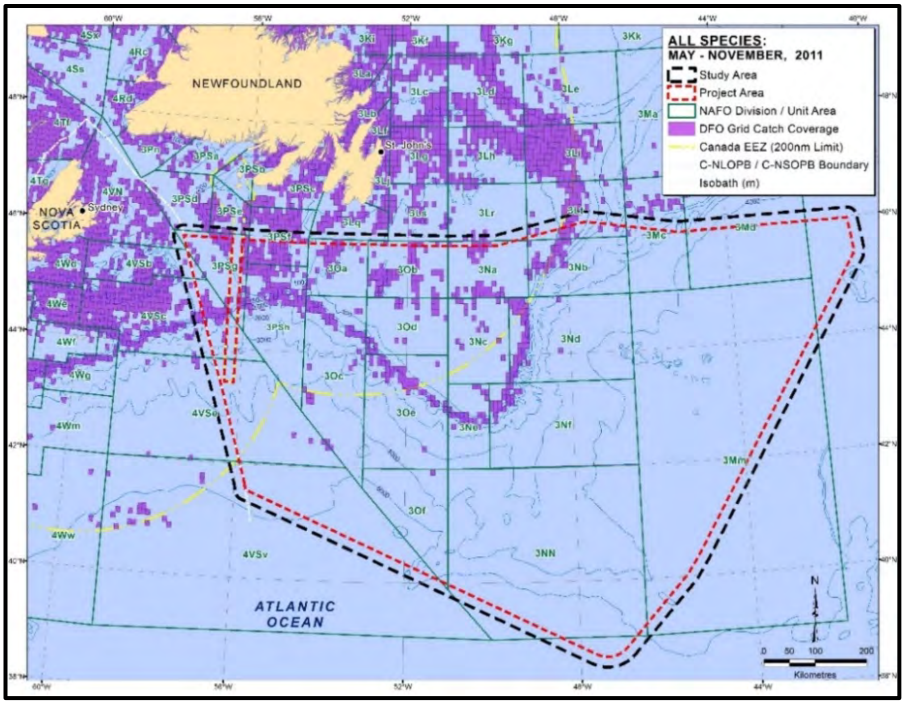
Overall Harvesting in the Study Area

Figure 4.3 shows georeferenced harvest locations in relation to the Study and Project Areas for all species, May to November, 2005 to 2010. As Figures 4.3 to 4.5 indicate, most of the fish harvesting occurs in the northwestern part of the Study and Project areas, principally on the Grand Banks shelf and slope to the 1,000 m isobath. A comparison with fisheries maps in the Laurentian Sub-basin EA (Buchanan et al. 2006) and the Southern Newfoundland SEA (LGL 2010a) indicates that these locations are generally consistent from year to year.



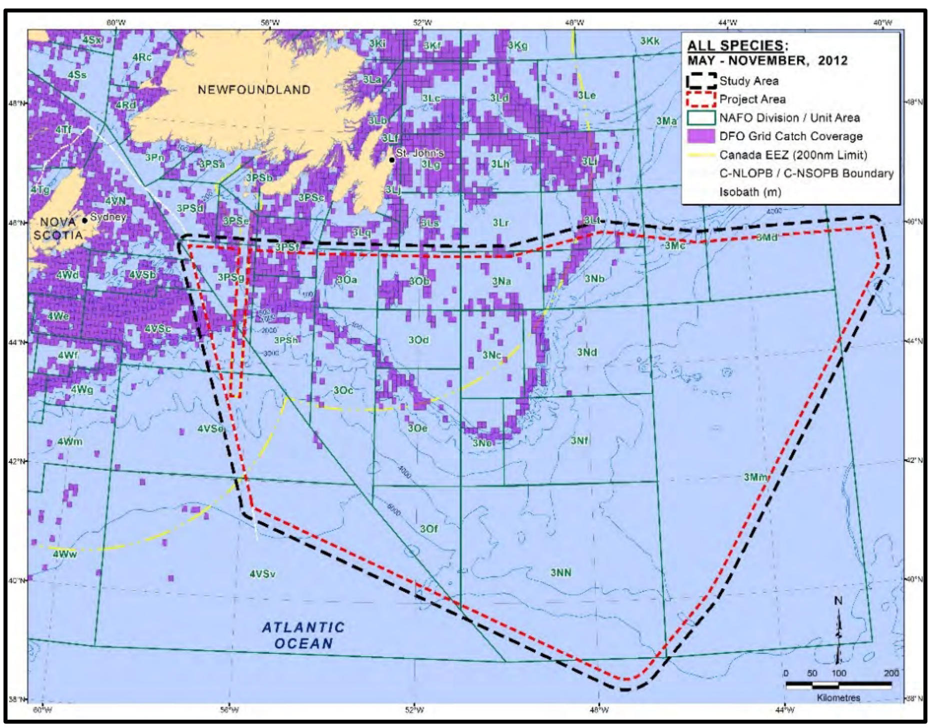
Source: DFO commercial landings database, 2005 to 2010.

Figure 4.3 Harvest Locations of All Species Combined, May to November, 2005-2010.



Source: DFO commercial landings database, 2011.

Figure 4.4 Harvest Location Distribution of All Species Combined within the Study Area, May to November, 2011.



Source: DFO commercial landings database, 2012.

Figure 4.5 Harvest Location Distribution of All Species Combined within the Study Area, May to November, 2012.

Fishing Gear in the Study Area

The fishing gear used in the Study Area in 2005 to 2010 typically reflects the species being exploited (Table 4.3). Crab pots target snow crab, yellowtail flounder and redfish are harvested using primarily trawls, dredges harvest cockles, and gillnets harvest Atlantic cod. Trawls and dredges, both mobile gears, accounted for 47% (35 and 12%, respectively) of the total catch weight of all species in the Study Area between May and November, 2005 to 2010. Pots/traps and gillnets, fixed gears, accounted for 37% (24 and 13%, respectively) of the total catch weight during this period. Overall, mobile and fixed gears each accounted for approximately half of the total catch weight during this period (Table 4.3).

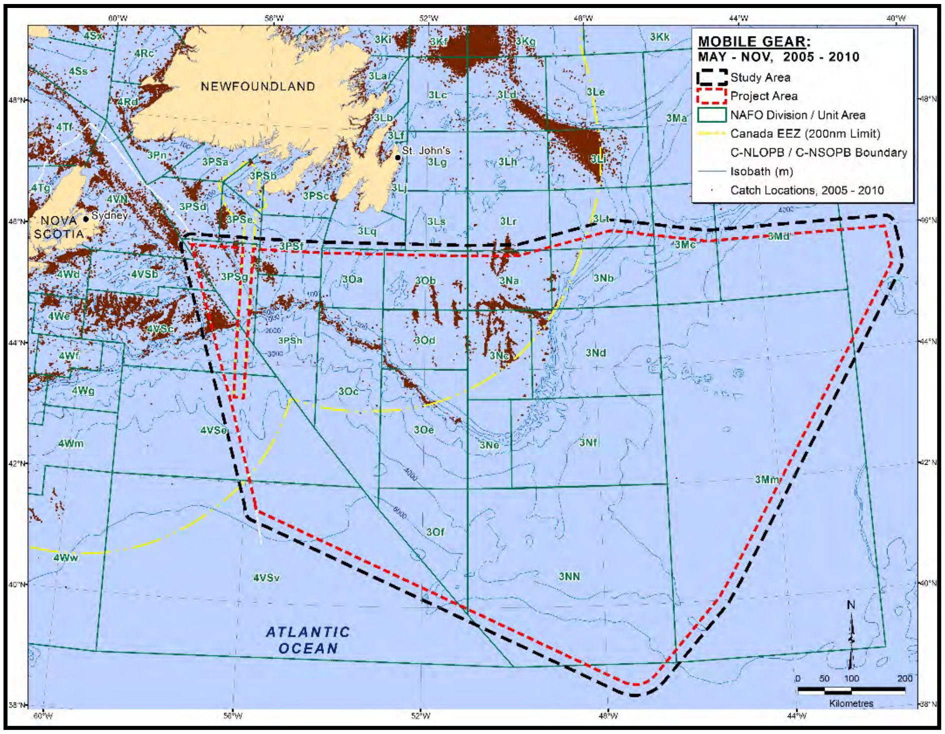
Fishing gears typically used in the Study Area are provided in Table 3.5 of the Southern Newfoundland SEA (LGL 2010a). In general, the fixed gears have greater potential for interacting with Project activities than mobile gears, because they use submerged lines attached to buoys at the ocean surface, which can be easily snagged by towed seismic gear, causing damage to both the fishing gear and to the seismic streamer. They are often placed in one location for several days, are difficult to detect and may be set out over long distances in the water. Figures 4.6 and 4.7 show locations of mobile and fix gear harvesting locations during 2005 to 2010.

Table 4.3 Average Annual Study Area Catch Weight by Gear Type, May to November, 2005-2010.

Species	Fixed Gear (mt)	% of Total Fixed	Mobile Gear (mt)	% of Total Mobile
Snow Crab	5,871	45.8	0	0
Yellowtail Flounder	3	<0.1	4,152	35.9
Redfish	34	0.3	3,221	27.9
Cockles	0	0	1,724	14.9
Atlantic Cod	1,199	9.4	311	2.7
Whelks	2,341	18.3	0	0
Stimpson's Surf Clam	0	0	749	6.5
White Hake	1,117	8.7	19	0.2
American Plaice	45	0.4	610	5.3
Skate sp.	377	2.9	67	0.6
Monkfish	446	3.5	5	<0.1
Pollock	390	3.0	17	0.1
Atlantic Halibut	239	1.9	13	0.1
Icelandic Scallops	0	0	352	3.0
Witch Flounder	<0.1	<0.1	33	0.3
Haddock	140	1.1	20	0.2
Swordfish	243	1.9	<0.1	<0.1
Hagfish	233	1.8	0	0
Sea Scallops	0	0	181	1.6
Greenland Halibut (Turbot)	77	0.6	4	<0.1
Propellor Clams	0	0	25	0.2
Herring	11	0.1	16	0.1
Bluefin Tuna	6	<0.1	15	0.1

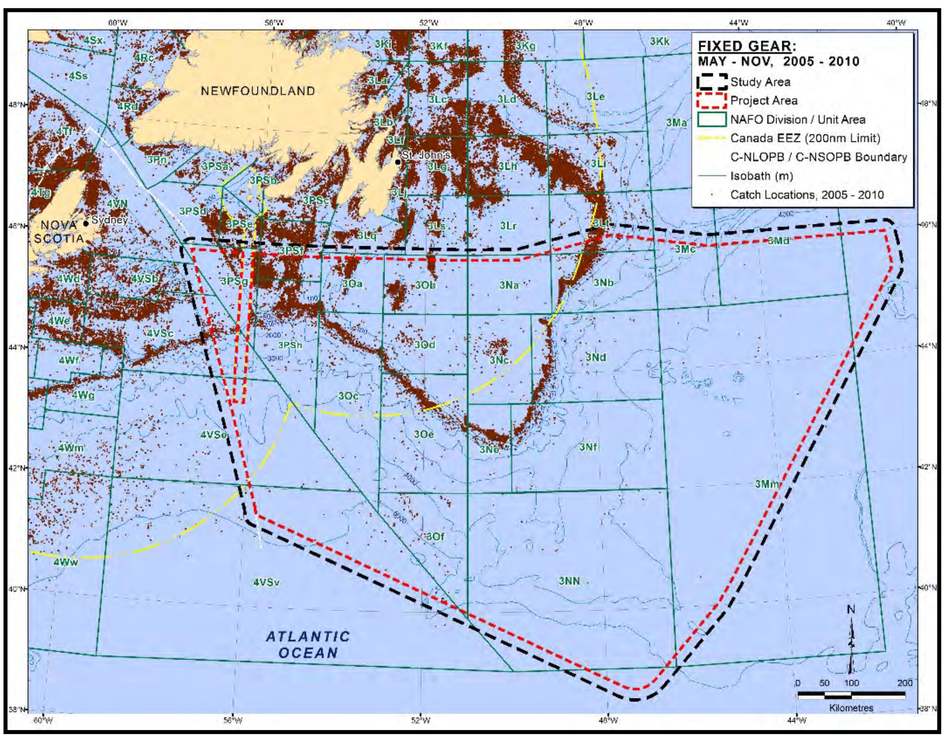
Species	Fixed Gear (mt)	% of Total Fixed	Mobile Gear (mt)	% of Total Mobile
Cusk	9	0.1	<0.1	<0.1
Mako Shark	8	0.1	0	0
Bigeye Tuna	7	0.1	<0.1	<0.1
Sea Cucumber	0	0	7	0.1
Porbeagle Shark	5	<0.1	<0.1	<0.1
Northern Shrimp	0	0	5	<0.1
Mackerel	0	0	5	<0.1
Catfish	3	<0.1	<0.1	<0.1
Roundnose Grenadier	2	<0.1	<0.1	<0.1
Flounder sp.	<0.1	<0.1	<0.1	<0.1
Roughhead Grenadier	1	<0.1	<0.1	<0.1
Blue Shark	2	<0.1	0	0
Albacore Tuna	1	<0.1	0	0
Winter Flounder	<0.1	<0.1	0	0
Mahi mahi (Dolphinfish)	<0.1	<0.1	0	0
Alantic (Striped) Wolffish	<0.1	<0.1	<0.1	<0.1
Shark sp.	<0.1	<0.1	0	0
Argentine	0	0	0.2	<0.1
Red Hake	0	0	0	0
Yellowfin Tuna	<0.1	<0.1	0	0
White Squid	0	0	0.1	<0.1
Thresher Shark	<0.1	<0.1	0	0
Jonah Crab	<0.1	<0.1	0	0
Groundfish sp.	<0.1	<0.1	0	0
Lobster	<0.1	<0.1	0	0
Dogfish	<0.1	<0.1	<0.1	<0.1
Pelagic Fish sp.	<0.1	<0.1	0	0
Squid sp.	0	0	<0.1	<0.1
White Marlin	<0.1	<0.1	0	0
Silver Hake	0	0	<0.1	<0.1
Sculpin	0	0	<0.1	<0.1
Sand Tiger Shark	<0.1	<0.1	0	0
Blue Marlin	<0.1	<0.1	0	0
Basking Shark	<0.1	<0.1	0	0
Tuna sp.	<0.1	<0.1	0	0
Illex Squid	0	0	<0.1	<0.1
Totals	**12,812**	**100.0**	**11,553**	**100.0**

Source: DFO commercial landings database, 2005 to 2010.



Source: DFO commercial landings database, 2005 to 2010.

Figure 4.6 Mobile Gear Harvesting Locations, May to November, 2005-2010.

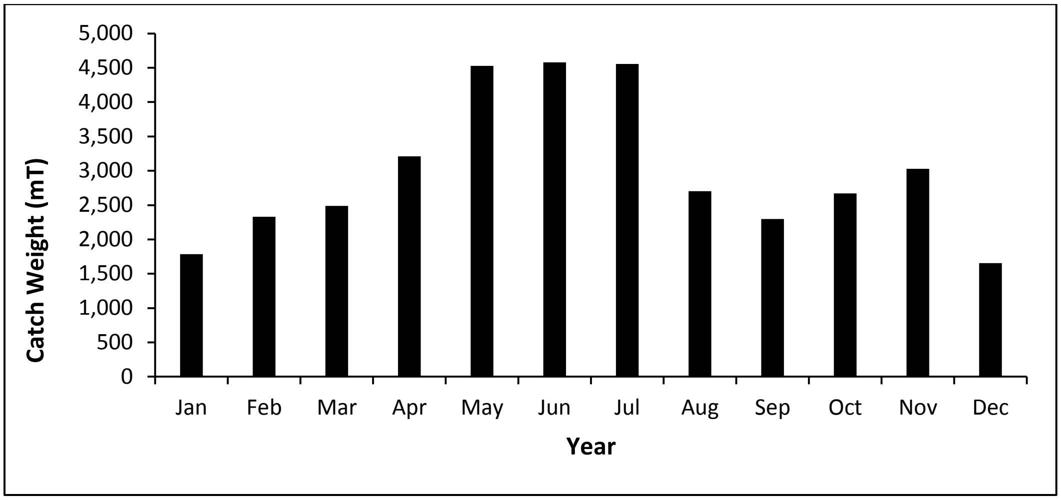


Source: DFO commercial landings database, 2005 to 2010.

Figure 4.7 Fixed Gear Harvesting Locations, May-November, 2005 to 2010.

Harvest Timing in the Study Area

Monthly timing of commercial harvesting of all species within the Study Area for 2005 to 2010 is indicated in Figure 4.8. Overall catch weight was highest May to July and lowest during winter. However, the timing of the harvests can vary from year to year with resource availability, fisheries management plans, and enterprise harvesting strategies.



Source: DFO commercial landings database, 2005 to 2010.

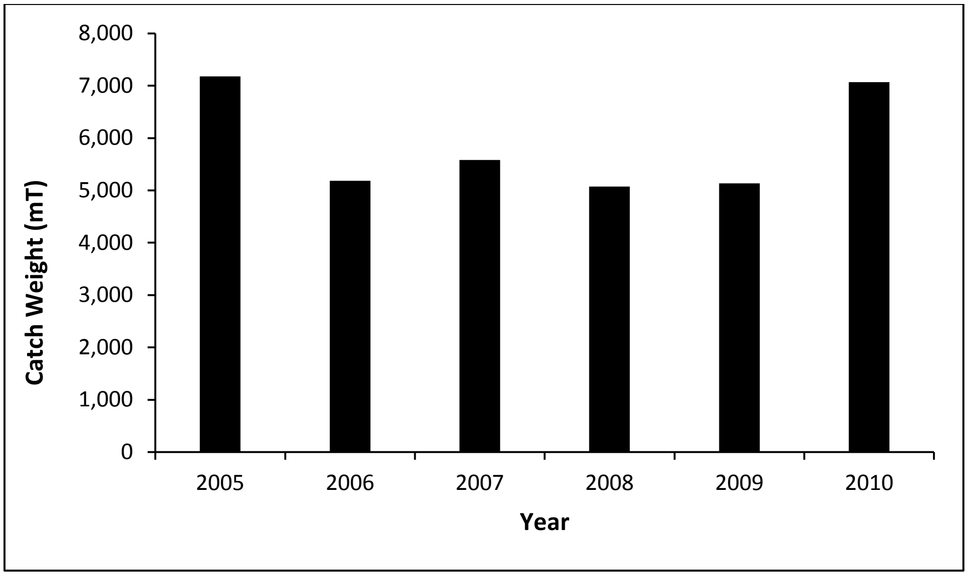
Figure 4.8 Average Monthly Catch Weight of All Species in the Study Area, 2005-2010.

Principal Species in the Study Area

The following section provides information on the principal species caught during fisheries being prosecuted in the Study Area.

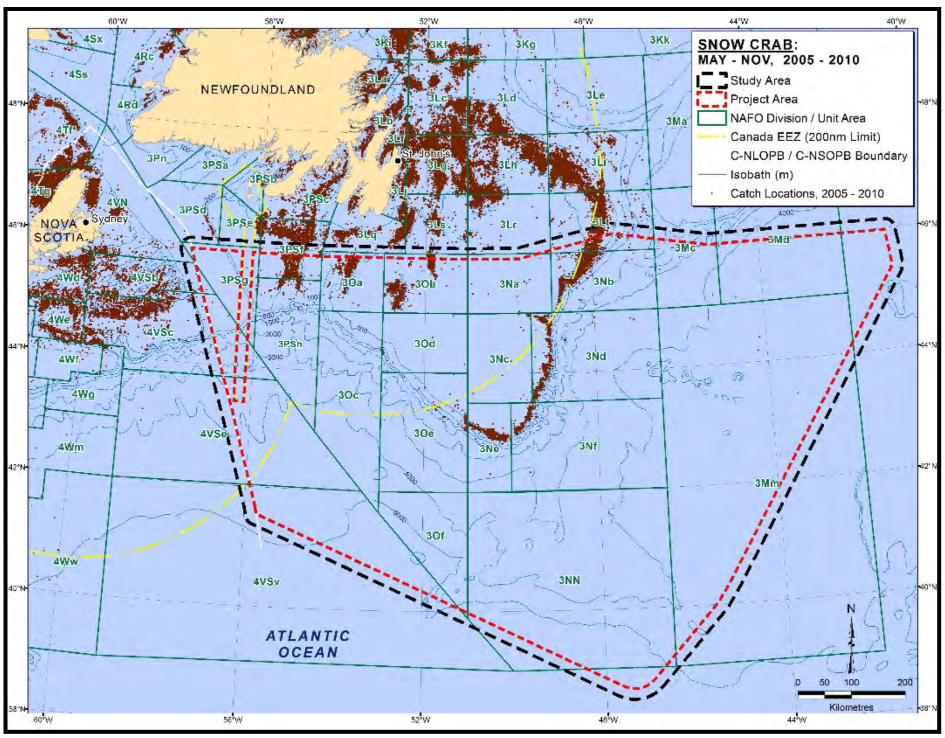
Snow Crab

Snow crab is the most important commercial species in the Study Area by both quantity and value. Total annual catch weights for snow crab in the Study Area between May and November, 2005 to 2010, are indicated in Figure 4.9. Figure 4.10 shows the snow crab harvesting locations for 2005-2010. Figures 4.11 to 4.12 show harvest patterns for 2011 and 2012, respectively. The average monthly snow crab harvests in the Study Area during the 2005 to 2010 period are shown in Figure 4.13. May and June were the two months during which most of the snow crab was caught.



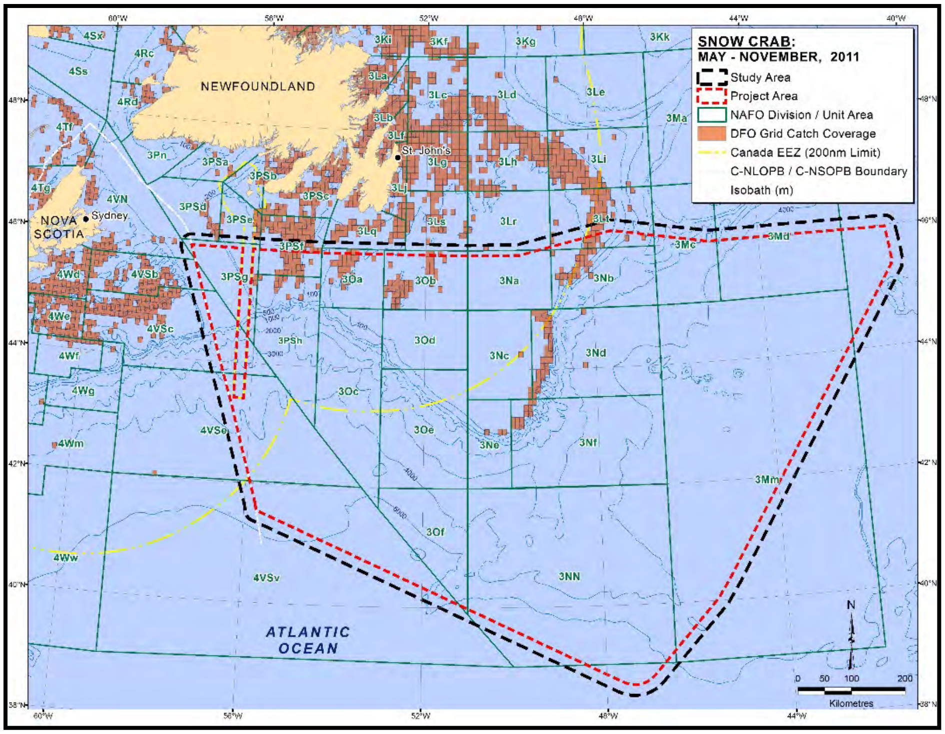
Source: DFO commercial landings database, 2005 to 2010.

Figure 4.9 Total Annual Catch Weights for Snow Crab in the Study Area, May to November, 2005-2010.



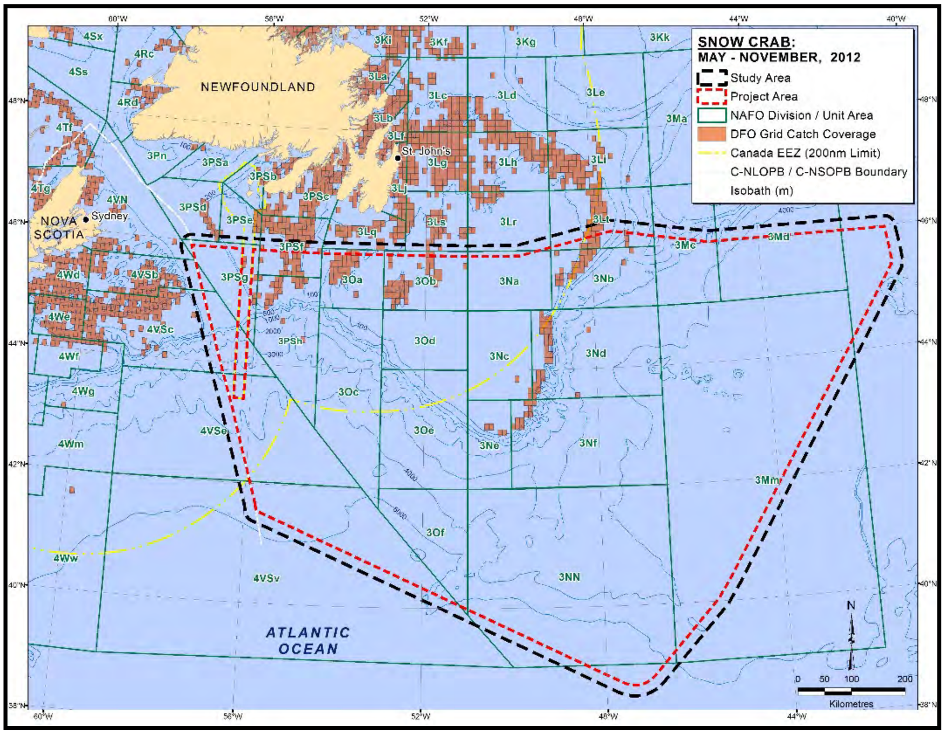
Source: DFO commercial landings database, 2005 to 2010.

Figure 4.10 Commercial Harvesting Locations for Snow Crab, May to November, 2005-2010.



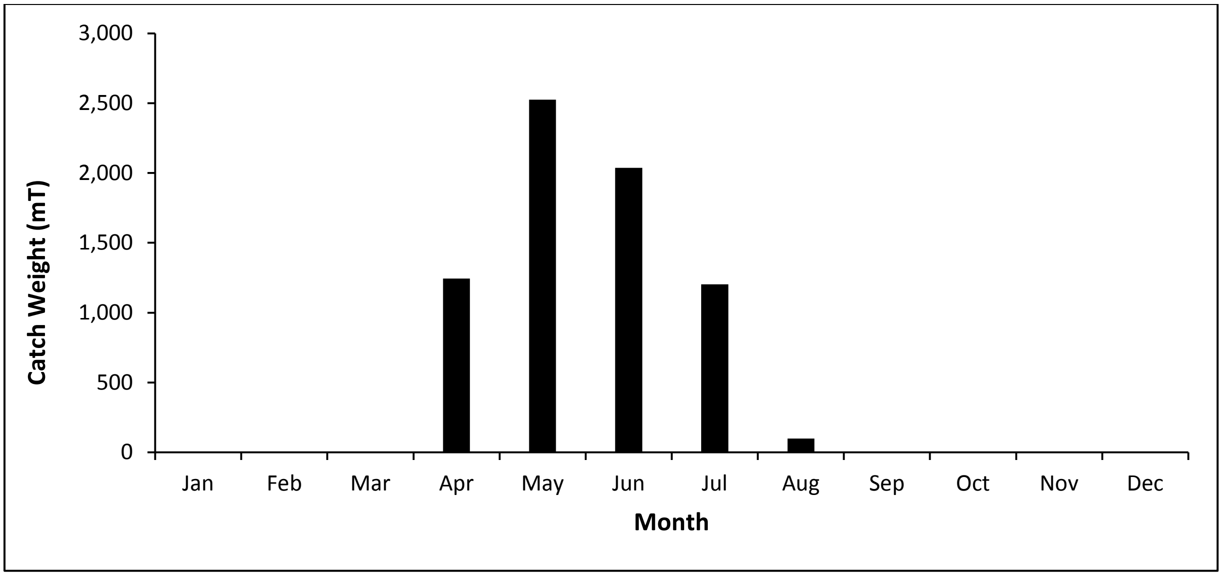
Source: DFO commercial landings database, 2011.

Figure 4.11 Commercial Harvesting Pattern for Snow Crab, May to November, 2011.



Source: DFO commercial landings database, 2012.

Figure 4.12 Commercial Harvesting Pattern for Snow Crab, May to November, 2012.

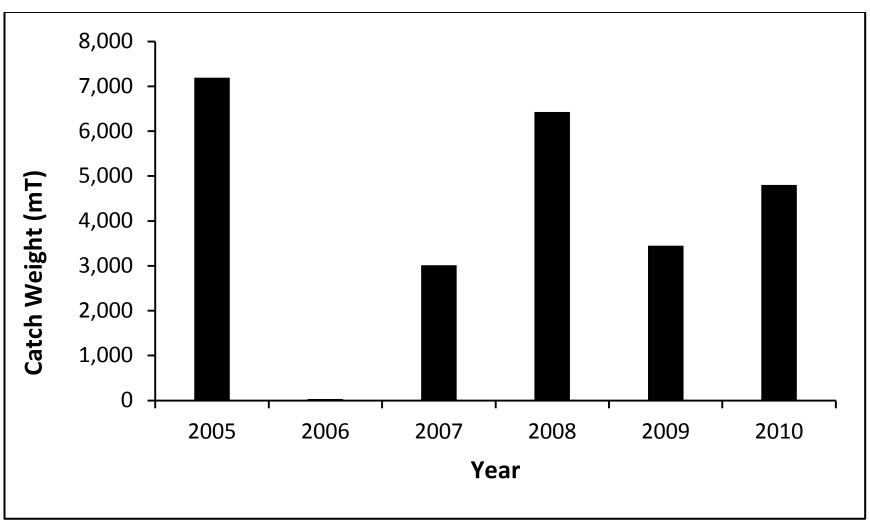


Source: DFO commercial landings database, 2005 to 2010.

Figure 4.13 Average Monthly Catch Weights for Snow Crab in the Study Area, 2005-2010.

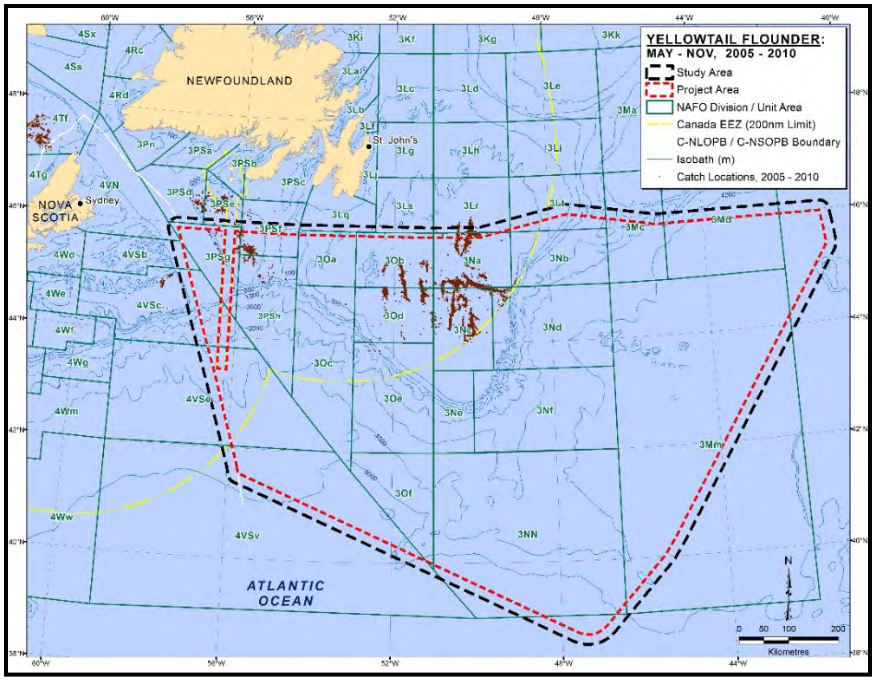
<u>Yellowtail Flounder</u>

Yellowtail founder made up the largest part of groundfish catches in the Study Area from 2005 to 2010. Total annual catch weights for yellowtail flounder in the Study Area between May and November, 2005 to 2010 are indicated in Figure 4.14. There was considerable variability in total catch weight during that time. Figure 4.15 shows the yellowtail flounder harvesting locations for 2005 to 2010 combined. Figures 4.16 to 4.17 show yellowtail harvesting patterns for 2011 and 2012, respectively. The average monthly yellowtail flounder harvests for the 2005 to 2010 period in the Study Area are shown in Figure 4.18. Spring and fall were the two seasons during which most of the yellowtail flounder was caught.



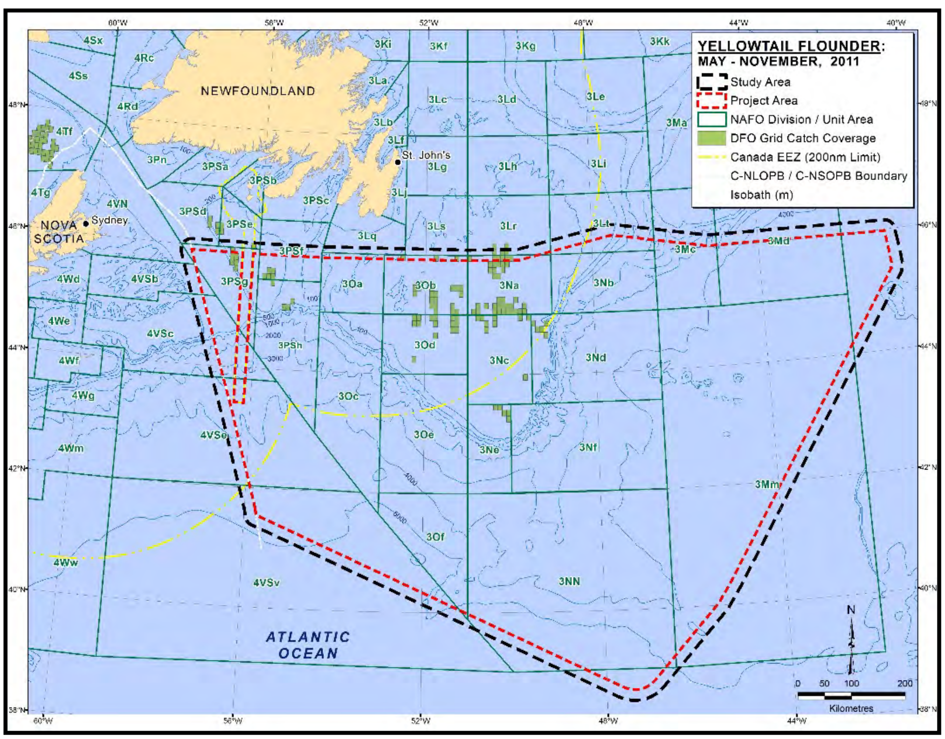
Source: DFO commercial landings database, 2005 to 2010.

Figure 4.14 Total Annual Catch Weights for Yellowtail Flounder in the Study Area, May to November, 2005-2010.



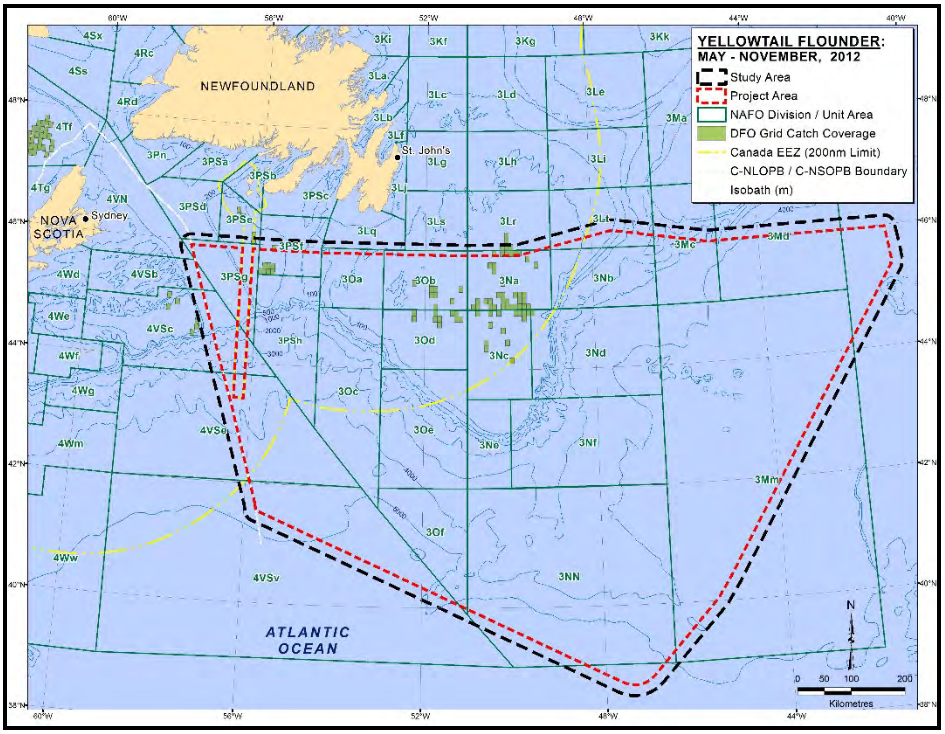
Source: DFO commercial landings database, 2005 to 2010.

Figure 4.15 Commercial Harvesting Locations for Yellowtail Flounder, May to November, 2005-2010.



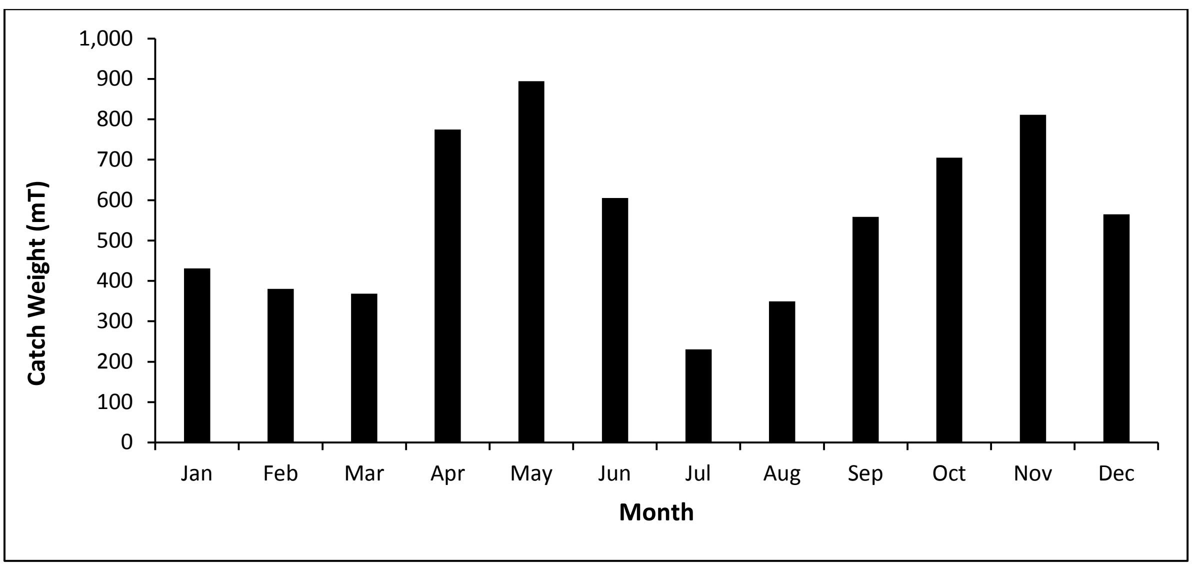
Source: DFO commercial landings database, 2011.

Figure 4.16 Commercial Harvesting Pattern for Yellowtail Flounder, May to November, 2011.



Source: DFO commercial landings database, 2012.

Figure 4.17 Commercial Harvesting Pattern for Yellowtail Flounder, May to November, 2012.



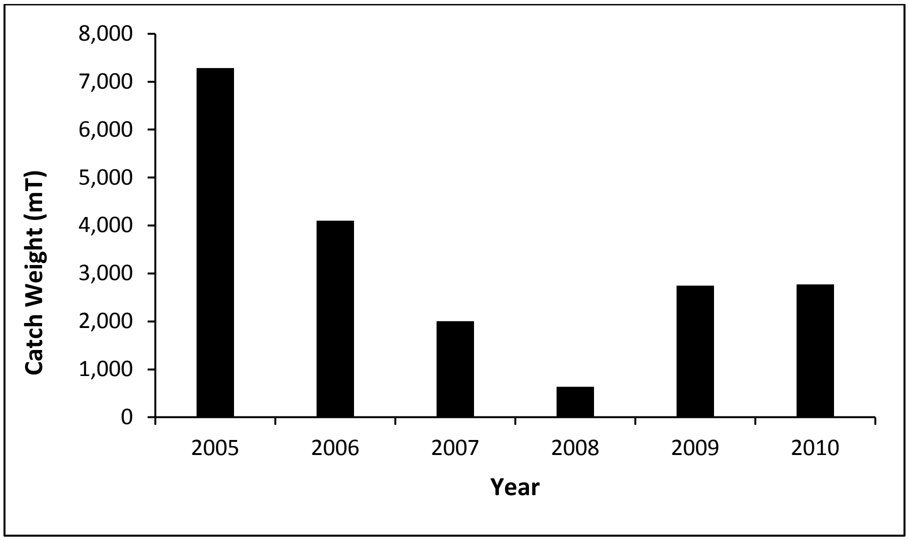
Source: DFO commercial landings database, 2005 to 2010.

Figure 4.18 Average Monthly Catch Weights for Yellowtail Flounder in the Study Area, 2005-2010.

Redfish

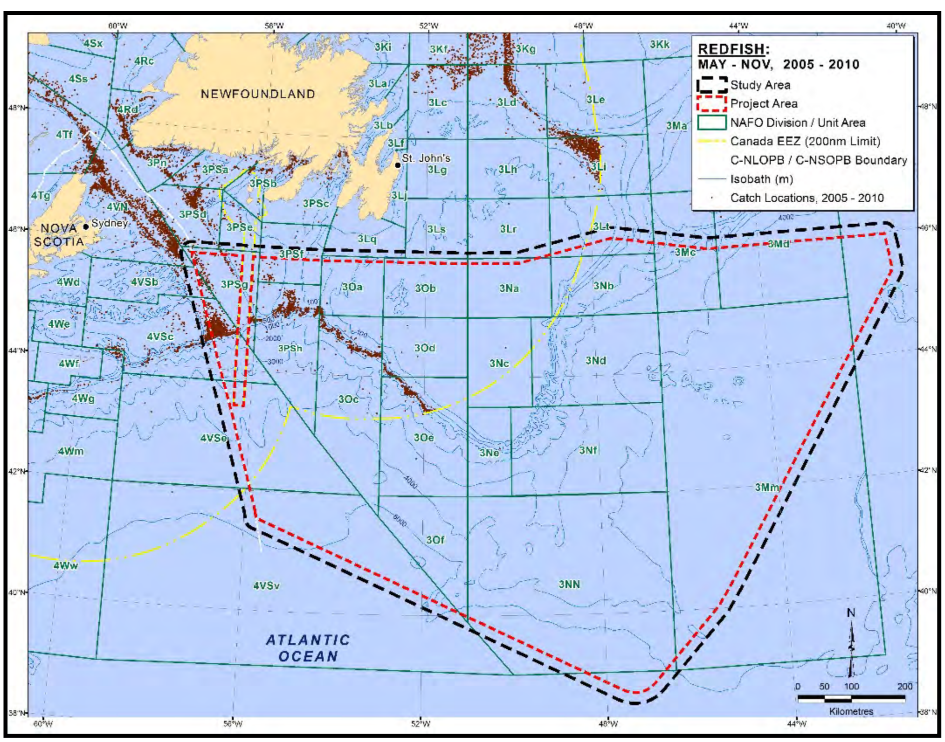
The third most important commercial species, in terms of average annual catch weight, in the Study Area between 2005 and 2010, redfish catches were valued at nearly $3 million over six year period.

Total annual catch weights for redfish in the Study Area between May and November, 2005 to 2010 are indicated in Figure 4.19. Figure 4.20 shows the redfish harvesting locations for 2005 to 2010. Figures 4.21 to 4.22 show harvesting patterns for 2011 and 2012, respectively. The average monthly redfish harvests during the 2005 to 2010 period in the Study Area are shown in Figure 4.23. March and July through November were the primary harvesting periods for this species.



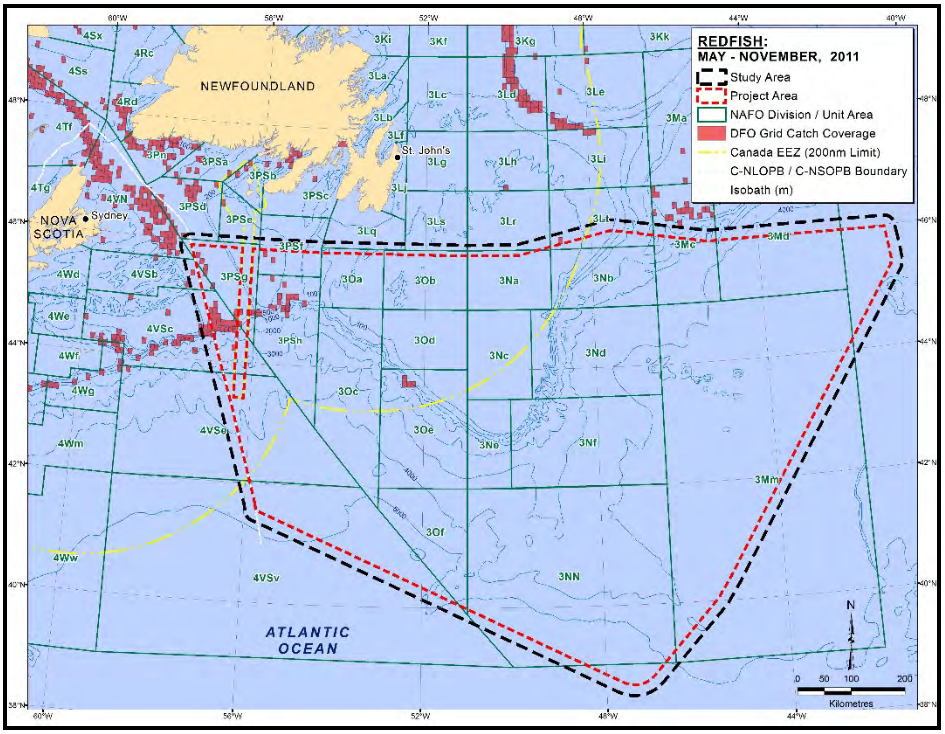
Source: DFO commercial landings database, 2005 to 2010.

Figure 4.19 Total Annual Catch Weights for Redfish, May to November, 2005-2010.



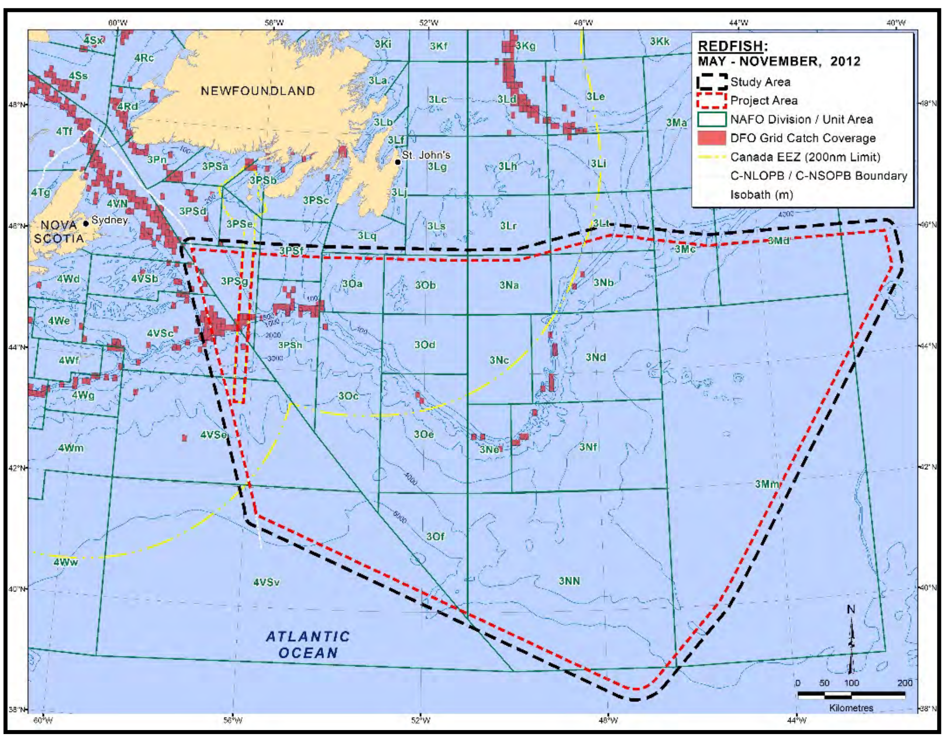
Source: DFO commercial landings database, 2005 to 2010.

Figure 4.20 Commercial Harvesting Locations for Redfish, May to November, 2005-2010.



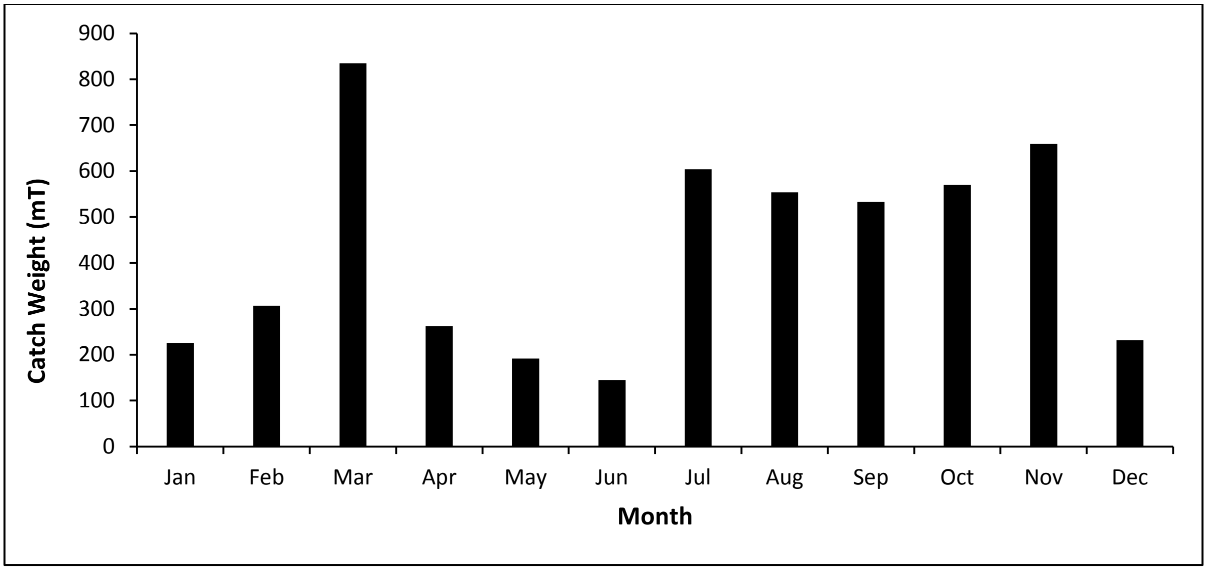
Source: DFO commercial landings database, 2011.

Figure 4.21 Commercial Harvesting Pattern for Redfish, May to November, 2011.



Source: DFO commercial landings database, 2012.

Figure 4.22 Commercial Harvesting Pattern for Redfish, May to November, 2012.

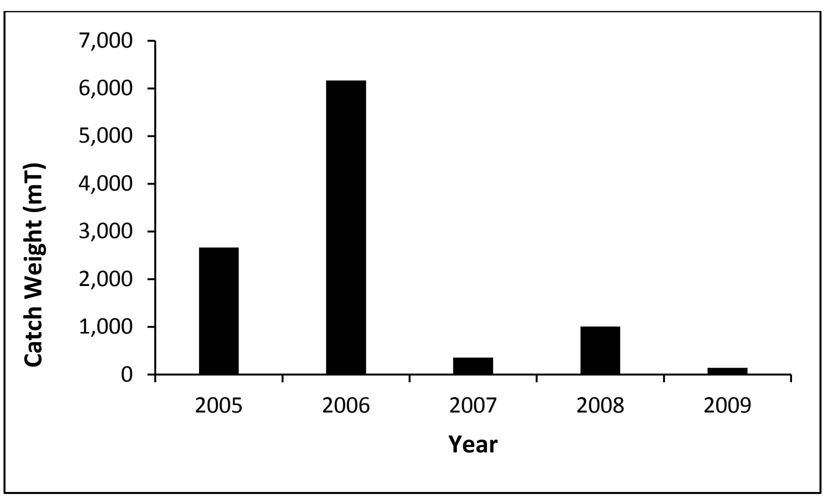


Source: DFO commercial landings database, 2005 to 2010.

Figure 4.23 Average Monthly Catch Weights for Redfish in the Study Area, 2005-2010.

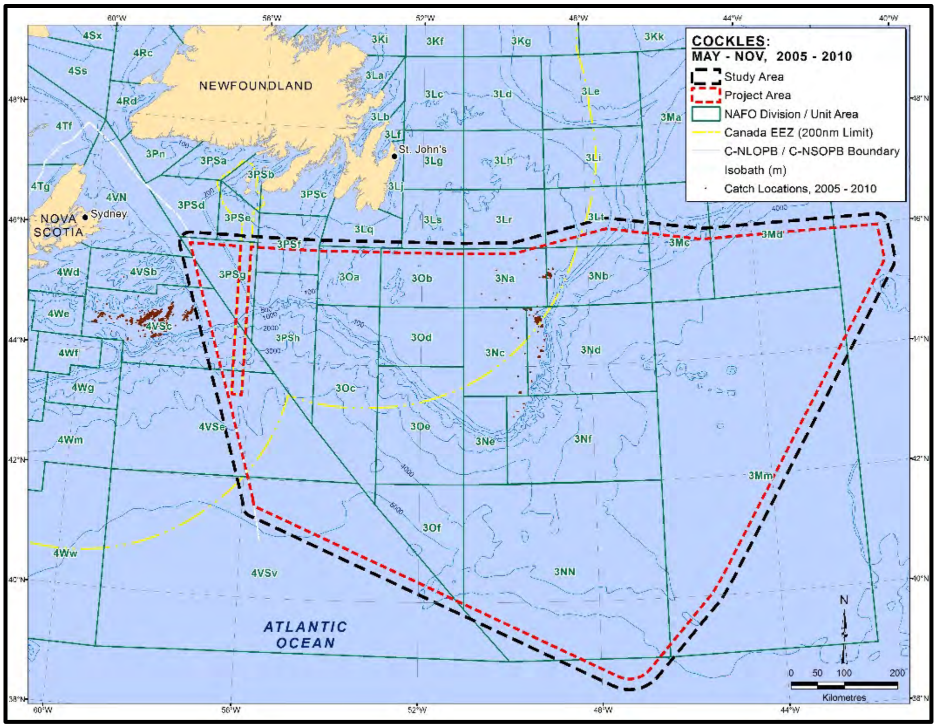
<u>**Cockles**</u>

Cockle catches in the Study Area were valued at more than $3 million between 2005 and 2010. Total annual catch weights for cockles in the Study Area between May and November, 2005 to 2010, are indicated in Figure 4.24. As the figure illustrates, there was a considerable decrease in total annual catch after 2006. Figure 4.25 shows the cockle harvesting locations for 2005 to 2010. Figures 4.26 to 4.27 show harvesting patterns for 2011 and 2012, respectively. The average monthly cockle harvests during 2005 to 2010 period in the Study Area are shown in Figure 4.28. Most of the cockles were caught during March and the fall.



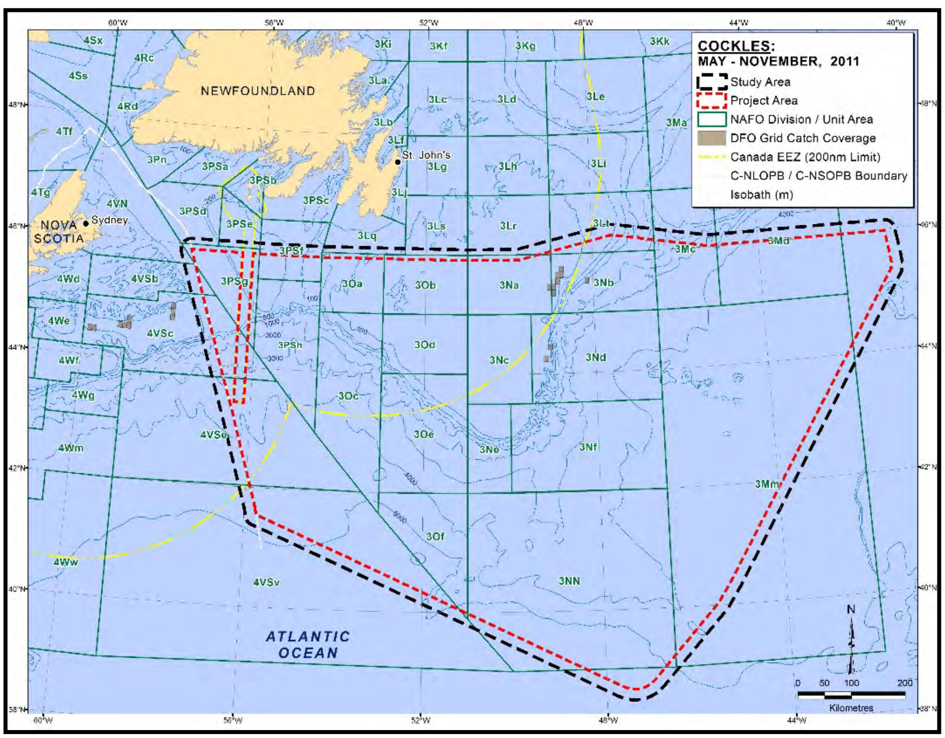
Source: DFO commercial landings database, 2005 to 2010.

Figure 4.24 Total Annual Catch Weights for Cockles in the Study Area, May to November, 2005-2010.



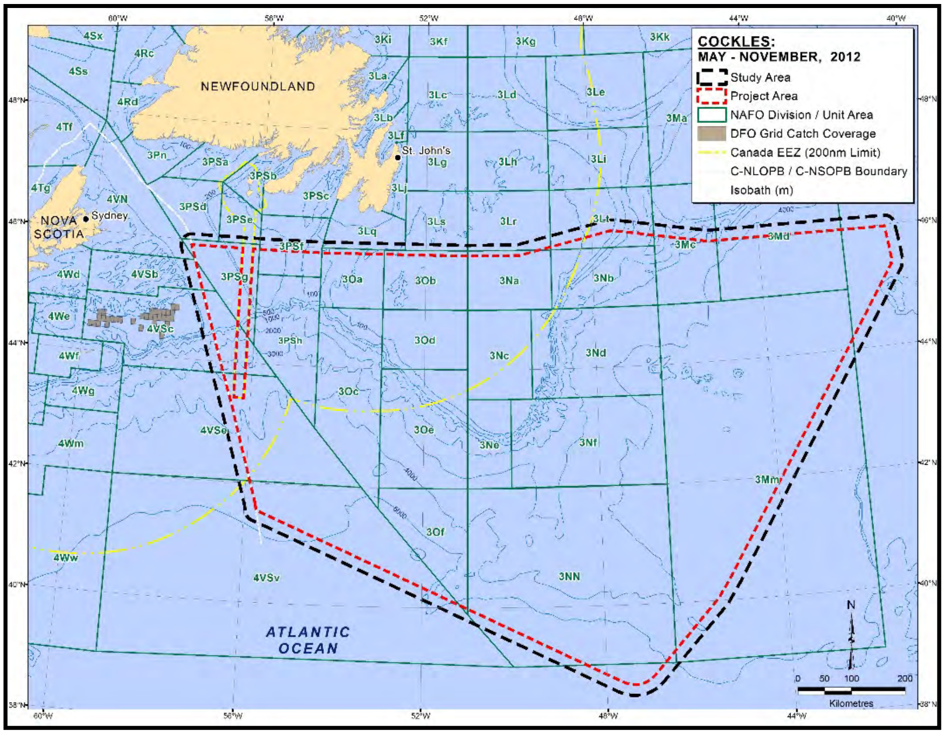
Source: DFO commercial landings database, 2005 to 2010.

Figure 4.25 Commercial Harvesting Locations for Cockles, May to November, 2005-2010.



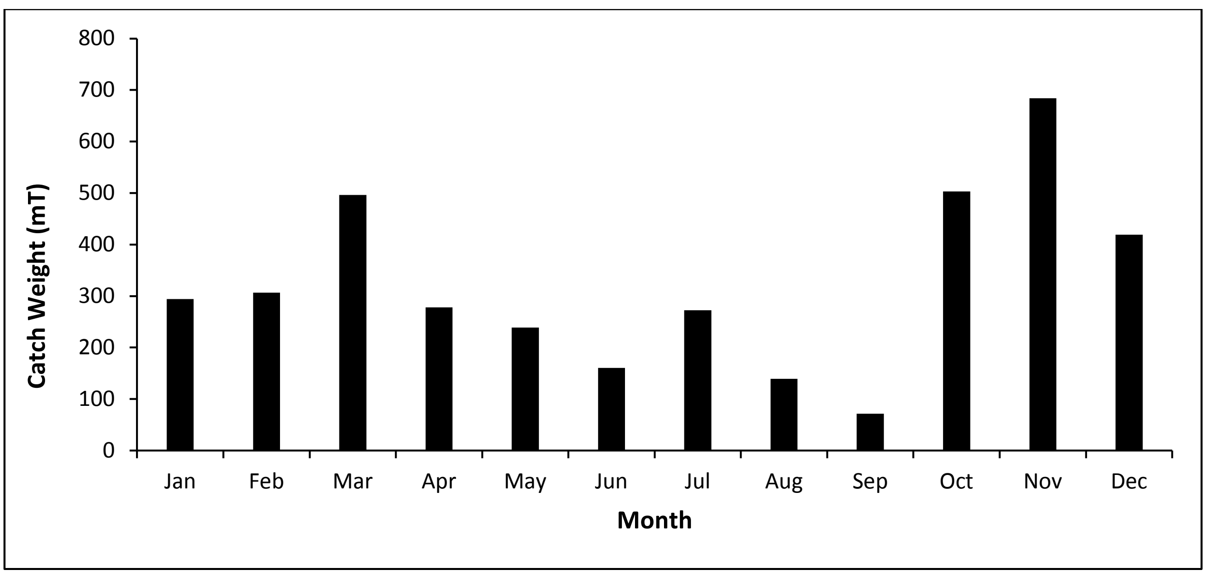
Source: DFO commercial landings database, 2011.

Figure 4.26 Commercial Harvesting Pattern for Cockles, May to November, 2011.



Source: DFO commercial landings database, 2012.

Figure 4.27 Commercial Harvesting Pattern for Cockles, May to November, 2012.



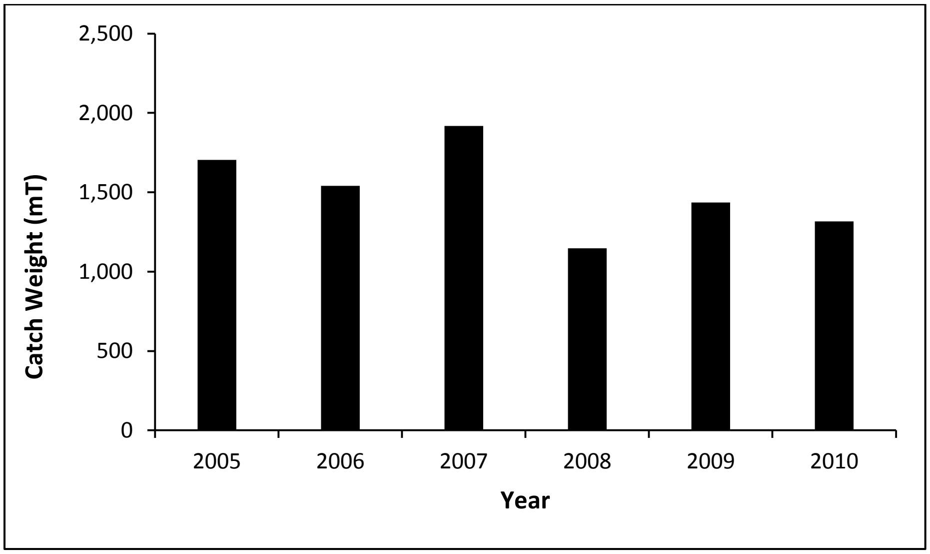
Source: DFO commercial landings database, 2005 to 2010.

Figure 4.28 Average Monthly Catch Weights for Cockles in the Study Area, 2005-2010.

<u>Atlantic Cod</u>

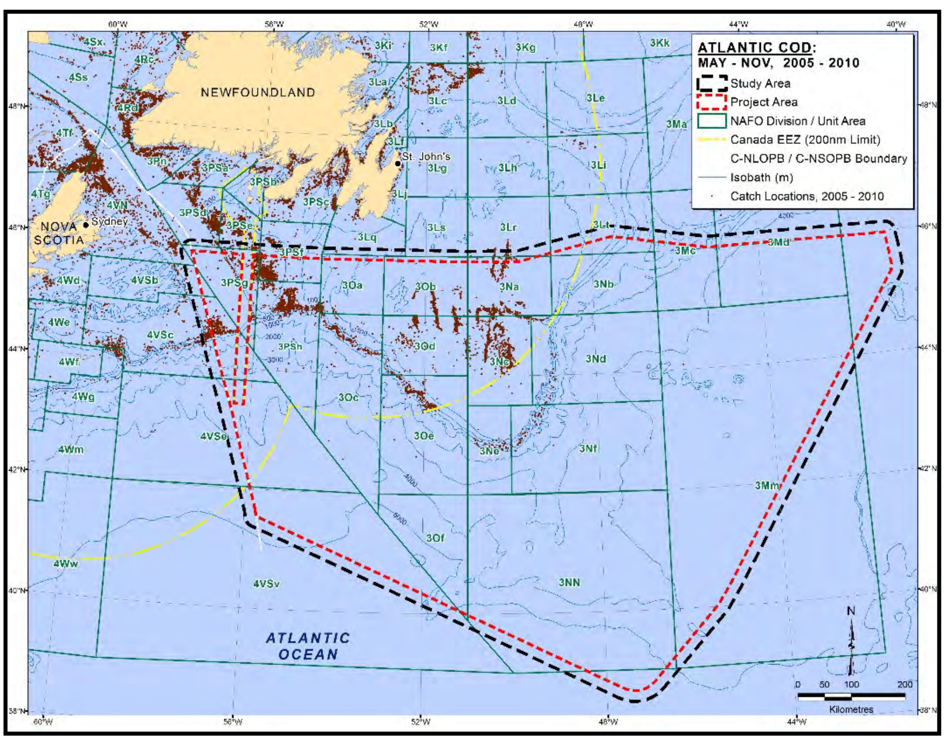
In terms of average annual catches, Atlantic cod was the most valuable groundfish species and the second most valuable species overall in the Study Area from 2005 to 2010. Total annual catch weights for Atlantic cod in the Study Area between May and November, 2005 to 2010 are indicated in

Figure 4.29. Figure 4.30 shows the Atlantic cod harvesting locations for 2005 to 2010 combined. Figures 4.31 to 4.32 show harvesting patterns for 2011 and 2012, respectively. The average monthly Atlantic cod harvests during the 2005 to 2010 period in the Study Area are shown in Figure 4.33. Most of the Atlantic cod was caught during the winter.



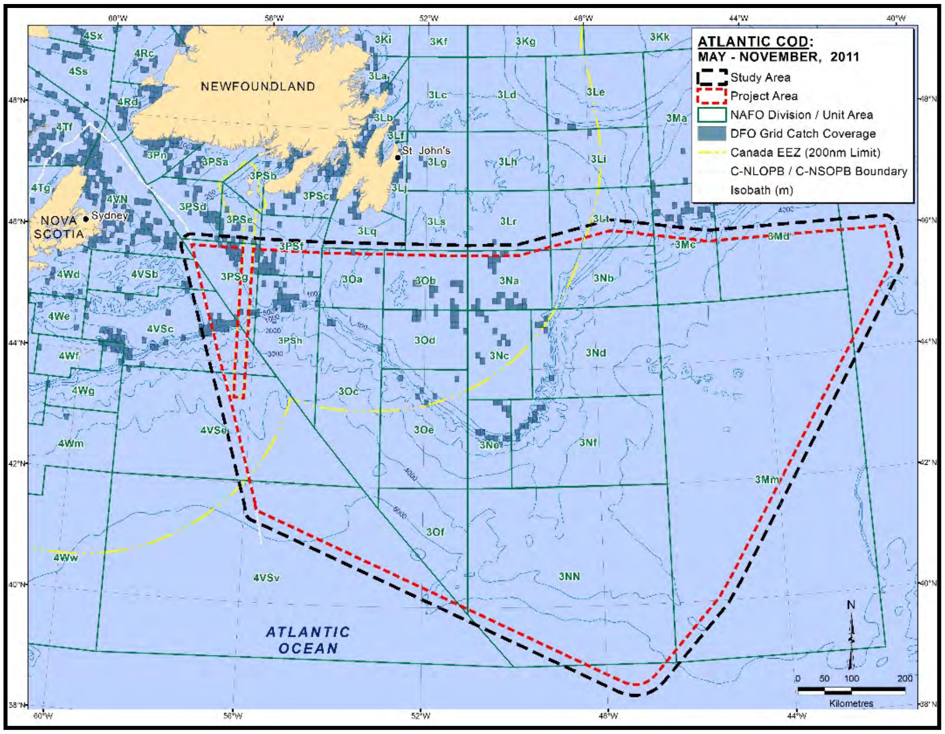
Source: DFO commercial landings database, 2005 to 2010.

Figure 4.29 Total Annual Catch Weights for Atlantic Cod in the Study Area, May to November, 2005-2010.



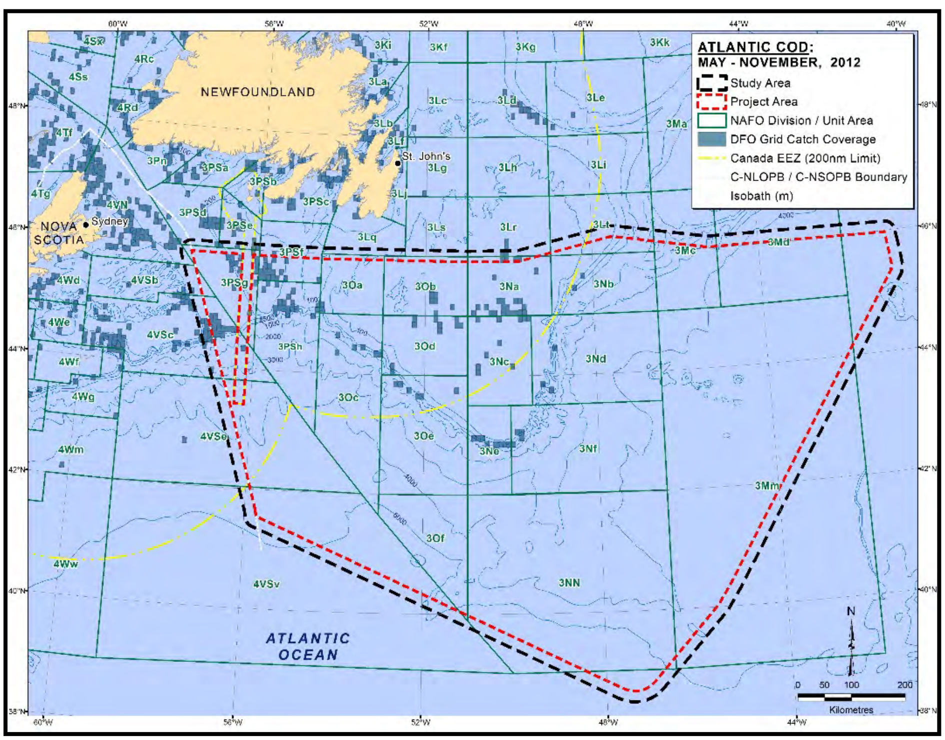
Source: DFO commercial landings database, 2005 to 2010.

Figure 4.30 Commercial Harvesting Locations forAtlantic Cod, May to November, 2005-2010.



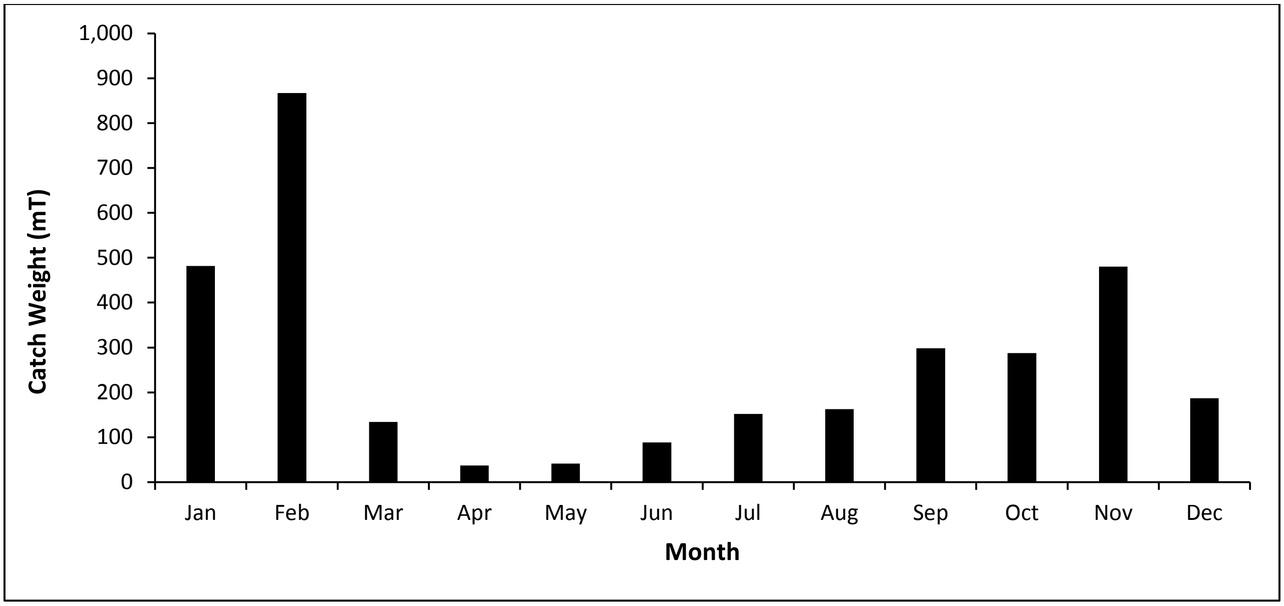
Source: DFO commercial landings database, 2011.

Figure 4.31 Commercial Harvesting Pattern for Atlantic Cod, May to November, 2011.



Source: DFO commercial landings database, 2012.

Figure 4.32 Commercial Harvesting Pattern for Atlantic Cod, May to November, 2012.



Source: DFO commercial landings database, 2005 to 2010.

Figure 4.33 Average Monthly Catch Weights for Atlantic Cod in the Study Area, 2005-2010.

4.3.4 Traditional and Aboriginal Fisheries

According to the Southern Newfoundland SEA (LGL 2010a), portions the Study Area waters are used by the Conne River Band Council (Miawpukek First Nation Government) for Food, Social and Ceremonial fisheries as well as Communal/Commercial fishing activities. Fish harvesting activities occur within NAFO Division 3Ps, in the same areas, during the same seasons and under the same regulations as those applicable to other non-Aboriginal fisheries in the region. These fishing activities are described in detail in Section 3.3.4 of the Southern Newfoundland SEA (LGL 2010a).

Information on Aboriginal fish harvesting activities in southern Newfoundland was collected by traditional knowledge interviews and during public consultation meetings for the Sydney Basin SEA (JW 2007), and consultations with the Conne River Band Council for the Southern Newfoundland SEA (LGL 2010a) indicated no changes in these activities.

4.3.5 Recreational Fisheries

In 2013, the recreational groundfish fishery will occur in all NAFO areas around Newfoundland and Labrador, including NAFO Divisions 2GH, 2J3KL, 3Ps, 3Pn and 4R (DFO 2013j). Of these NAFO areas, portions of 3L and 3Ps are within the Study Area. This fishery is largely conducted in inshore waters (LGL 2010a), and is open for three weeks in the summer beginning on the third Saturday of July and for eight days in the fall beginning on the third Saturday of September (dates are subject to change; effective for 2013 to 2015) (DFO 2013j). Species that are harvested recreationally typically include brown trout, Atlantic mackerel, squid, capelin, and Atlantic cod (C. Boland, DFO, pers. comm., 2009 *in* LGL 2010a). Management measures in place for 2013 to 2015 indicate there is no requirement for licences or tags for the recreational fisheries for these species (DFO 2013j). Scallops may also be harvested with a recreational license (LGL 2010a). Species harvested in the recreational fisheries are described in Sections 3.3.3.1 to 3.3.3.6 of the Southern Newfoundland SEA (LGL 2010a).

The retention of Atlantic halibut, spotted and northern wolfish, and any species of shark is prohibited in Newfoundland and Labrador recreational fisheries (DFO 2013j).

4.3.6 Aquaculture

Currently there are no approved aquaculture sites within the Study Area. Aquaculture does occur in the Coast of Bays region along the south coast of Newfoundland (spanning the north shore of Fortune Bay, Bay d'Espoir, and the Connaigre Peninsula), however this region is north of the Study Area.

4.3.7 Macroinvertebrates and Fishes Collected during DFO Research Vessel (RV) Surveys

DFO RV data collected during annual multi-species trawl surveys provide distributional information for species not discussed in the commercial fisheries as well as added information for commercial species.

Data collected during 2007 to 2011 spring and fall DFO RV surveys in the Study Area were analyzed, and catch weights and catch numbers of species/groups are presented in Table 4.4.

Deepwater redfish accounted for 46.2% of the total 2007 to 2011 catch weight, followed by yellowtail flounder (11.8%), American plaice (8.0%), thorny skate (6.2%), Atlantic cod (5.3%), sponges (2.5%), sea cucumber (*Cucumaria frondosa*) (2.2%), offshore sand lance (2.0%), silver hake (1.2%), capelin (1.1%), and witch flounder (1.0%). All other species/groups accounted for less than 1% of the total 2007-2011 catch weight in the Study Area. Principal species captured during the 2007 to 2011 DFO RV surveys were generally representative of predominant species targeted in the commercial fishery in recent years. The distribution of geo-referenced catch locations reported during the 2007 to 2011 DFO RV surveys within the Study Area are shown in Figure 4.34. Across all species caught during the 2007 to 2011 DFO RV surveys in the Study Area, total catch weight ranged from 108,230 kg in 2007 to 153,176 kg in 2009.

Spring (April to July) and fall (September to December) surveys each accounted for approximately half of the total catch weight. The average mean depths of catch during spring and fall surveys from 2007 to 2011 were 203 m (min: 35 m; max: 741 m) and 360 m (min: 38 m; max: 1,454 m), respectively. In descending order, the top five species/groups in terms of catch weight during the 2007-2011 spring surveys were deepwater redfish, yellowtail flounder, American plaice, Atlantic cod, and thorny skate. In descending order, the top five species/groups in terms of catch weight during the 2007-2011 fall surveys were deepwater redfish, yellowtail flounder, American plaice, thorny skate, and sponges.

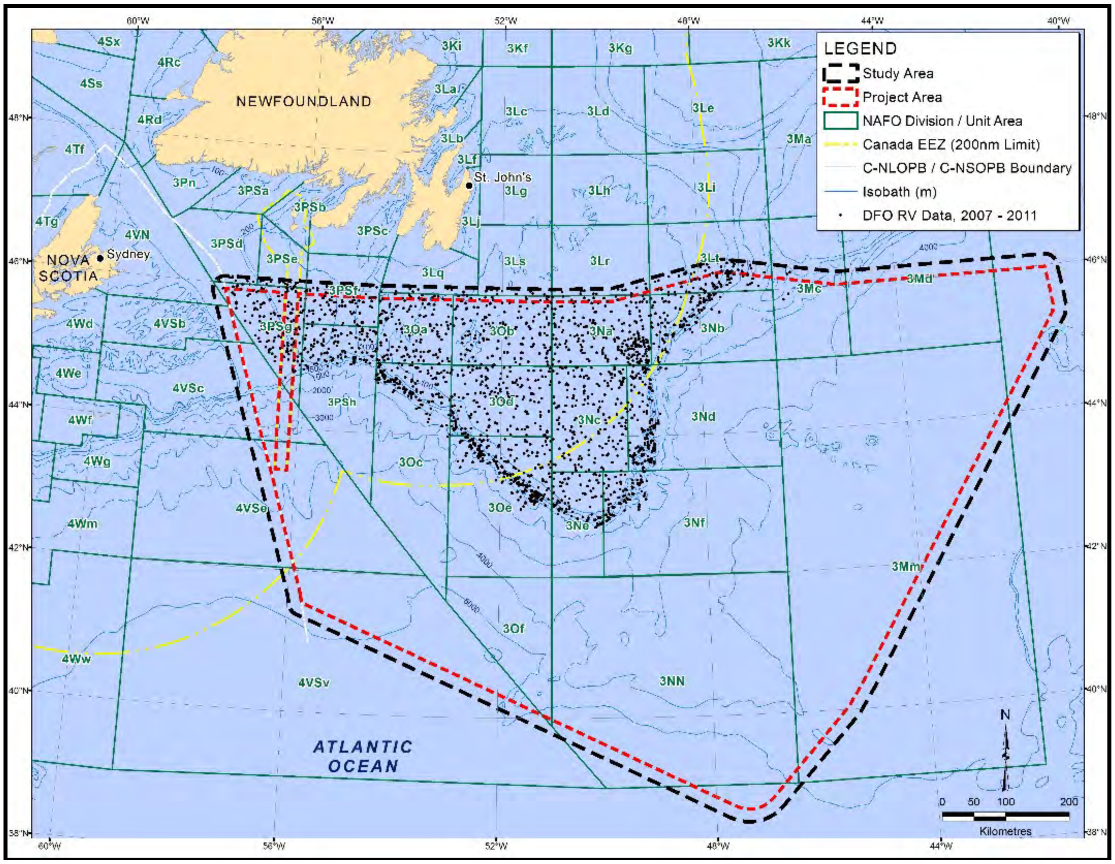
Species/groups that were caught predominantly during the spring RV surveys included various sea stars (i.e., *Ctenodiscus crispatus*, *Astropecten americanus*, *Psilaster Andromeda, Ctenodiscus* sp.), echinoids (*Brisaster fragilis*), sand dollars (*Echinarachnius parma*), sea anemones, tunicates, shrimp (*Sergestes arcticus*), winter (spotted) skate, Atlantic argentine, capelin, Atlantic herring, pollock, common lumpfish, and shorthorn sculpin. Species/groups that were caught in essentially equal amounts during both surveys included Atlantic halibut, offshore sand lance, witch flounder, cusk, spotted wolfish, American plaice, deepwater redfish, striped shrimp, and purple sun star. Species/groups that were caught predominantly during the fall RV surveys included sponges, squids (*Illex* sp.), Icelandic scallop, polar sea star, sunstar (*Crossaster papposus*), smoothheads, eelpout (*Lycodes* sp.), Jensen's skate, longnose and deepwater chimaeras, moustache sculpin, blue hake, roundnose grenadier, and black dogfish. The survey depth differences between spring and fall surveys likely account for some of the seasonal differences.

Table 4.4 Catch Weights and Numbers of Macroinvertebrate and Fish Species Collected during DFO RV Surveys within the Study Area, 2007-2011.

Species	Catch Weight (kg)	Catch Number
Deepwater Redfish (*Sebastes mentella*)	312,896	2,340,156
Yellowtail Flounder (*Limanda ferruginea*)	79,563	269,697
American Plaice (*Hippoglossoides platessoides*)	54,125	299,845
Thorny Skate (*Raja radiata*)	41,833	22,256
Atlantic Cod (*Gadus morhua*)	35,829	70,399
Sponges (Porifera)	17,184	n/d
Sea Cucumber (*Cucumaria frondosa*)	14,776	48,312
Offshore Sand Lance (*Ammodytes dubius*)	13,801	1,092,686
Silver Hake (*Merluccius bilinearis*)	8,321	69,747
Capelin (*Mallotus villosus*)	7,195	502,944
Witch Flounder (*Glyptocephalus cynoglossus*)	6,640	25,672
Roughhead Grenadier (*Macrourus berglax*)	6,320	11,672
Longfin Hake (*Urophycis chesteri*)	5,657	65,221
Greenland Halibut (*Reinhardtius hippoglossoides*)	5,245	9,207
White Hake (*Urophycis tenuis*)	4,186	3,959
Haddock (*Melanogrammus aeglefinus*)	3,499	8,098
Atlantic (Striped) Wolffish (*Anarhichas lupus*)	3,205	2,837
Polar Sea Star (*Leptasterias polaris*)	3,084	21,909
Marlin Spike (*Nezumia bairdi*)	2,532	45,575
Black Dogfish (*Centroscyllium fabricii*)	2,481	4,176
Snow Crab	2,075	12,816
Comb-jelly (Ctenophora)	2,075	10
Blue Hake (*Antimora rostrata*)	2,057	12,896
Longnose Eel (*Synaphobranchus kaupi*)	2,015	35,571
Monkfish (*Lophius americanus*)	1,895	482
Longhorn Sculpin (*Myoxocephalus octodecemspinosus*)	1,823	6,560
Sea Cucumber (Holothuroidea)	1,690	9,003
Atlantic Halibut (*Hippoglossus hippoglossus*)	1,637	146
Greenland Shark (*Somniosus microcephalus*)	1,550	2
Shorthorn Sculpin (*Myoxocephalus scorpius*)	1,488	2,683
Sea Raven (*Hemitripterus americanus*)	1,312	842
Sea Cucumber (Chiridotidae)	1,302	2,704
Scyphozoa (Jellyfish)	1,276	155
Sea Urcin (Echinoidea)	1,224	54,685
Invertebrates	1,037	n/d
Roundnose Grenadier (*Coryphaenoides rupestris*)	940	7,292
Tunicate (*Boltenia* sp.)	915	7,590
Atlantic Argentine (*Argentina silus*)	907	4,613
Shrimp (Natantia)	891	n/d
Northern Wolffish (*Anarhichas denticulatus*)	846	283
Brittle Star (Ophiuroidea)	803	24,132

Species	Catch Weight (kg)	Catch Number
Toad Crab (*Hyas* sp.)	732	52,413
Sea Anemones	717	32,853
Corals	716	n/d
Sand Sifting Sea Star (*Astropecten americanus*)	698	7,940
Mailed Sculpin (*Triglops* sp.)	681	71,492
Icelandic Scallop (*Chlamys islandica*)	679	8,924
Pollock (*Pollachius virens*)	676	209
Striped Shrimp (*Pandalus montagui*)	651	237,104
Arctic Eelpout (*Lycodes reticulatus*)	590	1,541
Spinytail Skate (*Raja* [*Bathyraja*] *spinicauda*)	532	53
Sea Urchin (Strongylocentrotidae)	470	11,784
Basket Star (Gorgonocephalidae)	459	87
Sand Dollar (*Echinarachnius parma*)	453	18,621
Vahl's Eelpout (*Lycodes vahlii*)	396	2,035
Moustache Sculpin (*Triglops murrayi*)	381	34,823
Sea Urchin (*Strongylocentrotus droebachiensis*)	362	21,804
Sea Star (*Ctenodiscus* sp.)	356	42,967
Spotted Wolffish (*Anarhichas minor*)	349	155
Sun Star (*Crossaster papposus*)	326	6,127
Smooth Skate (*Raja senta*)	310	732
Longnose Chimaera (*Harriotta raleighana*)	290	187
Spiny Crab (*Lithodes maja*)	275	530
Echinoid (*Brisaster fragilis*)	248	13,981
Smoothheads (Alepocephalidae)	237	689
Large Scale Tapirfish (*Notacanthus nasus*)	235	403
Sand Dollar (Clypeasteroida)	227	10,425
Sea Star (*Ctenodiscus crispatus*)	226	24,722
Atlantic Herring (*Clupea harrengus*)	215	1,301
Northern Shrimp	209	35,024
Jensen's Skate (*Raja jenseni*)	207	71
Squid (*Illex* sp.)	205	1,379
Tunicate (Ascidiacea)	194	5,321
Common Lumpfish (*Cyclopterus lumpus*)	189	62
Basket Star (*Gorgonocephalus arcticus*)	167	27
Eelpout (*Lycodes* sp.)	147	805
Brittle Star (*Ophiura sarsi*)	134	2,012
Shrimp (*Sergestes arcticus*)	129	143,286
Snake Blenny (*Lumpenus lumpretaeformis*)	125	4,336
Sea Star (*Psilaster andromeda*)	125	10,087
Winter (Spotted) Skate (*Raja ocellata*)	124	33
Purple Sun Star (*Solaster endeca*)	124	1,195
Atlantic Hagfish (*Myxine glutinosa*)	119	2,068
Sea Cucumber (*Psolus fabricii*)	113	524
Sea Star (Asteroidea)	110	2,820
Lanternfishes (Myctophidae)	109	25,529
Octopus (Octopoda)	109	760
Deepwater Chimaera (*Hydrolagus affinis*)	106	19
Cusk (*Brosme brosme*)	16	7
Total	**673,375**	**-**

Source: DFO RV Survey Data, 2007-2011.
Note: n/d denotes data unavailable.

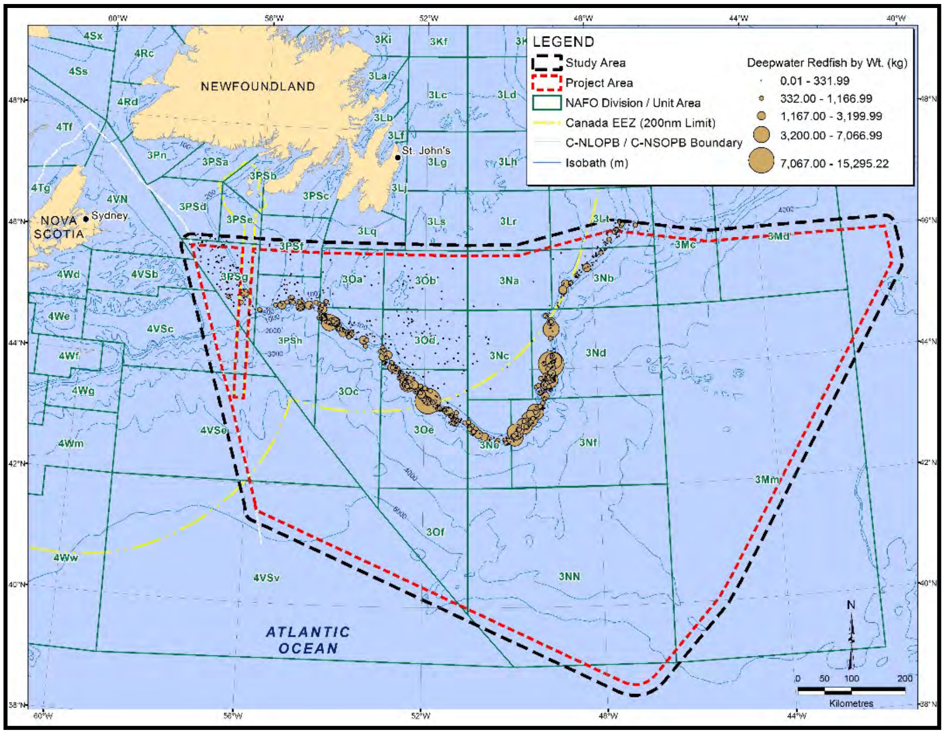


Source: DFO Research Vessel Survey Database, 2007 to 2011.

Figure 4.34 DFO RV Survey Catch Locations within the Study Area, 2007-2011.

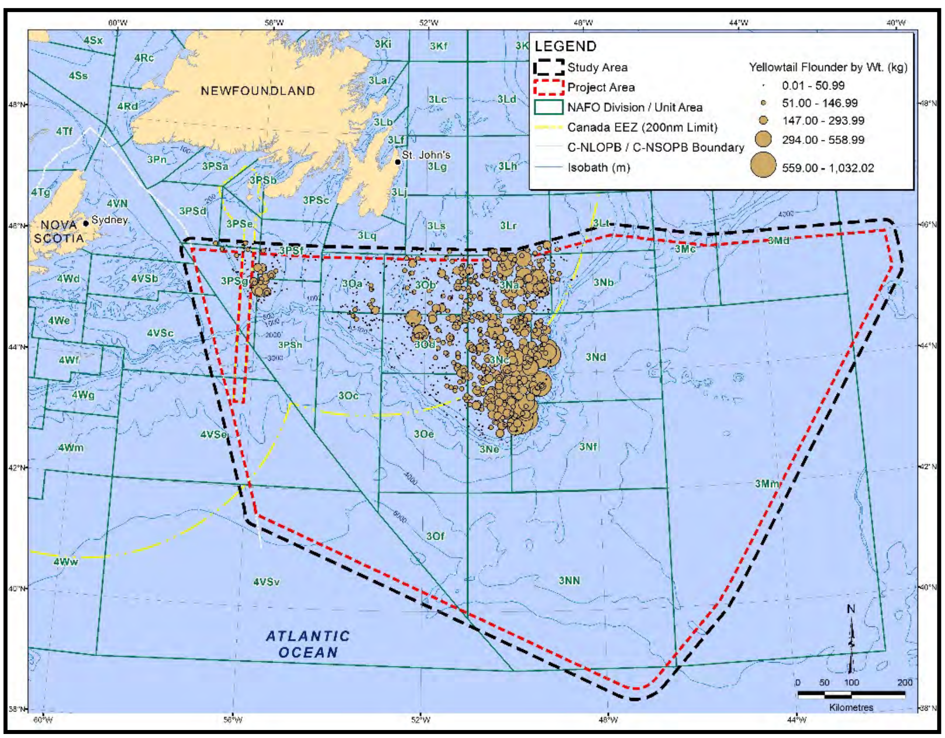
Figures 4.35 to 4.41 indicate DFO RV survey catch locations for deepwater redfish, yellowtail flounder, American plaice, thorny skate, Atlantic cod, sponges, corals, and wolffishes, respectively, during 2007 to 2011. The sizes of the circular symbols used in these figures are proportional to the catch weight range they represent for each species.

Catches at various mean depth ranges are also examined in this section. Table 4.5 presents total catch weights and predominant species caught within each mean depth range in the Study Area during the 2007 to 2011 period. Deepwater redfish was caught primarily at depths ranging from 200 to 500 m, yellowtail flounder, American plaice and thorny skate at depths <100 m, and Atlantic cod from <100 to 200 m.



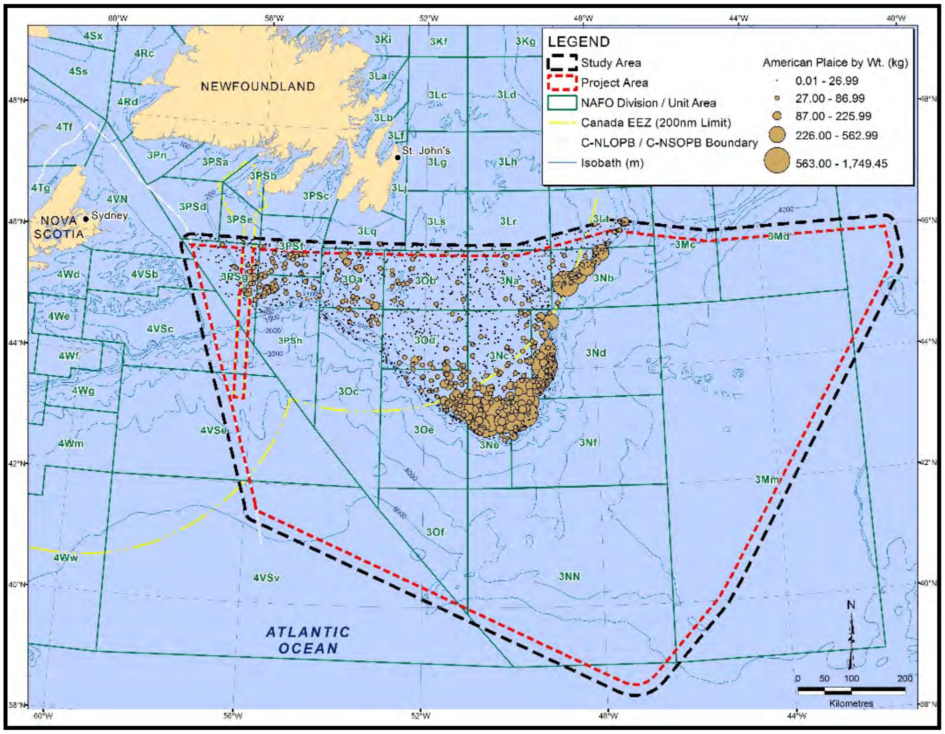
Source: DFO Research Vessel Survey Database, 2007 to 2011.

Figure 4.35 DFO RV Survey Deepwater Redfish Catch Locations in the Study Area, 2007-2011.



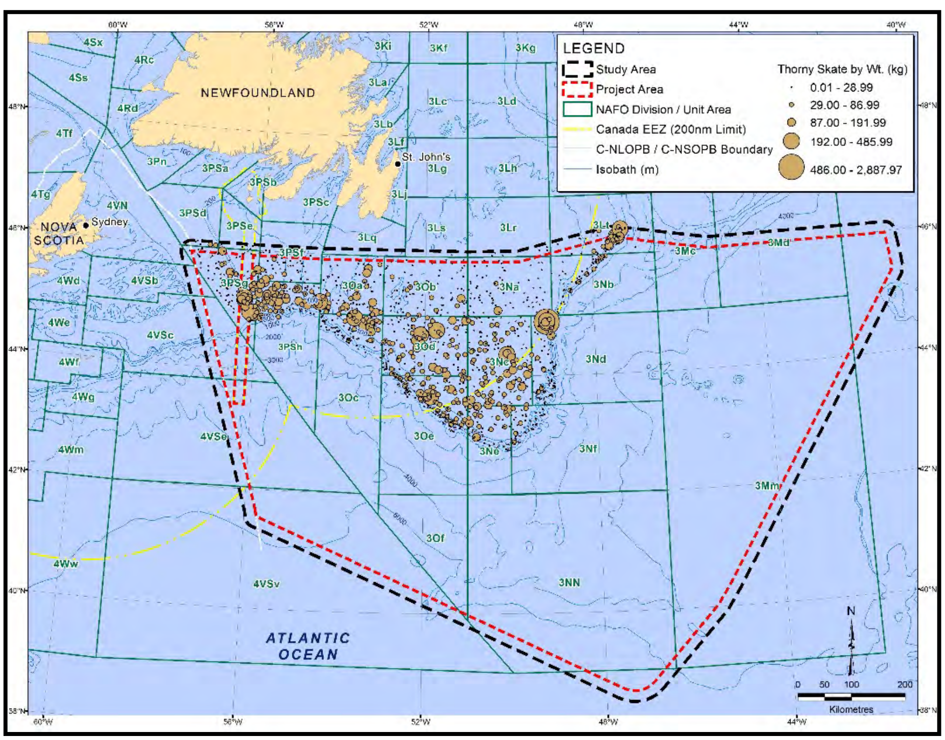
Source: DFO Research Vessel Survey Database, 2007 to 2011.

Figure 4.36 DFO RV Survey Yellowtail Flounder Catch Locations in the Study Area, 2007-2011.



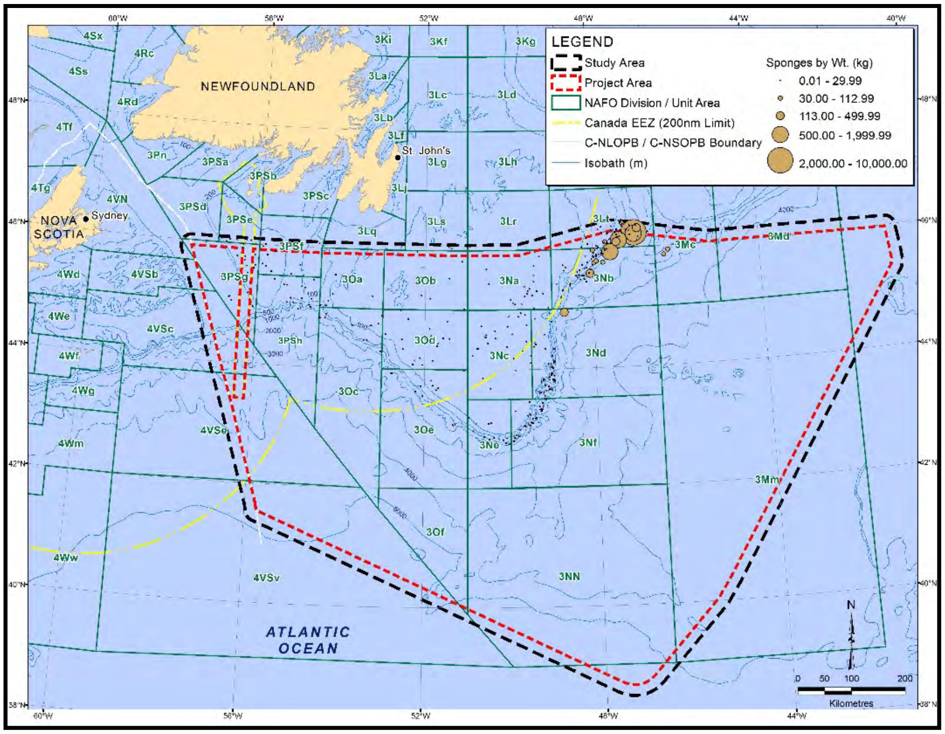
Source: DFO Research Vessel Survey Database, 2007 to 2011.

Figure 4.37 DFO RV Survey American Plaice Catch Locations in the Study Area, 2007-2011.



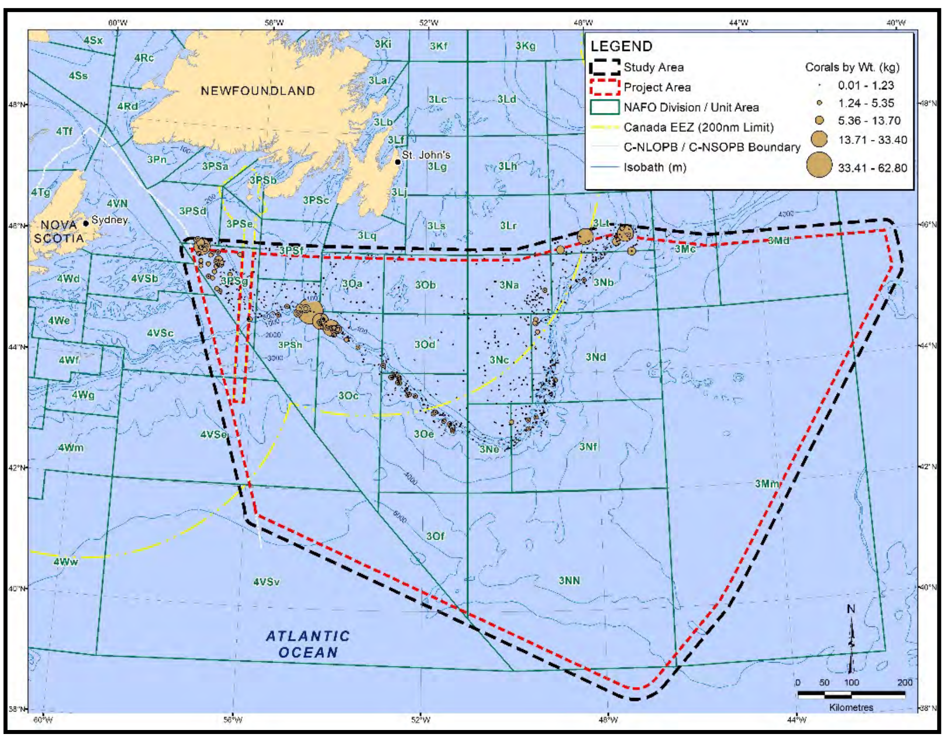
Source: DFO Research Vessel Survey Database, 2007 to 2011.

Figure 4.38 DFO RV Survey Thorny Skate Catch Locations in the Study Area, 2007-2011.



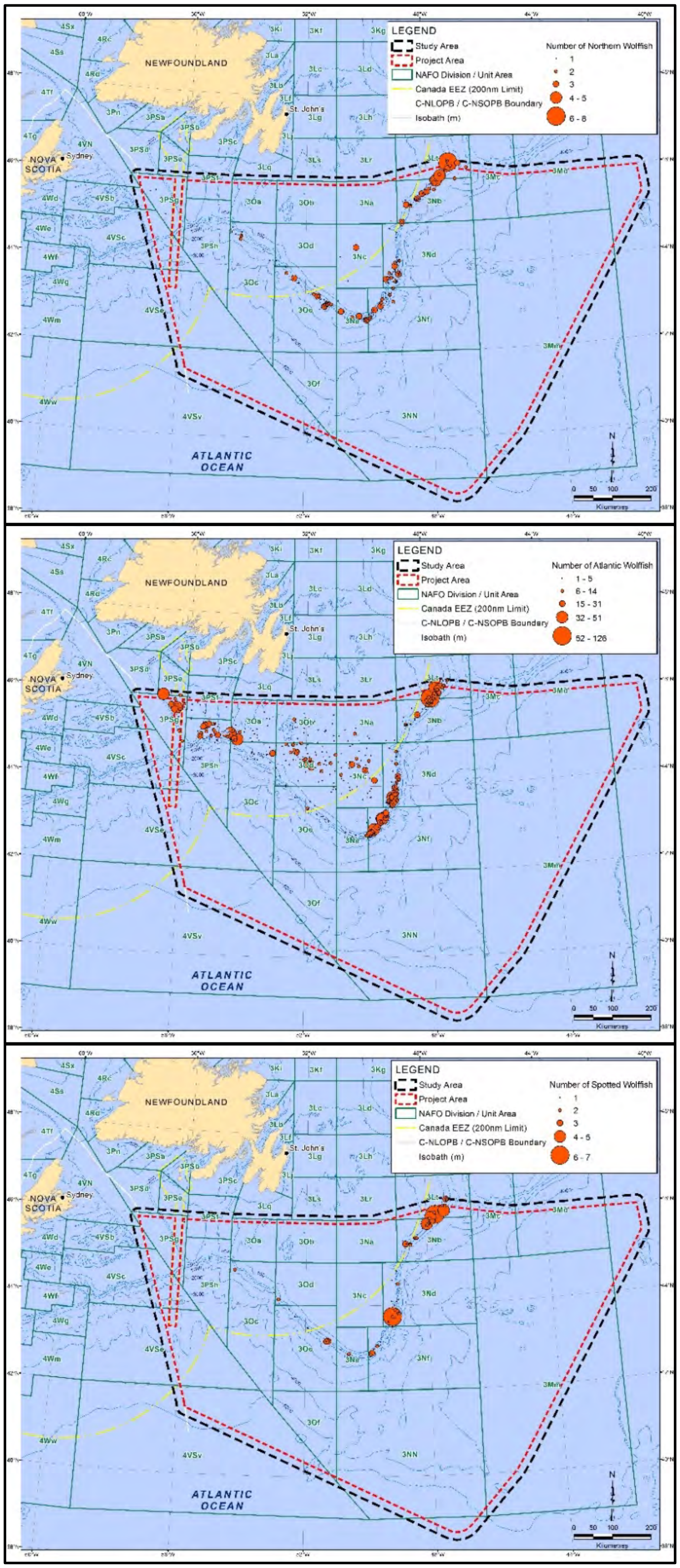
Source: DFO Research Vessel Survey Database, 2007 to 2011.

Figure 4.39 DFO RV Survey Sponge Catch Locations in the Study Area, 2007-2011.



Source: DFO Research Vessel Survey Database, 2007 to 2011.

Figure 4.40 DFO RV Survey Coral Catch Locations in the Study Area, 2007-2011.



Source: DFO Research Vessel Survey Database, 2007 to 2011.

Figure 4.41 DFO RV Survey Northern (top), Atlantic (middle), and Spotted (bottom) Wolffish Catch Locations within the Study Area, 2007-2011.

Table 4.5 Total Catch Weights and Predominant Species Caught at Various Mean Catch Depth Ranges, DFO RV Surveys, 2007-2011.

Mean Catch Depth Range	Total Catch Weight (kg)	Predominant Species
<100	129,803	Yellowtail Flounder (61%) Sea Cucumber (*Cucumaria frondosa*; 11%) Offshore Sand Lance (11%)
≥100 - <200	150,287	American Plaice (36%) Thorny Skate (28%) Atlantic Cod (24%)
≥200 - <300	32,471	Silver Hake (26%) Witch Flounder (20%) White Hake (13%) Monkfish (6%) Atlantic Halibut (5%)
≥300 - <400	335,249	Deepwater Redfish (93%) Sponges (5%)
≥ 400 - <500	13,574	Longfin Hake (42%) Greenland Halibut (39%)
≥500 - <600	10,842	Roughhead Grenadier (58%) Marlin Spike (23%) Scyphozoa (Jelly-fish; 12%)
≥600 - <700	4,105	Longnose Eel (49%) Greenland Shark (38%)
≥700 - <800	403	Large Scale Tapirfish (58%) Shrimp (*Acanthephyra pelagica*; 12%) Threebeard Rockling (10%)
≥800 - <900	5,544	Black Dogfish (45%) Bivalve (*Corbula contracta*; 37%)
≥900 - <1,000	154	Snubnose Eels (Simenchelydae; 21%) Blacksmelt (*Bathylagus euryops*; 20%) Shortnose Snipe Eel (14%) Smoothhead (*Alepocephalus agassizii*; 13%) Scopelosaurus (Scopelosauridae; 12%)
≥1,000	1,215	Longnose Chimaera (24%) Smoothheads (Alepocephalidae; 20%) Jensen's Skate (17%) Deepwater Chimaera (9%) Deepsea Cat Shark (8%)

Source: DFO Research Vessel Survey Database, 2007-2011.

4.3.7.1 Other Information

- RV Data (2007 to 2011):
  - On average (based on catch weight): Fish (91.3%), Invertebrates (8.6%), Corals (0.1%)
    - Greatest catch in 2009; driven by higher Atlantic cod and sponge catches than other survey years
  - Percent Total (based on catch weight): Spring (50.8%), Fall (49.2%)
  - Coral Mean Depth: Summer (307 m), Fall (566 m)
  - Sponge Mean Depth: Summer (253 m), Fall (408 m)

4.3.8 Industry and DFO Science Surveys

Fisheries research surveys conducted by DFO, and sometimes by the fishing industry, are important to the commercial fisheries to determine stock status, as well as for scientific investigation. In any year, there may be overlap between the Study Area and DFO research surveys in NAFO Divisions 3L, 3M, 3N, 3O, 3Ps and 4Vs, depending on the timing in a particular year.

The Groundfish Enterprise Allocation Council (GEAC) has been involved in conducting fisheries research, including multispecies surveys (target Atlantic cod, American plaice, witch flounder and haddock) in NAFO Division 3Ps (fall 1997 to 2005, and 2007) (McClintock 2007, 2011), and redfish surveys in Unit 2, 3Pn, 3Ps, 4Vn and 4Vs (winter 1997; summer 1998 to 2001, 2003, 2005, and 2007) (McClintock and Teasdale 2009). In 2007, the multispecies trawl survey was completed in 15 days from late November to mid-December (McClintock 2011). Previous multispecies surveys were also conducted during this time of year, however there were fewer stations and they were generally completed in 12 days (LGL 2009a; McClintock 2011). Most of the multispecies survey locations were within the Study Area (see Figures 1 and 2 in McClintock 2011). Similar to previous survey years, in 2007 the majority of cod, American plaice, witch flounder and haddock were primarily located at the southern entrance to the Halibut Channel (McClintock 2007, 2011), located between St. Pierre Bank and Green Bank in the northwest portion of the Study Area. In 2007, the redfish survey similarly included more trawl sets than previous surveys, and was completed in 18 days; this survey was conducted later than in previous years (late September to early October, versus mid-August to mid-September, respectively). Many redfish survey locations were within the Study Area (see Figure 1a in McClintock and Teasdale 2009). Overall redfish numbers and biomass were reduced in 2007 compared to several previous surveys, with the exception of 3Ps which saw an increase; the majority of the redfish population consisted of *Sebastes fasciatus*, followed by *S. mentella* and heterozygotes (McClintock and Teasdale 2009).

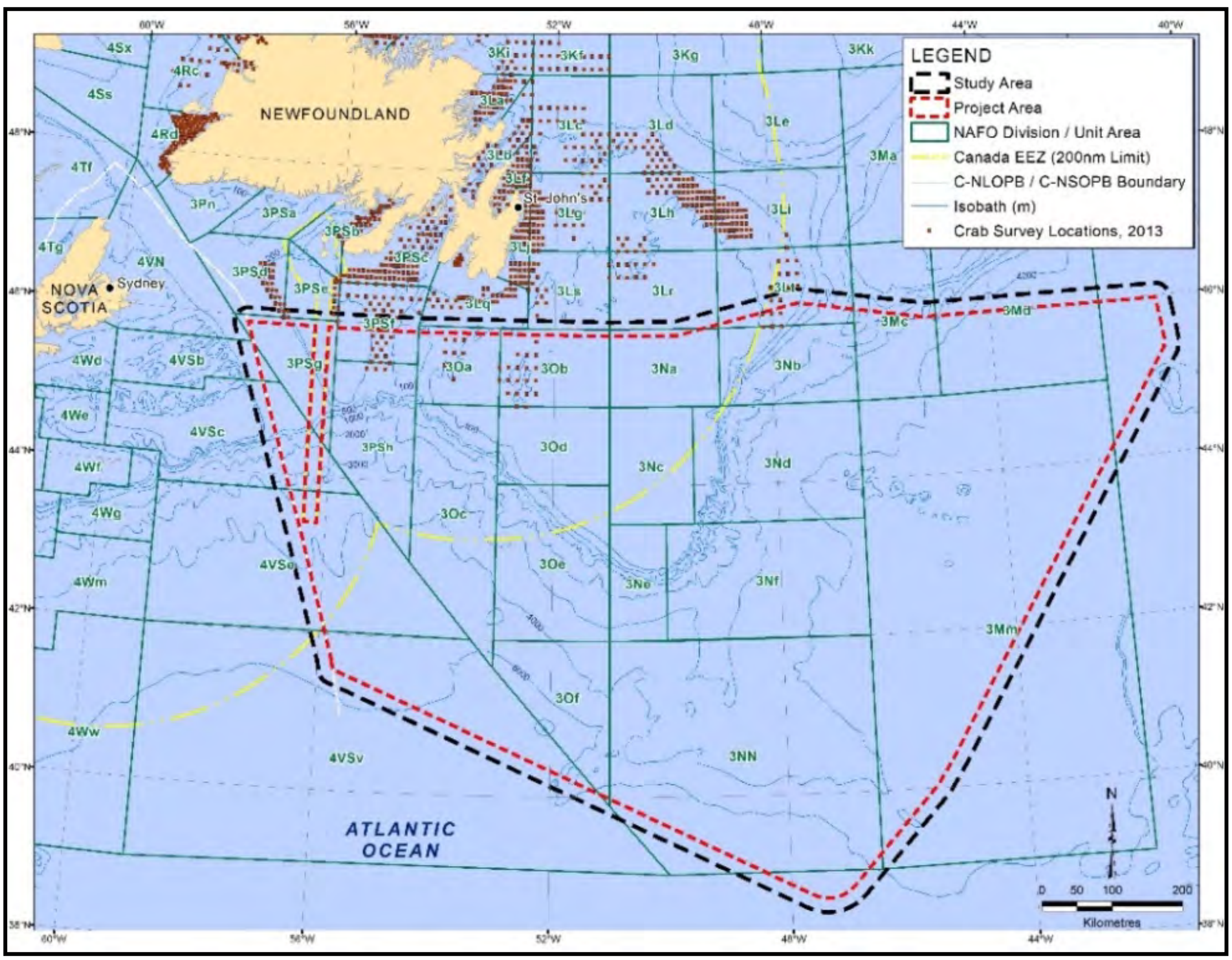
The tentative schedule of DFO RV surveys in the Study Area in 2014 is indicated in the following table (Table 4.6). Spring surveys are currently to begin during the last week in March 2014, and continue into mid-June (G. Sheppard, DFO, pers. comm., 2014). Based on recent survey years, DFO fall research surveys are likely to occur in the Study area for the latter part of September, most or all of October and November, and a small portion of early December.

Members of the FFAW have been involved in a DFO-industry collaborative post-season snow crab trap survey for a number of years. This survey, which is conducted every year, typically starts around September 1 and may continue until November before completion. The set locations are determined by DFO and do not change from year to year. Several of the southern stations fall within northern portions of the Study Area. Research station locations in relation to the Study Area are shown in Figure 4.42.

Table 4.6 Tentative Schedule of DFO Research Vessel Surveys in the Study Area, 2014.

NAFO Division	Start Date	End Date	Vessel
3P	28 March	31 March	*Needler*
3P	02 April	15 April	*Needler*
3L	06 April	10 April	*Teleost*
3P + 3KLMNO	11 April	29 April	*Teleost*
3P + 3O	16 April	29 April	*Needler*
2J + 3KL	30 April	09 May	*Teleost*
3O + 3N	30 April	14 May	*Needler*
3KL	10 May	27 May	*Teleost*
3L + 3N	15 May	27 May	*Needler*
3L	28 May	16 June	*Needler*
3O + 3N	17 September	30 September	*Needler*
3O + 3N	01 October	14 October	*Needler*
3N + 3L	15 October	28 October	*Needler*
3L	29 October	11 November	*Needler*
3K + 3L	12 November	25 November	*Needler*
3K +3L Deep	25 November	09 December	*Teleost*

Start/end dates subject to change as trip plans are finalized.



Source: DFO 2013.

Figure 4.42 Locations of DFO-Industry Collaborative Post-Season Snow Crab Trap Survey Stations in Relation to the Project and Study Areas.

4.4 Seabirds

4.4.1 Background

The occurrence of seabirds in the Study Area is influenced greatly by the substantial portion of the area that is the Grand Banks and its associated slope waters. The highly productive Grand Banks supports large numbers of seabirds at all times of the year (Lock et al. 1994). Seabirds tend to concentrate over oceanographic features such as continental shelf edges and convergences of warm and cold currents, both of which occur in the Study Area. The upwelling of cold water brings mineral nutrients to the surface, allowing high phytoplankton productivity, which forms the basis for increased productivity at higher trophic levels (such as seabirds). Part of the Study Area is located on the edge of the Grand Banks where it begins to slope into the deep waters beyond the continental shelf. The major flow of the Labrador Current flows south along the outer edge of the Grand Bank. An inshore branch flows westward along the south coast of Newfoundland (Lock et al. 1994). Seabirds also concentrate at fish spawning areas, such as the inshore waters of Newfoundland and the Southeast Shoal, both of which are areas where capelin spawn in great numbers.

The Study Area supports seabirds from not only Newfoundland, but from areas around the northern and southern Atlantic Ocean, and Arctic Ocean. During spring and summer, several million pelagic seabirds concentrate inshore near the Study Area at large nesting colonies on islands and headlands. Nearshore concentrations of spawning fish such as capelin and herring attract numerous seabirds as well. The number and species diversity of these nesting and feeding seabirds is particularly high on the Avalon Peninsula. During summer, large numbers of Great and Sooty shearwaters from the southern Atlantic use the continental shelf, shelf break, and Placentia Bay as do many non-breeding local seabirds. In autumn, tens of thousands of adults and young from the nearby Newfoundland coastal nesting colonies shift offshore to forage. Their numbers are enhanced by the probable few million more seabirds that arrive from nesting colonies in the Canadian and European arctic and Greenland to winter inshore and offshore on the continental shelf and shelf break in the Study Area.

Leach's Storm-Petrel, Northern Gannet, cormorants, gulls, terns, murres, Razorbill, Black Guillemot, and Atlantic Puffin are common nesting seabirds concentrated in several colonies in or near the Study Area, especially around the Avalon Peninsula. All of these birds feed on the Grand Banks during the nesting season from May to September. Some may reach the Southwest Grand Banks during the breeding season. Egg-laying for most species commences in mid to late May and into June; most species are fledged by July or August, with Northern Gannets fledging into October and November.

The only seabird species at risk with a possibility of occurrence in the Study Area is the Ivory Gull. The Ivory Gull was designated as an *endangered* species by COSEWIC in April 2006 and has *endangered* status under *SARA* Schedule 1. However, its occurrence in the Study Area would be outside of the May-November temporal scope of the EA. The highest probability of Ivory Gull occurrence is in the extreme northwest corner of the Study Area (ice from the Gulf of St. Lawrence) during February to April. Considering this, Ivory Gull is not included in Section 4.6 on the Species at Risk VEC.

The following sections describe in more detail the species and their patterns of abundance and distribution in the Study Area. The Study Area is well offshore and distant from coastal Newfoundland. Consequently, this section includes only those species of birds that are expected to use the offshore. Strictly coastal species (e.g., cormorants, waterfowl, shorebirds) will not be affected by the proposed seismic program and thus are not addressed here. Information on nesting colonies is provided but not highlighted because the program will not affect colonies directly either.

4.4.2 Information Sources

The seabird information presented here is based primarily on the Southern Newfoundland SEA (LGL 2010a). The SEA summarized data on the offshore occurrence of seabirds for a smaller study area that comprises roughly the western half of the MKI Study Area. However, the SAE maps provide coverage of the larger MKI Study Area, which extends farther eastward into deeper waters off the continental shelf. Please refer to the SEA for details regarding offshore densities of seabirds, and maps of offshore distribution. More recent literature has been used to update the SEA where relevant.

The state of knowledge has not advanced substantially since the SEA was prepared. However, much of the offshore distribution data contained in the SEA, incorporating recent surveys by the Canadian Wildlife Service and industry through the Eastern Canada Seabirds At Sea (ECSAS) program, is now published and available in Fifield et al. (2009). As stated in the SEA, knowledge of the offshore distribution and abundance of seabirds in this area is still incomplete. There are gaps in the data that are geographic, seasonal, temporal, and statistical. There are portions of the SEA Area that have never been surveyed for seabird distribution. Among areas that have been surveyed, many have not been surveyed in all four seasons of the year. Data summarized in Lock et al. (1994) from some areas may not accurately represent current conditions because those data date from 1976 to the mid-1980s. Lastly, within many subdivisions of the SEA Area, the survey effort, as measured by the number of 10-minute seabird watches, has been low. Without a sufficient number of watches, the full range of environmental conditions and other biases have not been sampled. As a result, there is uncertainty about whether data from such an area accurately represent its bird distribution and abundance.

Some seabird nesting colonies have been re-surveyed since the SEA and that information has been incorporated here. Also, recent tracking studies have revealed connections between specific seabird nesting colonies and the Study Area.

4.4.3 Geographic and Seasonal Distribution

As expected, the composition, distribution and size of the seabird population in the Study Area vary geographically and seasonally in response to the nesting cycle, prey distribution, and other factors. Regardless, the Study Area supports large number of seabirds throughout the year. During the winter, Northern Fulmars, Black-legged Kittiwakes, Glaucous Gulls, Thick-billed Murres and Dovekies from breeding colonies in the Arctic live in offshore waters south of the ice edge (Lock et al. 1994). During the nesting season, many adult seabirds are closer to shore at and near nesting colonies, but the immature non-breeding cohorts are present offshore and in adjacent waters. Great Shearwater, Sooty Shearwater, Wilson's Storm-Petrel, and South Polar Skua nest in the South Atlantic during the northern hemisphere winter and are present in waters of Newfoundland and Labrador and Nova Scotia during the summer (June to October). Great Shearwater is particularly abundant in the Study Area because most of this species' population spends the austral winter in Newfoundland waters. Other arctic-nesting species (e.g., jaegers, phalaropes, and Arctic Tern) pass through the Study Area during spring and autumn migration.

The seasonal occurrence of these seabirds in the Study Area is summarized in Figure 3.6 of JWEL (2003) and Table 4.7 of this report. A listing of the principal nesting colonies near the Study Area is provided in Table 4.8 with their locations mapped in Figure 4.43.

4.4.3.1 Overall Pelagic Seabird Distribution and Abundance

Winter (November–February)

Pelagic seabird abundance (all species combined) in most of the 1-degree blocks in the Study Area during November through February, as derived from the ECSAS database (Fifield et al. 2009), fell in the range of 2–30 birds/km^2. The highest densities were found over the Grand Banks, Green Bank, St. Pierre Bank, and Laurentian Channel and the lowest densities were beyond the shelf slope in deeper waters (Fifield et al. 2009). The most abundant species/groups were Northern Fulmar, Black-legged Kittiwake, Dovekie, and murres.

Spring (March–April)

Seabird densities in the Study Area during spring were notably higher than during winter. Densities were in the range of 1–100 birds/km^2, with many 1-degree blocks having densities of >10 birds/km^2 (Fifield et al. 2009). Densities were highest over the Tail of the Grand Banks and west along the shelf edge to the Laurentian Channel. The seabird community was gradually changing; some of the overwintering species (e.g., Northern Fulmar, Dovekie, murres) were still abundant while other groups (e.g., Black-legged Kittiwake and other gulls) were increasing in abundance.

Summer (May–August)

Seabird densities were relatively high throughout the Study Area during the summer months (Fifield et al. 2009). They ranged from approximately 4 birds/km^2 to >20 birds/km^2. No one species or group was notably more abundant than others in the offshore waters of the Study Area, except for murres. During monitoring of ConocoPhillips' 2005 seismic program in the Laurentian Sub-basin, seabird abundance and distribution were sampled during a total of 837 10-minute counts conducted from 16 June to 29 September (Moulton et al. 2006a). Twenty-eight species of seabirds were recorded.

The average density of all species combined per month varied from 5.6 birds/km^2 in June to 10.51 birds/km^2 in August. Density was highest in July and August owing to the large numbers of Leach's Storm-Petrels. Average densities tended to be lowest in the deepest water off the continental shelf.

Table 4.7 Monthly Relative Abundance of Seabird Species with Reasonable Likelihood of Occurrence in the Study Area.

Common Name	Scientific Name	Monthly Abundance											
		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Procellariidae													
Northern Fulmar	*Fulmarus glacialis*	U-C	U-C	U-C	U-C	U-C	S-U	S-U	S-U	U-C	U-C	U-C	U-C
Cory’s Shearwater	*Calonectris diomedea*							S	S	S			
Great Shearwater	*Puffinus gravis*					S	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	VS	VS		
Hydrobatidae													
Leach's Storm-Petrel	*Oceanodroma leucorhoa*				S-U	S-U	S-C	S-C	S-C	S-C	S-U	S	
Wilson's Storm-Petrel	*Oceanites oceanicus*						S	S	S	S			
Sulidae													
Northern Gannet	*Morus bassanus*				S	S	S	S	S	S	S		
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*	S-U	S-U	VS-S	VS-S	VS-S	VS-S	VS-S	VS-S	S-U	S-U	S-U	S-U
Iceland Gull	*Larus glaucoides*	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	VS-S	VS-S	VS-S	VS-S	VS-S	U	U	U	U	U
Black-legged Kittiwake	*Rissa tridactyla*	U-C	U-C	U-C	U-C	S-U	S-U	S-U	S-U	S-U	U-C	U-C	U-C
Arctic Tern	*Sterna paradisaea*					S	S	S	S	S			
Stercorariidae													
Great Skua	*Stercorarius skua*					VS	VS	VS	VS	S	S		
South Polar Skua	*Stercorarius maccormicki*					VS	S	S	S	S	S		
Pomarine Jaeger	*Stercorarius pomarinus*					S-U	S	VS	VS	S-U	S		
Parasitic Jaeger	*Stercorarius parasiticus*					S-U	S	VS	VS	S-U	S		
Long-tailed Jaeger	*Stercorarius longicaudus*					S-U	S	S-C	S-U	S-U			
Alcidae													
Dovekie	*Alle alle*	U-C	U-C	U-C	U-C	S	VS	VS	VS	S	C	C	U-C
Common Murre	*Uria aalge*	S-U	S-U	S-U	S-U	S	S	S	S	S	S-U	S-U	S-U
Thick-billed Murre	*Uria lomvia*	U-C	U-C	U-C	U-C	VS-S	VS-S	VS-S	VS-S	VS-S	U-C	U-C	U-C
Razorbill	*Alca torda*				S	S	S	S	S	S	S	S	
Atlantic Puffin	*Fratercula arctica*				S-U	S	S	S	S	S-U	S-U	S-U	

Notes: This is neither a comprehensive list of all species known to have occurred in the Study Area, nor of all records of the listed species in the Study Area. The purpose of this table is to show the principal periods during which these species occur. Sources: Brown (1986); Lock et al. (1994); Baillie et al. (2005); Moulton et al. (2005, 2006); Lang et al. (2006); Lang and Moulton (2008); Abgrall et al. (2008a); Fifield et al. (2009). C = Common, present daily in moderate to high numbers; U = Uncommon, present daily in small numbers; S = Scarce, present, regular in very small numbers; VS = Very Scarce, very few individuals or absent. Blank spaces indicate not expected to occur in that month, or to occur rarely.

Table 4.8 Estimated Numbers of Pairs of Colonial Seabirds Nesting at Important Bird Areas (IBAs) and other Important Sites (not designated IBAs) along Newfoundland's South Coast.

Species	Witless Bay Islands IBA[m]	Mistaken Point IBA[m]	Western Head	Cape St. Mary's IBA[m]	Corbin Island IBA	Middle Lawn Island IBA	Green Island IBA	Grand Colombier Island IBA	Miquelon Cape IBA	Penguin Islands	Ramea Colombier Island
Northern Fulmar	22[a,d]			Present[a]	-	-	-				
Manx Shearwater	-			-	-	7[i]	-				
Leach's Storm-Petrel	667,086[f,g,h]			-	100,000[h]	13,879[f]	103,833[b]	363,787[o]		100[h]	1000[h]
Northern Gannet	-			14,789[k]	-	-	-				
Herring Gull	4638[c,h]		100[h]	Present[h]	5000[h]	20[h]	Present[j]	60-100[p]	265[h]		
Great Black-backed Gull	166[c,h]		15[h]	Present[h]	25[h]	6[h]	-	10-20[p]			Present[h]
Black-legged Kittiwake	23,606[d,h]	4750[l]	1100[h]	10,000[h]	50[h]	-	-	196[p]	2415[h]		Present[k]
Arctic and Common Terns	-			-	-	-	Breeding[j]			Present[n]	<100[h]
Common Murre	83,001[d,h]	~ 100[l]	27[h]	15,484[k]	-	-	-	>3[p]			
Thick-billed Murre	600[h]			1000[h]	-	-	-				
Razorbill	676[d,h]	Present[l]	7[h]	100[h]	-	-	-	>50[p]			
Black Guillemot	20+[h]	Present[l]	20[h]	Present[h]	-	-	-	>46[p]	Present[h]		
Atlantic Puffin	272,729[d,e,h]	50[h]		-	-	-	-	9543[p]			75[h]
TOTALS	**1,052,544**	**>4900**	**1269**	**>41,373**	**105,075**	**13,912**	**>103,833**	**>373,695**	**>2680**	**>100**	**~1100**

Sources: [a] Stenhouse and Montevecchi (1999a); [b] Russell (2008); [c] Robertson et al. (2001) *in* Robertson et al (2004); [d] Robertson et al. (2004); [e] Rodway et al. (2003) *in* Robertson et al. (2004); [f] Robertson et al. (2002); [g] Stenhouse et al (2000); [h] Cairns et al. (1989); [i] Fraser et al. (2013), [j] www.ibacanada.ca; [k] CWS (unpubl. data) ; [l] Parks and Natural Areas (unpubl. data) ; [m] provincial Ecological Reserve; [n] Lock et al. (1994); [o] Lormée et al. (2012); [p] Lormée et al. (2008) as cited in Lormée et al. (2012).

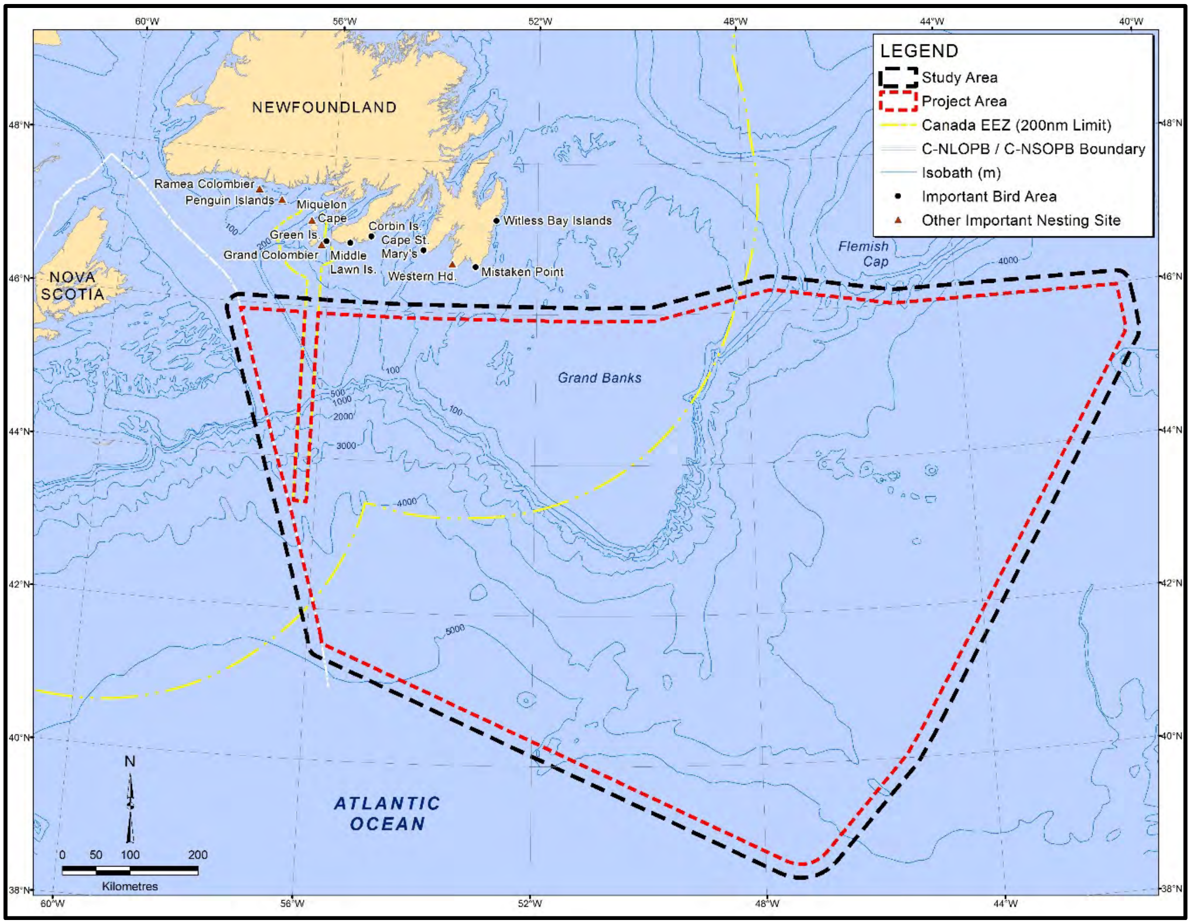


Figure 4.43 Locations of Important Coastal Nesting Sites for Seabirds within and adjacent to the Study Area.

Fall (September–October)

Seabird densities were at comparatively moderate levels in the Study Area during September and October, although many 1-degree blocks on the Grand Banks were not surveyed so there are gaps in the coverage (Fifield et al. 2009). Densities in those blocks that were surveyed were in the range of 2.4-21.9 birds/km^2. Shearwaters were comparatively abundant (compared to other species/groups) along the shelf edge.

4.4.3.2 Northern Fulmar

Northern Fulmar is present in the Study Area year-round, but is most abundant during winter when birds arrive from Arctic nesting colonies and supplement the non-breeding sub-adults that use the Study Area during the summer. Few fulmar nest around Newfoundland (Hatch and Nettleship 1998).

The ECSAS data show that Northern Fulmar abundance in the Study Area was not uniform during winter. Densities per 1-degree block ranged from 0 birds/km^2 on parts of the Grand Banks, to 17.2 birds/km^2 along the Laurentian Channel (Fifield et al. 2009). Survey coverage in the eastern portion of the Study Area, in the deeper waters beyond the shelf edge, was limited. Densities on most surveyed 1-degree blocks over the Grand Bank were <1.0 birds/km^2. Densities were generally higher throughout the Study Area during March through April, with the highest densities over the Tail and Nose of the Grand Banks and southern Flemish Cap (Fifield et al. 2009). Densities were notably lower (<1.0 birds/km^2) close to shore. Many fulmars moved north, to waters offshore Labrador, during the summer months (May–August). Relatively few birds were found in the Study Area; densities were generally <0.5 birds/km^2. In the fall, no fulmar were observed in many blocks; the highest densities in the Study Area were near the Laurentian Channel and along the eastern edge of the Grand Banks, but were all <10 birds/km^2. Moulton et al. (2006a) recorded fulmar densities ranging from 0.02 birds/km^2 in August to 0.99 birds/km^2 in September in the Laurentian Sub-basin in 2005.

4.4.3.3 Shearwaters

Four species of shearwaters are of regular annual occurrence in the Study Area. In decreasing order of abundance, they are — Great, Sooty, Manx, and Cory's shearwaters. Manx and Cory's shearwaters are of scarce to very scarce status in the Study Area (Table 4.7). Manx Shearwaters nest in very low numbers near the Study Area on Middle Lawn Island (Table 4.8; Fraser et al. 2013). As a group, shearwaters are known to occur in the Study Area during all seasons (Fifield et al. 2009). However, they are by far most abundant during the summer months. During that period a significant percentage of the total world population of Great Shearwater (five million), and significant numbers of Sooty Shearwater, migrate to eastern Newfoundland in late May, particularly the Grand Banks, for the annual moult in June and July, and departs in September to October (Lock et al. 1994).

Shearwaters were recorded in few 1-degree blocks in the Study Area during winter (Fifield et al. 2009). During spring (March and April), shearwaters were widely distributed on the Grand Banks where densities ranged up to 6.30 birds/km^2. The numbers of shearwaters in the Study Area increase dramatically in the summer, particularly over the St. Pierre Bank and Laurentian Channel (average density approximately 5 birds/km^2). However, survey coverage was incomplete over the Grand Banks and deeper off-shelf waters to the east so densities may have been high there as well (Fifield et al. 2009). Shearwaters appeared to be unevenly distributed during September and October in the Study Area, with the highest densities occurring along the shelf edge to the west of the Grand Banks but very low densities along the Tail of the Bank.

4.4.3.4 Storm-Petrels

Two species of storm-petrels occur in Newfoundland waters; Leach's Storm-Petrel and Wilson's Storm-Petrel. Over an estimated three million Leach's Storm-Petrel nest near the Study Area, most on Baccalieu Island off the northeastern Avalon Peninsula. They are locally abundant in waters offshore Newfoundland during summer, especially after the young are fledged. Wilson's Storm-Petrels, on the other hand, nest on islands in the South Atlantic Ocean, including the Antarctic and Subantarctic, December to March. In their non-breeding season (our summer in the northern hemisphere), the south Atlantic population migrates to the Northern Hemisphere. Storm-Petrels are present in the Study Area during all seasons, but are almost completely absent during the winter months (November through February) (Fifield et al. 2009). Wilson's are much less abundant that Leach's during all periods.

Based on the ECSAS database (Fifield et al. 2009), storm-petrels as a group were present during spring in moderate densities (1–10 birds/km^2) only over deep water off the Tail of the Bank. They were not recorded in many 1-degree blocks over shelf waters of the Study Area, and in low densities (<1 bird/km^2) elsewhere in the Study Area. Distribution was patchy during the summer months, with locally higher densities over the Laurentian Channel and Grand Banks (Fifield et al. 2009). Most had departed the shelf waters of the Study Area during fall; low densities occurred off the shelf to the east of the Grand Banks and around the Laurentian Fan.

4.4.3.5 Northern Gannet

The Northern Gannet is uncommon in the Study Area during spring, summer, and fall (Fifield et al. 2009). They are absent from the Study Area during winter. Gannets tend to frequent areas near shore and over the shelf. During the summer, gannets are most common in the vicinity of the large nesting colony at Cape St. Mary's on the southwestern Avalon Peninsula (Figure 4.43; Table 4.8). Gannets are scarce beyond 100 km from shore.

The ECSAS database shows gannets occurred in the highest densities during spring near the Laurentian Channel, with low densities over the Grand Banks (Fifield et al. 2009). Gannets were more widespread during summer, but remained closer to shore, around the Burin and Avalon peninsulas (near the Cape St. Mary's colony and outside the Study Area). Moulton et al. (2006a) recorded densities in the Laurentian Sub-basin of 0 birds/km^2 from June to August, and 0.01 in September. Gannets were recorded in a few 1-degree blocks near Cape St. Mary's during fall, and there were low (<1 bird/km^2) to very low (<0.1 bird/km^2) densities along the shelf edge near the Laurentian Channel in the Study Area, but many blocks around and east of the Grand Banks had no gannets (Fifield et al. 2009).

4.4.3.6 Gulls

Gulls generally are not abundant offshore in the Study Area, tending to frequent near shore areas more often. Nevertheless, they do occur well offshore regularly, often following fishing vessels. The kittiwake is the most pelagic of the group. This group is composed of five common species, and two uncommon to rare species. Those species that are expected to occur regularly offshore are Herring Gull, Great Black-backed Gull, Iceland Gull, Glaucous Gull, and Black-legged Kittiwake. Lesser Black-backed Gull is scarce at best. The Ivory Gull is of rare occurrence, seen during the winter and early spring months only.

Herring and Great Black-backed gulls and kittiwakes nest commonly around Newfoundland and are found throughout the year. Iceland Gull and Glaucous Gull nest north of Newfoundland, along the north Labrador coast (Glaucous Gull) and into the Arctic. They are found in the Study Area only from fall through early spring. The Lesser Black-backed Gull is a visitor from Europe.

The following summarizes the general occurrence of gulls in the Study Area as a group, based on the ECSAS database (Fifield et al. 2009). During winter, gulls were widely but unevenly distributed. Moderate densities (1–10 birds/km^2) were found over the northern Grand Banks and in scattered 1-degree blocks over and beyond the shelf while during the same period there were blocks with no gulls. Distribution in the Study Area was also widespread but uneven during spring. However, then most blocks had gulls. Densities were low (<1 bird/km^2) to moderate (1–10 birds/km^2) along the shelf edge and especially over the Grand Banks. Higher densities tended to occur closer to shore during the summer months, when gulls presumably were spending time closer to their nesting colonies. Moulton et al. (2006a) found densities of Great Black-backed Gull in the Laurentian Sub-basin ranging from 0 birds/km^2 in July and August to 0.2 birds/km^2 in September. They found Herring Gull in densities ranging from 0 birds/km^2 from June to August, to 0.28 birds/km^2 in September. Lang and Moulton (2004) recorded no large gulls in late June in the South Whale sedimentary sub-basin along the slope of Southwest Grand Banks. Most 1-degree blocks during fall had either no gulls or low densities.

The Arctic Tern, related to gulls, nests in small colonies around Newfoundland and is scarce offshore in the Study Area during the summer (see Table 4.7).

4.4.3.7 Auks

The Study Area is important for the five species of auks that use the Study Area — Dovekie, Common Murre, Thick-billed Murre, Razorbill, and Black Guillemot (see Table 4.7). The mix of species changes somewhat each season, but as a group they use the area throughout the year. Common Murres and Atlantic Puffins nest in large colonies near the Study Area, around the Avalon Peninsula. Both those species generally remain within tens of kilometres of their nesting colonies during the breeding season, but many shift offshore during winter. Most Thick-billed Murres and all Dovekies nest in colonies far north of the Study Area, in the arctic. Large percentages of the Eastern Canadian Arctic and Greenland breeding populations of Dovekie and Thick-billed Murre winter in the western Atlantic, especially off Newfoundland and Labrador (Brown 1986; Lock et al. 1994). They occur in the Study Area primarily during the winter months. Razorbill and Black Guillemot frequent coastal areas and, to some extent, shelf waters, and thus are the least likely alcids to occur in any numbers in the Study Area, especially beyond the Grand Banks.

Recent tracking studies of Common and Thick-billed Murres have revealed connections between the Study Area (and offshore areas immediately north of the Study Area) and several murre nesting colonies along the northern and eastern coasts of Canada, from the high arctic to Newfoundland (McFarlane Tranquilla et al. 2013). In particular, Common Murres from the Funk Island nesting colony spent most of the non-breeding season in or near the Study Area (Hedd et al. 2011; Montevecchi et al. 2012), although both species used the Study Area. Some Funk Island parental male Common Murres with fledglings swam through the Orphan Basin during August and September en route to the Southeast Shoal of the Grand Bank (Montevecchi et al. 2012).

During winter, Dovekies and murres predominate in the Study Area. Densities of the two species in many 1-degree blocks were moderate (1–10 birds/km^2) to high (10–100 birds/km^2) (Fifield et al. 2009). Dovekies occurred in the deeper waters east of the Grand Banks, as well as on the shelf and banks themselves. Murres were not recorded in the deeper waters.

Dovekies and most Thick-billed Murres begin to migrate north during spring, thus densities in the Study Area were overall lower than during the winter and distribution was patchy. However, moderate densities of Dovekies still occurred, especially along the shelf slope (Fifield et al. 2009). Murres as a group (i.e., Common and Thick-billed) occurred in most 1-degree blocks in moderate densities

(1-10 birds/km^2). They were found in most blocks on the Grand Banks and associated slopes, but less so in the western portion of the Study Area.

According to the ECSAS database, murres and other alcids (except Dovekies) were the most abundant and widespread auks in the Study Area during summer (May–August). Most Dovekies presumably had departed to their arctic nesting colonies. Murres were recorded in moderate densities over the Grand Banks and on shelf waters west of the Grand Banks whereas no murres were seen in most blocks beyond the shelf (Fifield et al. 2009).

Comparatively few auks were recorded in the Study Area during fall, although there was no survey coverage of many 1-degree blocks. Most blocks with survey effort had no Dovekies. Murres were seen in moderate densities on the eastern Grand Banks, and other alcids occurred in moderate densities around the Avalon Peninsula (Fifield et al. 2009).

Moulton et al. (2006a) recorded densities of Common Murre in the Laurentian Sub-basin ranging from 0 birds/km^2 during August and September to 0.09 birds/km^2 in June. They recorded no Thick-billed Murre, Razorbill, or Atlantic Puffin.

4.4.4 Prey and Foraging Habits

Seabirds in the Study Area employ a variety of foraging strategies and feed on a variety of prey species (Table 4.9). Many of the shearwaters, storm-petrels, gulls, and phalaropes capture their food by seizing it from the surface, either while flying or resting on the surface. Gannets and terns search for prey from the air, then plunge dive to capture the prey item. Members of the auk family (Alcidae) dive from a resting position on the surface and actively pursue their prey underwater. Consequently, they spend most of their time on or under the ocean's surface. Diving depth and time also varies by species. Some species such as terns and phalaropes specialize in foraging in shallow depths at the surface, while at the opposite end of the range, species such as alcids and loons dive to great depths (i.e., 20 to 50 m or more). Larger species of seabirds feed on capelin, sand lance, short-finned squid, crustaceans, or offal, whereas smaller species such as phalaropes and Dovekies feed primarily on copepods, amphipods, and other zooplankton (Table 4.9).

Foraging strategies of seabirds affects their breeding success during periods of limited food availability. In 1992 and 1993, Black-legged Kittiwakes, Herring and Great Black-backed Gulls had lower hatching, fledging and breeding success than in previous years. This was attributed to reductions in food availability for seabirds in the Study Area because the inshore spawning migration of capelin (a major prey species) was delayed by one month in the NW Atlantic (Bryant et al. 1999; Regehr and Rodway 1999). As well, the ground fisheries moratorium eliminated the production of fish offal, an important alternative food source for large gulls and kittiwakes. Other species, such as Atlantic Puffins and Common Murres were not negatively affected, and offshore surface feeders such as the Leach's Storm-Petrel had high breeding success (Regehr and Rodway 1999). Predation by large gull species on seabird adults, chicks and eggs increased in 1992 and 1993 (Rodway et al. 1996; Stenhouse and Montevecchi 1999b), and seabirds shifted their diets in concert with changes in sea surface temperature on the Newfoundland Shelf (Montevecchi and Myers 1997). The significance of gull predation on other seabirds and sea ducks is a matter of considerable debate, as some researchers have demonstrated such mortality to be compensatory to starvation or mediated by human disturbance (Swennen 1989; Goudie 1991).

Table 4.9 Foraging Strategy and Prey Types of Pelagic Seabirds that Frequent the Study Area.

Species (Group)	Foraging Strategy	Prey	Source
Northern Fulmar	Surface seizing	Fish, cephalopods, crustaceans, offal	Hatch & Nettleship (1998)
Cory's Shearwater	Surface seizing, pursuit plunging, pursuit diving	Fish, cephalopods, crustaceans	Brooke (2004)
Great Shearwater	Surface seizing, pursuit plunging, pursuit diving	Capelin, squid, crustaceans, offal	Brown et al. (1981), Brooke (2004)
Sooty Shearwater	Pursuit diving, pursuit plunging	Capelin, squid, crustaceans, offal	Brown et al. (1981) , Brooke (2004)
Manx Shearwater	Surface seizing, pursuit diving, pursuit plunging	Fish, cephalopods, crustaceans, offal	Lee and Haney (1996)
Storm-petrels	Surface seizing	Crustaceans, fish, cephalopods	Huntington et al. (1996)
Northern Gannet	Deep pursuit plunging	Mackerel, capelin, herring, squid	Mowbray (2002)
Phalaropes	Surface seizing	Copepods, other invertebrates	Rubega et al. (2000), Tracy et al. (2002)
Herring Gull [1]	Surface seizing	Fish, crustaceans, cephalopods, offal	Pierotti and Good (1994)
Iceland Gull	Surface seizing	Fish, invertebrates, tetrapods, offal	Snell (2002)
Glaucous Gull	Surface seizing	Fish, invertebrates, tetrapods, offal	Gilchrist (2001)
Great Black-backed Gull [1]	Surface seizing	Fish, invertebrates, offal, tetrapods	Good (1998)
Black-legged Kittiwake	Surface seizing	Fish, crustaceans, cephalopods, offal	Baird (1994)
Arctic Tern	Surface and pursuit plunging	Fish, invertebrates	Hatch (2002)
Jaegers and skuas	Kleptoparasitism, surface seizing	Fish, offal, invertebrates, mammals, birds	Wiley & Lee (1998, 1999, 2000)
Dovekie	Pursuit diving	Copepods, amphipods, mollusks, fish	Montevecchi & Stenhouse (2002)
Common Murre	Pursuit diving	Fish, cephalopods, crustaceans	Ainley et al. (2002)
Thick-billed Murre	Pursuit diving	Fish, invertebrates	Gaston & Hipfner (2000)
Black Guillemot	Pursuit diving	Fish, invertebrates	Cairns (1981)
Razorbill	Pursuit diving	Fish, invertebrates	Hipfner & Chapdelaine (2002)
Atlantic Puffin	Pursuit diving	Fish, crustaceans, cephalopods	Lowther et al. (2002)

Note: [1] These species feed on eggs and chicks of seabirds, and occasionally adults (Rodway et al. 1996; Stenhouse and Montevecchi 1999b).

4.4.5 Important Bird Areas

This section includes areas officially designated Important Bird Areas (IBAs), and other areas not officially designated as IBAs but still of regional importance. The IBA program identifies sites that provide essential habitat for one or more species of breeding or non-breeding birds (www.ibacanada.ca). The criteria used to identify important habitat are internationally standardized and are based on the presence of threatened and endangered species, endemic species, species representative of a biome (keystone species), or a significant proportion of a species' population. These criteria focus on sites of national and international importance.

Sites are included here only for those species that are expected to occur in the Study Area. Consequently, sites that support species that are primarily coastal in occurrence such as waterfowl and shorebirds, are not listed here. All sites are seabird nesting colonies, but none is in the Study Area. Nevertheless, seabirds nesting at these colonies are expected to use the Study Area. There are a total of eight IBA sites near the Study Area – six Canadian, and two French (on St. Pierre and Miquelon; BirdLife International 2009):

- Witless Bay Islands;
- Mistaken Point;
- Cape St. Mary's;
- Corbin Island;
- Middle Lawn Island;
- Green Island;
- Grand Colombier Island (St. Pierre); and
- Miquelon Cape (Miquelon).

Other regionally important sites are as follow:

- Ramea Colombier Island;
- Penguin Islands; and
- Western Head.

Aside from the above nesting colonies, the Grand Banks is an internationally important feeding area for many species of seabirds. All the above sites are mapped on Figure 4.43, and Table 4.8 lists the numbers of nesting pairs of seabirds nesting at each of the above colonies.

4.4.5.1 Witless Bay Islands IBA

Nesting seabirds on four small islands, named Green, Great, Gull, and Pee Pee, comprise a globally important seabird colony along the east coast of the Avalon Peninsula (www.ibacanada.ca). The colony includes the largest Atlantic Puffin colony in North America, and 9.5% of the global Leach's Storm-Petrel population. Over 83,000 pairs of Common Murre and almost 24,000 pairs of Black-legged Kittiwake nest here also. The islands are protected as the Witless Bay Ecological Reserve

4.4.5.2 Mistaken Point IBA

The Mistaken Point Ecological Reserve on the southeast Avalon Peninsula includes the coast and marine waters from Cape Race to The Drook, 20 km to the west. This site is designated an IBA for the significant numbers of Purple Sandpiper and Common Eider that it supports during winter (www.ibacanada.ca). Neither of those species are likely to occur in the Study Area, but the estimated 4,750 pairs of Black-legged Kittiwake that nest there probably will.

4.4.5.3 Cape St. Mary's IBA

This IBA consists of four kilometres of coastline and a sea stack with a combined 30,000 pairs of nesting seabirds (www.ibacanada.ca). This includes 2% of the global Northern Gannet population and large numbers of Common Murre and Black-legged Kittiwake.

4.4.5.4 Corbin Island IBA

This island is important for its globally significant number of nesting Leach's Storm-Petrel (www.ibacanada.ca). As many as 100,000 pairs have nested here, comprising 2% of the western Atlantic population of this species.

4.4.5.5 Middle Lawn Island IBA

This island is an IBA because of the only North American nesting colony of Manx Shearwater (Robertson 2002) and because of globally significant numbers of nesting Leach's Storm-Petrel (www.ibacanada.ca). Up to 26,313 pairs of Leach's Storm-Petrels have nested here; the most recent census tallied close to 14,000 pairs.

4.4.5.6 Green Island IBA

A globally significant number of Leach's Storm-Petrel pairs nest at Green Island between Miquelon Island and the Burin Peninsula (www.ibacanada.ca). Herring Gull, Common Tern, and Arctic Tern also nest here.

4.4.5.7 Grand Colombier Island IBA

Grand Columbier Island, just north of St. Pierre Island, is the location of a large seabird colony. The most abundant species are over 360,000 pairs of Leach's Storm-Petrel, approximately 9,500 pairs of Atlantic Puffin, and about 200 pairs of Black-legged Kittiwake (Table 4.8) (Lormée et al. 2012).

4.4.5.8 Miquelon Cape IBA

Over 2,000 pairs of kittiwake nest at Miquelon Cape at the northern tip of Miquelon (Table 4.8) (Cairns et al. 1989).

4.4.5.9 Ramea Colombier Island

Ramea Colombier Island is the nesting site for 1,000 pairs of Leach's Storm-Petrel (Cairns et al. 1989), as well as Black-legged Kittiwake (CWS, unpubl. data).

4.4.5.10 Penguin Islands

Species nesting on the Penguin Islands include Leach's Storm-Petrel, Caspian Tern (*Hydroprogne caspia*), Common Tern, and Arctic Tern (Lock et al. 1994).

4.4.5.11 Western Head

Western Head, near the southern-most tip of the Avalon Peninsula, hosts over 1,000 nesting pairs of kittiwake, Common Murre, and Razorbill (Cairns et al. 1989).

4.5 Marine Mammals and Sea Turtles

At least 23 marine mammal species are known to occur within the Study Area (Table 4.10), including 19 species of cetaceans (whales, dolphins, and porpoises) and four species of phocids (true seals). Additional marine mammal species, such as the pygmy sperm whale (*Kogia breviceps*), ringed seal (*Pusa hispida*), and bearded seal (*Erignathus barbatus*) may occur very rarely in the area; they are not discussed further here. Several marine mammals are seasonal inhabitants of the Study Area (see Table 4.10), using the Grand Banks and surrounding coastal, shelf, and offshore waters from spring through fall as foraging and breeding areas. The *SARA* and COSEWIC designations for each species expected to occur in the Study Area are shown in Table 4.10.

Marine mammal occurrence and sightings within the Study Area were described in the southern Newfoundland SEA (LGL 2010a), as well as previous EAs for the Laurentian Sub-basin and Laurentian Channel (e.g., Meltzer Research and Consulting 1996; JWEL 2003; Buchanan et al. 2004, 2006; JW 2007; LGL 2009a,b). Meltzer Research and Consulting (1996) also compiled maps of cetacean sightings contributed by researchers based in St. John's, by month, for the south coast of Newfoundland, but did not indicate spatial effort and in which year sightings occurred. Canning and Pitt (2007) summarized population estimates for marine mammals that may occur in the White Rose area of the Jeanne d'Arc Basin; most of these species and populations overlap with those found in the Project Area. Historical and more recent sightings of cetaceans within Newfoundland and Labrador waters have also been compiled by DFO in St. John's (J. Lawson, DFO, pers. comm., 2013).

4.5.1 DFO Cetacean Sighting Database

DFO in St. John's has compiled a database of cetacean sightings in Newfoundland and Labrador waters (J. Lawson, DFO, pers. comm., 2013) which has been made available for the purposes of describing cetacean sightings within the Study Area. These data can be used to indicate what species can be expected to occur in the Study Area, but they cannot provide fine-scale descriptions or predictions of marine mammal abundance or distribution in the area.

The summary of sightings (Table 4.11) combines the data sources described above as well as historical and recently added sightings from fisheries observers and the general public. Within the Study Area, sighting dates ranged from 1964 to 2007 and included baleen whales (Figure 4.44), large toothed whales (Figure 4.45), and dolphins and porpoises (Figure 4.46).

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

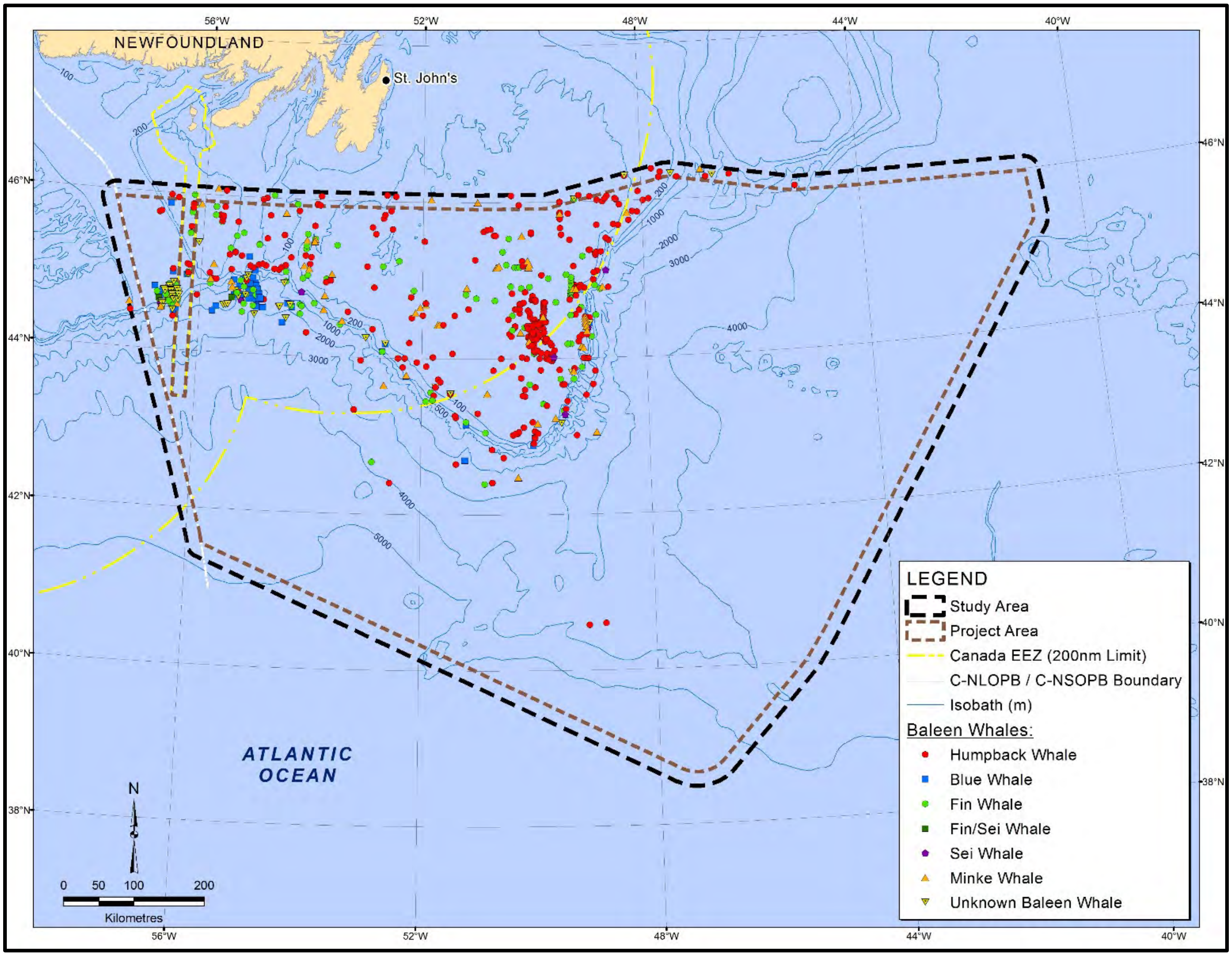
Species	Study Area		Habitat	*SARA* Status[a]	COSEWIC Status[b]
	Occurrence	Season			
Baleen Whales (Mysticetes)					
North Atlantic right whale (*Eubalaena glacialis*)	Rare	Summer	Coastal & shelf	Schedule 1: Endangered	E
Humpback whale (*Megaptera novaengliae*)	Common	Year-round, but mostly May-Oct.	Coastal & banks	Schedule 3: Special Concern	NAR
Blue whale (*Balaenoptera musculus*)	Rare	Year-round, but mostly spring	Coastal & pelagic	Schedule 1: Endangered	E
Fin whale (*Balaenoptera physalus*)	Common	Year-round, but mostly summer	Slope & pelagic	Schedule 1: Special Concern	SC
Sei whale (*Balaenoptera borealis*)	Uncommon	May-Sept.?	Pelagic	NS	DD
Minke whale (*Balaenoptera acutorostrata*)	Common	Year-round, but mostly May-Oct.	Shelf, banks & coastal	NS	NAR
Toothed Whales (Odontocetes)					
Sperm whale (*Physeter macrocephalus*)	Common	Year-round, but mostly summer	Palagic, slope & canyons	NS	NAR; LPC
Northern bottlenose whale (*Hyperoodon ampullatus*)[c]	Uncommon	Year-round	Palagic, slope & canyons	Schedule 1: Endangered	E
Sowerby's beaked whale (*Mesoplodon bidens*)	Rare	Summer?	Palagic, slope & canyons	Schedule 1: Special Concern	SC
Beluga whale (*Delphinapterus leucas*)[d]	Rare	Winter or Summer?	Coastal & ice edge	Schedule 1: Threatened	T
Killer whale (*Orcinus orca*)	Uncommon	Year-round, but mostly June-Oct.	Widely distributed	NS	SC
Long-finned pilot whale (*Globicephala melas*)	Common	May-Sept.	Mostly pelagic	NS	NAR
Common bottlenose dolphin (*Tursiops truncatus*)	Uncommon	Summer	Coastal & pelagic	NS	NAR
Short-beaked common dolphin (*Delphinus delphis*)	Common	Summer	Shelf & pelagic	NS	NAR
Atlantic white-sided dolphin (*Lagenorhynchus acutus*)	Common	Year-round, but mostly June-Oct.	Shelf & slope	NS	NAR
White-beaked dolphin (*Lagenorhynchus albirostris*)	Common	Year-round, but mostly June-Sept.	Shelf	NS	NAR
Striped dolphin (*Stenella coeruleoalba*)	Uncommon	Summer	Shelf & pelagic	NS	NAR
Risso's dolphin (*Grampus griseus*)	Uncommon	Year-round?	Slope	NS	NAR
Harbour porpoise (*Phocoena phocoena*)	Uncommon	Year-round, but mostly spring-fall	Shelf, coastal	Schedule 2: Threatened	SC
True Seals (Phocids)					
Harbour seal (*Phoca vitulina*)	Uncommon	Year-round	Coastal	NS	NAR
Harp seal (*Pagophilius groenlandicus*)	Uncommon	Year-round, but mostly winter-spring	Pack ice & pelagic	NS	NC; MPC
Hooded Seal (*Cystophora cristata*)	Uncommon	Year-round, but mostly winter-early spring	Pack ice & pelagic	NS	NAR; MPC
Grey seal (*Halichoerus grypus*)	Uncommon	Summer?	Coastal & shelf	NS	NAR

Note: ? indicates uncertainty.
[a] Species designation under the Species at Risk Act (http://www.sararegistry.gc.ca); NS = No Status.
[b] Species designation under COSEWIC (http://www.cosewic.gc.ca); E = Endangered, 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] Scotian Shelf population.
[d] St. Lawrence Estuary population.

Table 4.11 Cetacean Records that Occurred within the Southern Grand Banks Study Area, 1964-2007.

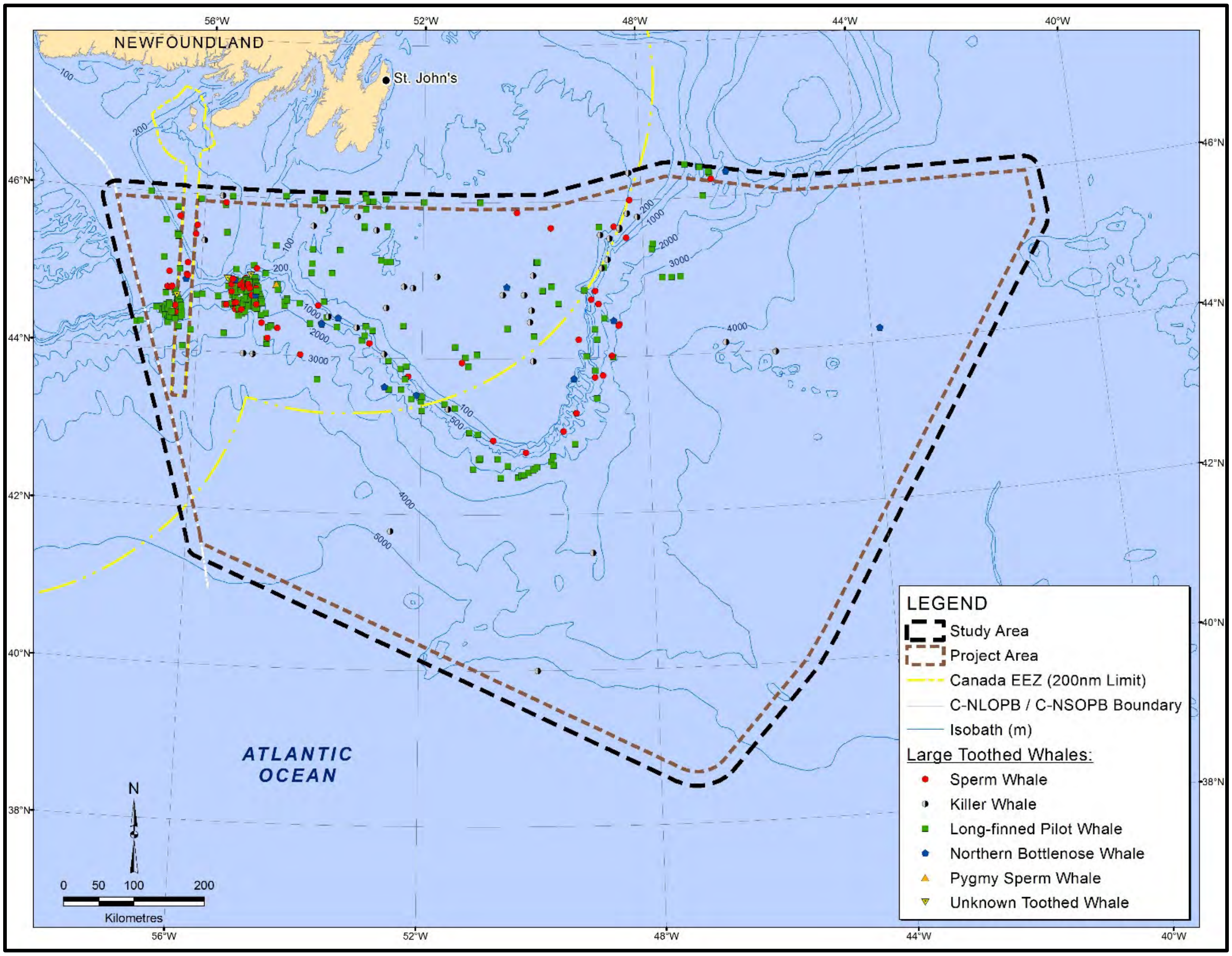
Species	Number of Sightings	Minimum Number of Individuals	Months Sighted
Mysticetes			
Fin whale	169	265	Mar-Oct
Sei whale	8	11	Feb, Jun, Aug, Sep
Fin/Sei whale	6	6	Jul-Sep
Humpback whale	522	1,630	Mar-Dec
Minke whale	65	92	Mar, May-Nov
Blue whale	61	75	May-Sep, Nov
Odontocetes			
Sperm whale	67	94	Feb-Mar, May-Aug, Oct
Pygmy sperm whale	1	2	Jun
Northern bottlenose whale	20	112	Mar-Sep
Killer whale	27	83	Apr-Nov
Pilot whale	355	4,248	Feb-Nov
Common dolphin	162	2,368	Jan, Apr, Jun-Nov
Bottlenose dolphin	8	121	Aug, Sep
Atlantic white-sided dolphin	162	2,883	Jun-Nov
White-beaked dolphin	57	582	Feb, Jun-Aug
Striped dolphin	4	192	Aug-Sep
Risso's dolphin	6	42	Jun-Aug
Harbour Porpoise	38	424	Mar, May-Nov
Other			
Unidentified dolphin	348	9,361	Jan-Dec
Unidentified toothed whale	4	10	Jul-Aug
Unidentified small whale	9	24	Jun-Aug
Unidentified medium whale	4	5	Jun, Oct
Unidentified large whale	280	531	Feb-Nov
Unidentified baleen whale	54	67	May-Oct
Unidentified whale	163	184	Jan-Dec
Unidentified cetacean	4	20	Jun

Source: DFO (see text for description and *caveats* associated with these data). Strandings and commercial whaling data are not included.



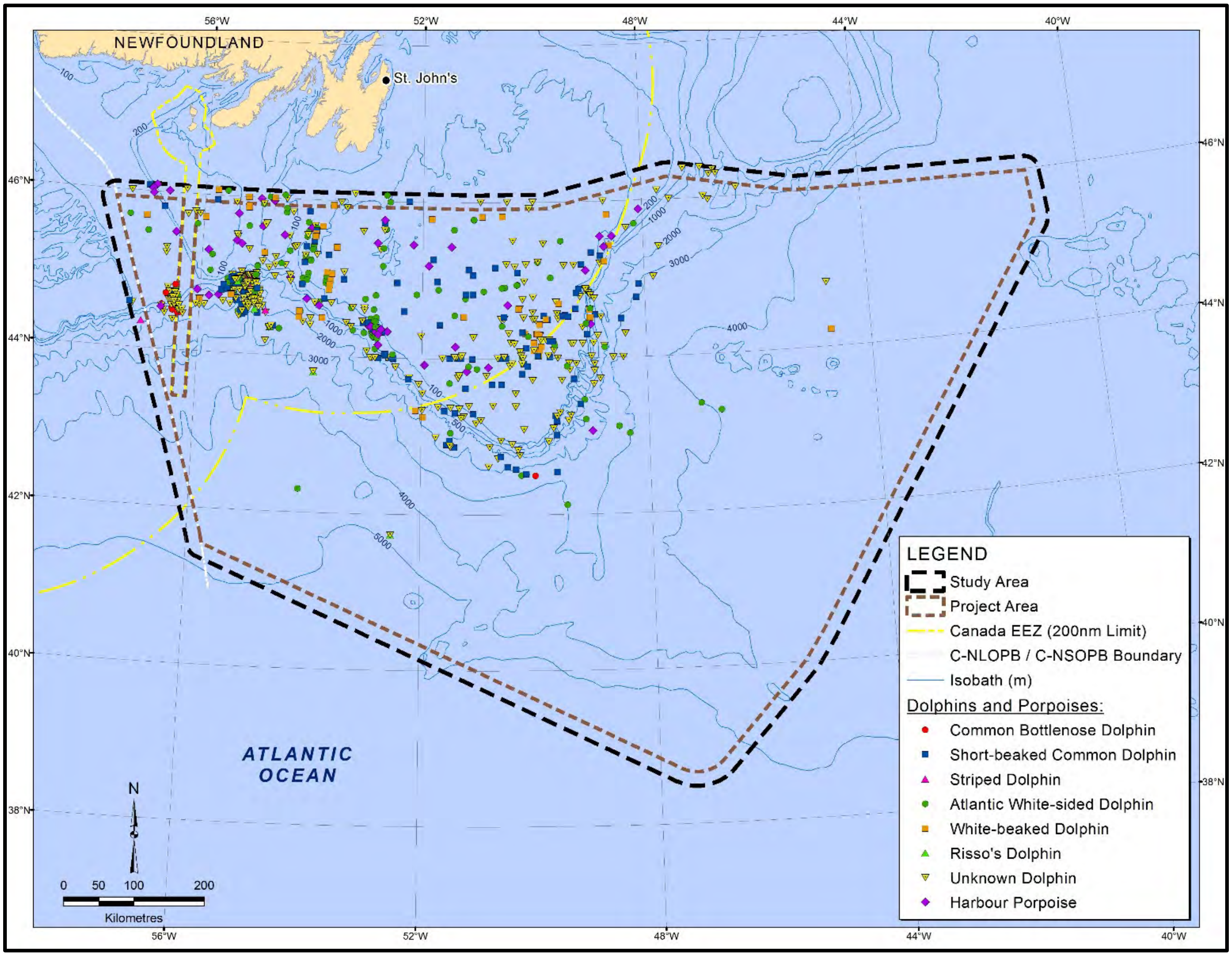
Source: DFO cetacean sightings database, see text for description of data and *caveats* associated with these data.

Figure 4.44 Baleen Whale Sightings in the Study Area.



Source: DFO cetacean sightings database, see text for description and caveats associated with these data.

Figure 4.45 Toothed Whale Sightings in the Study Area.



Source: DFO cetacean sightings database, see text for description and caveats associated with these data.

Figure 4.46 Dolphin and Porpoise Sightings in the Study Area.

A number of *caveats* should be noted when considering these data:

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

years, and areas. There are large gaps between years. Thus seasonal, depth, and distribution information should be interpreted with caution, and

8. Many sightings could not be identified to species, but are listed to the smallest taxonomic group possible.

Given the limitations due to inconsistent seasonal, annual, and distributional effort (as noted in the above caveats), patterns in cetacean distribution should be regarded with caution when using the DFO database.

Lawson and Gosselin (2009) provided preliminary abundance estimates, without the application of correction factors, for the most frequently sighted cetacean species detected during aerial surveys from Nova Scotia to Labrador during the summer of 2007. These abundance estimates have recently been corrected for perception and availability biases (Lawson and Gosselin, unpublished data). A total of 741,699 km^2 were surveyed off southern and eastern Newfoundland and off Labrador from 17 July to 24 August 2007, yielding a total of 584 cetacean sightings and a density of 0.0008 sightings/km^2. The southern Newfoundland survey strata included part of the Study Area. During 10,387 km of effort off southern Newfoundland, there were 430 cetacean sightings and a density of 0.002 sightings/km^2. These sightings included blue (3 sightings of 5 individuals), fin (55 sightings of 69 individuals), humpback (85 sightings of 116 individuals), minke (28 sightings of 31 individuals), northern bottlenose (8 sightings of 38 individuals), pilot (7 sightings of 65 individuals), sei (1 sighting of 1 individual), sperm (9 sightings of 9 individuals), unknown large (5 sightings of 6 individuals), and unknown small whales (2 sightings of 2 individuals), as well as common (25 sightings of 443 individuals), white-beaked (53 sightings of 474 individuals), white-sided (84 sightings of 1,759 individuals), and unknown dolphins (30 sightings of 176 individuals), and harbour porpoises (35 sightings of 57 individuals).

Humpback whales, followed by fin and minke whales, were the most common baleen whale observed within the southern Newfoundland survey strata while white-sided dolphins were the most frequently sighted odontocete. The locations of each species sightings were not provided, so it is not possible to describe the distribution of species relative to the Study Area, water depth, or distance to shore.

4.5.2 Baleen Whales (Mysticetes)

Six species of baleen whales are known to occur in the Project Area, including the North Atlantic right, humpback, blue, fin, sei, and minke whale. Although some individuals may be present in offshore waters of Newfoundland and Labrador year-round, most baleen whale species presumably migrate to lower latitudes during winter months. The Atlantic populations of blue whale and North Atlantic right whale are currently listed as *endangered* on Schedule 1 of *SARA*. The Atlantic population of fin whale is currently listed as *special concern* on Schedule 1 of *SARA*. These three species are discussed in Section 4.6 on Species at Risk.

4.5.2.1 Humpback Whale

The humpback whale is cosmopolitan in distribution and is most common over the continental shelf and in coastal areas (Jefferson et al. 2008). The best abundance estimate for the entire North Atlantic is 11,570 animals (Stevick et al. 2003). The western North Atlantic population of humpback whales is listed as *special concern* under Schedule 3 of *SARA* and it is considered *not at risk* by COSEWIC. Lawson and Gosselin (2009) provided an abundance estimate of 1,427 humpback whales for Newfoundland, based on aerial surveys conducted off the southern and eastern coast; the corrected abundance estimate is 3,712 whales (Lawson and Gosselin, unpublished data).

In the North Atlantic, humpback whales migrate annually from high-latitude summer foraging areas to winter breeding grounds in the West Indies (Clapham et al. 1993; Stevick et al. 1998; Kennedy et al. 2014). Some whales do not migrate to the West Indies every winter, and lower densities of humpbacks can be found in mid- and high-latitudes during this time (Clapham et al. 1993). Humpbacks appear to use deep, offshore migratory corridors between coastal and nearshore foraging and breeding grounds. Primary feeding areas in the North Atlantic have been described using genetic and individual identification data as the Gulf of Maine, eastern Canada, west Greenland, and the Northeast Atlantic (Stevick et al. 2006). Single animals or groups of two to three are commonly observed, but much larger groups can occur on foraging and breeding grounds (Clapham 2000).

Humpbacks regularly occur on the Grand Banks, the Gulf of St. Lawrence, Newfoundland's southern shore, and the eastern Scotian Shelf (Whitehead and Glass 1985; Meltzer Research and Consulting 1996; Kingsley and Reeves 1998). They are common over the banks and nearshore areas of Newfoundland and Labrador from spring to fall, sometimes forming large aggregations to feed primarily on spawning capelin, sand lance, and krill. The relative abundance and presence of humpback whales in Witless Bay, Newfoundland and Labrador, was directly related to the abundance of capelin in the area (Piatt and Methven 1992), while the presence of thermal fronts was linked to the distribution of foraging humpbacks in the Gulf of St. Lawrence (Doniol-Valcroze et al. 2007). Whitehead and Glass (1985) estimated that ~900 humpbacks use the Southeast Shoal of the Grand Banks as a summer feeding area, where their primary prey is capelin.

Based on the DFO sighting database, humpbacks are particularly common in the Study Area from spring to fall, with sightings peaking from June to August, although they can occur in the region during any season (see Table 4.10). They were the most frequently observed baleen whale in the Study Area and appear to prefer waters <500 m deep over banks and near shelf edges (see Table 4.11; Figure 4.44). Thus, humpback whales are considered common in the Study Area, in both shallow and deep areas, and could occur year-round, with highest densities in the summer.

4.5.2.2 Sei Whale

The distribution of sei whales is not well known, but they are found in all oceans and appear to prefer mid-latitude temperate waters (Jefferson et al. 2008). Sei whales appear to prefer offshore, pelagic, deep areas that are often associated with the shelf edge, seamounts, and canyons (Kenney and Winn 1987; Gregr and Trites 2001; COSEWIC 2003). In the Canadian Atlantic, sei whales have no status under *SARA* and are considered *data deficient* by COSEWIC. There is no current population estimate for the North Atlantic, but 1,393 to 2,248 individuals were estimated to use the Northwest Atlantic based on catch data collected during commercial whaling (Mitchell and Chapman 1977 *in* COSEWIC 2003).

Two stocks of sei whales are currently recognized off eastern Canada — a Labrador Sea and Nova Scotia stock (COSEWIC 2003). The Nova Scotia stock has a distribution that includes continental shelf waters of the northeastern U.S. to areas south of Newfoundland; the best available abundance estimate for this stock is 357 animals (Waring et al. 2013); there are no abundance estimates for the Labrador Sea. The Labrador Sea appears to be an important feeding area for sei whales from the Northeast Atlantic (Prieto et al. 2010). Although they sometimes eat fish, sei whales are primarily planktivorous and forage on euphausids and copepods (Flinn et al. 2002). They typically occur alone or in groups of two to five (Jefferson et al. 2008).

Mitchell and Chapman (1977) hypothesized that sei whales in the Northwest Atlantic move from spring feeding grounds 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 in winter.

Based on the DFO cetacean sightings database, there were eight sightings of sei whales in the Study Area; sightings occurred during February, June, August and September in offshore areas (see Table 4.11; Figure 4.44). Current knowledge suggests that sei whales are uncommon in the Study Area (see Table 4.10) relative to other cetacean species.

4.5.2.3 Minke Whale

Minke whales have a cosmopolitan distribution that spans polar, temperate, and tropical regions (Jefferson et al. 2008). Four populations are recognized in the North Atlantic, including the Canadian East Coast, west Greenland, central North Atlantic, and Northeast Atlantic stocks (Donovan 1991). However, DNA data suggest that there may be as few as two different stocks in the North Atlantic (Anderwald et al. 2011). There are an estimated 20,741 individuals in the Canadian east coast stock, which ranges from the Gulf of Mexico to Davis Strait (Waring et al. 2013). Lawson and Gosselin (2009) provided an abundance estimate of 1,315 minke whales for Newfoundland, based on aerial surveys conducted off the southern and eastern coast; the corrected abundance estimate is 4,691 whales (Lawson and Gosselin, unpublished data). Minke whales have no status under *SARA* and are considered *not at risk* in Atlantic Canada by COSEWIC.

Minke whales in the Gulf of St. Lawrence appear to associate with thermal fronts (Doniol-Valcroze et al. 2007). Some seasonal movements are apparent in many regions of the world, and movement patterns likely mirror the abundance and distribution of their primary prey species (Macleod et al. 2004). Minke whales feed primarily on small schooling fish in the western North Atlantic, generally occupy waters over the continental shelf, and are known to make short-duration dives (Stewart and Leatherwood 1985). They are commonly found on the Grand Banks in summer (Piatt et al. 1989), but sightings have been made off Newfoundland’s south coast in all seasons (Meltzer Research and Consulting 1996).

In the DFO sightings database, minke whales were sighted in March and May to November, although they were most frequently seen during summer periods (see Table 4.11). They appeared to prefer waters <500 m, but also occurred in the shelf region of the Study Area (see Table 4.11; Figure 4.44). Thus, minke whales are considered common (see Table 4.10), at least seasonally, within the Study Area.

4.5.3 Toothed Whales (Odontocetes)

Thirteen species of toothed whales are found in the Study Area (see Table 4.10), ranging from the largest living toothed whale, the sperm whale (~18 m for an adult male; Reeves and Whitehead 1997), to one of the smallest whales, the harbour porpoise (~1.6 m for an average adult; COSEWIC 2006a). Several of these species occur in the Study Area only seasonally, but there is generally little information about the distribution and abundance of these species. There was a single sighting of two pygmy sperm whales in the DFO cetacean sighting database, but this species would be considered a vagrant in the area and is not discussed further. On Schedule 1 of *SARA*, the northern bottlenose whale (Scotian Shelf population) is designated as *endangered,* the St. Lawrence Estuary beluga population is currently listed as *threatened*, and Sowerby's beaked whale is considered *special concern*. These three species are described in detail in Section 4.6. In addition, the harbour porpoise is considered *threatened* (Schedule 2), and COSEWIC has designated the Northwest Atlantic/Eastern Arctic population of killer whales as *special concern* and the sperm whale as a *low priority candidate species*.

4.5.3.1 Sperm Whale

The sperm whale has an extensive worldwide distribution, ranging from the edge of the polar pack ice to the equator (Jefferson et al. 2008). Whitehead (2002) estimated a total of 13,190 animals for the entire Iceland-Faeroes area, the area northeast of it, and the U.S. to Canadian east coast. Waring et al. (2013) reported an estimate of 1,593 animals for the U.S. Atlantic. Sperm whales have no status under *SARA* and are designated *not at risk* by COSEWIC. However, they are a *low priority candidate* species under COSEWIC.

Sperm whales are most abundant in tropical and temperate waters, but their distribution and relative abundance can vary in response to prey availability, most notably mesopelagic and benthic squid (Jaquet and Gendron 2002). Large aggregations or small groups of females and juveniles occur in tropical and sub-tropical regions, but males are most common singly or in small same-sex groups occurring at higher latitudes outside of the breeding season (Letteval et al. 2002; Whitehead 2003). Mixed groups with females and juveniles have occasionally been observed in higher latitudes, and males can form large same-sex aggregations (Whitehead and Weilgart 2000; Whitehead 2003).

Sperm whales generally occur in deep waters off the continental shelf, particularly areas with high secondary productivity, steep slopes, and canyons that may concentrate their primary prey of large-bodied squid (Jaquet and Whitehead 1996; Waring et al. 2001). Sperm whales are deep divers, routinely diving to hundreds of metres, sometimes to depths over 1,000 m and remaining submerged up to an hour (Whitehead and Weilgart 2000). Off the eastern North American coast, they are also known to concentrate in regions with well-developed temperature gradients, such as along the edges of the Gulf Stream and warm core rings, which may aggregate their primary prey (Jaquet 1996).

Whitehead et al. (1992) described high densities of sperm whales along the edge of the eastern Scotian Shelf, particularly in The Gully. Sperm whales are considered to occur regularly along edges of the Scotian Shelf and into the Gulf of St. Lawrence along the Laurentian Channel (Breeze et al. 2002).

Although sperm whales are likely most common in the Study Area during summer months, some occur throughout the year.

Based on the DFO sighting database, sperm whale sightings were common in offshore areas of the Study Area (see Table 4.10), particularly in slope areas with water depths ranging between >200 m to 2,500 m (see Figure 4.45). Sightings occurred in all seasons (see Table 4.11), but sperm whales were most common in the Study area during the summer (see Table 4.10). Thus, slope and offshore waters within the Study Area are potential primary habitats for sperm whales throughout the year, likely with higher numbers from spring to fall.

4.5.3.2 Killer Whale

Killer whales have a cosmopolitan distribution and occur in all oceans from polar pack ice to the equator, but they appear to be most common in coastal areas of higher latitudes (Jefferson et al. 2008). Killer whales offshore of Labrador and eastern Newfoundland are likely members of the Northwest Atlantic/eastern Arctic population, which is categorized as *special concern* by COSEWIC but has no status under *SARA*. The number of killer whales in the Northwest Atlantic/eastern Arctic population is unknown (COSEWIC 2008), but at least 67 individuals have been identified in the Northwest Atlantic (Lawson and Stevens 2013).

Although killer whales are found in tropical and offshore waters, they are more numerous in coastal waters and higher latitudes. Their movements are generally related to the distribution and abundance of their primary prey, which can include fish, other marine mammals, seabirds, and cephalopods (Ford et al. 2000). In Newfoundland and Labrador, killer whales have been observed approaching, attacking, and/or consuming other cetaceans, seals, seabirds and several species of fish; however, it is not known if there is any prey specialization among killer whale groups or individuals (Lawson et al. 2007). Stable isotope analysis of samples from seven killer whales suggests that killer whales off Newfoundland and Labrador mainly feed on fish, although one individual was found to have fed mostly on baleen whales (Matthews and Ferguson 2011). Observed group sizes range from 1 to 30 individuals (rarely more than 15), averaging 5.2 whales (Lawson and Stevens 2013).

Although they occur at relatively low densities, killer whales are considered year-round residents of Newfoundland and Labrador (Lien et al. 1988; Lawson et al. 2007; Lawson and Stevens 2013). Sightings seem to be increasing in recent years, but it is unclear if this is due to increasing abundance or observer effort. While sightings are also more common in coastal areas than offshore (Lawson et al. 2007; Lawson and Stevens 2013), it is unclear whether this is due to higher observer effort nearshore or a true representation of killer whale distribution.

A killer whale outfitted with a satellite tag at Admiralty Inlet, Baffin Island, on 15 August 2009, was tracked making a long-distance movement into the North Atlantic, traveling through the eastern part of the Study Area during early to mid-November (Matthews et al. 2011). However, it is uncertain whether killer whales from populations in other areas, such as the Canadian Arctic, Greenland, or Iceland mix with whales off Newfoundland and Labrador (Lawson and Stevens 2013).

Based on the DFO sighting database, killer whales have been observed in the Study Area from April to November on the shelf, upper slope, and in deeper water areas (see Table 4.11; Figure 4.45). However, sightings were less common (see Table 4.10) in the region relative to several other cetacean species. Thus, it is likely that killer whales are found in low densities throughout the year within the Study Area.

4.5.3.3 Long-finned Pilot Whale

The long-finned pilot whale is widespread in the North Atlantic (Jefferson et al. 2008). Although the total number of long-finned pilot whales off the east coast of the U.S. and Canada is uncertain, an estimated 12,619 individuals occur in the Northwest Atlantic (Waring et al. 2013). They are abundant, year-round residents of Newfoundland and Labrador (Nelson and Lien 1996). Long-finned pilot whales have no status under *SARA* and are considered *not at risk* by COSEWIC.

Pilot whales occur on the continental shelf break, in slope waters, and in areas of high topographic relief and have seasonal inshore/offshore movements coinciding with the abundance of their preferred prey, squid (Jefferson et al. 2008). Deep-diving occurs primarily at night when mesopelagic squid are closer to the surface (Mate 1989). Short-finned squid are a primary prey item in Newfoundland, but they also consume other cephalopods and fish (Sergeant 1962; Nelson and Lien 1996). Pilot whales are highly social, and appear to live in stable female-based groups (Jefferson et al. 2008). Pilot whales studied near Nova Scotia have an average group size of 20 individuals, but groups range in size from 2 to 135 animals (Ottensmeyer and Whitehead 2003).

Long-finned pilot whales are common in the Study Area and may be encountered closer to shore if squid are abundant or further offshore (Kingsley and Reeves 1998). Stenson et al. (2011) reported bycatch records of long-finned pilot whales in the spring for the Newfoundland Basin and the southern Grand Banks.

Long-finned pilot whales were the most frequently observed toothed whale in the DFO sightings database; they were sighted during February to November period (see Table 4.11). They appear to occur primarily on the shelf and upper slope of the Study Area (see Figure 4.45). Thus, long-finned pilot whales are considered common in the Study Area year-round (see Table 4.10).

4.5.3.4 Common Bottlenose Dolphin

Bottlenose dolphins range worldwide in tropical and temperate waters and can occupy a variety of habitats (Jefferson et al. 2008). Two morphologically and genetically distinct stocks occur in the Northwest Atlantic, referred to as the coastal and offshore forms (Hoelzel et al. 1998). The best population estimate for the offshore form is 81,588 (Waring et al. 2013). Bottlenose dolphins are considered *not at risk* by COSEWIC.

Bottlenose dolphins typically occur in groups of 2 to 15 animals, but can be observed offshore in groups of hundreds (Shane et al. 1986). They have a fluid and dynamic social organization. Habitat complexity and water depth is associated with group sizes; shallow-water areas tend to have smaller group sizes than open or pelagic regions (Shane et al. 1986). Bottlenose dolphins feed opportunistically on a range of fishes, cephalopods, and shrimp using a variety of foraging strategies (Jefferson et al. 2008).

Bottlenose dolphins are uncommon in Newfoundland waters (see Table 4.10). There were eight bottlenose dolphin sightings in the DFO cetacean sighting database (see Table 4.11); all occurred during the summer in a portion of the Laurentian Sub-basin (see Figure 4.46). Bottlenose dolphins may occur in the Study Area during the summer months, but are less common than other dolphin species.

4.5.3.5 Short-beaked Common Dolphin

The common dolphin is one of the most widely distributed cetaceans and occurs in temperate, tropical, and subtropical regions (Jefferson et al. 2008). An estimated 67,191 individuals reside in the Northwest Atlantic (Waring et al. 2013). An unknown number are found in eastern Canada (Gaskin 1992), but they are considered *not at risk* in Canada. Lawson and Gosselin (2009) provided an abundance estimate of 576 common dolphins for Newfoundland, based on aerial surveys conducted off the southern and eastern coast; the corrected abundance estimate is 1,806 dolphins (Lawson and Gosselin, unpublished data).

Groups of short-beaked common dolphins can range from several dozen to over 10,000, and they are typically fast-moving with many aerial behaviours such as jumping and bow-riding (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). Shifts in the seasonal distribution of short-beaked common dolphins also appear to coincide with peak abundances of mackerel, butterfish, and common 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. Based on the DFO sightings database, common dolphins were frequently sighted in the Study Area (Table 4.10), with most observations occurring during the summer (see Table 4.11). Sightings occurred in shelf, upper slope and deepwater regions of the Study Area (see Table 4.11; Figure 4.46). Short-beaked common dolphins are expected to occur throughout the Study Area from spring through fall, but are likely more common in summer.

4.5.3.6 Atlantic White-sided Dolphin

Atlantic white-sided dolphins inhabit temperate to sub-polar waters of the North Atlantic, primarily in deep waters of the outer continental shelf and slope (Jefferson et al. 2008). There may be at least three distinct stocks in the North Atlantic, including the Gulf of Maine, Gulf of St. Lawrence, and Labrador Sea areas, which combined are estimated to total ~48,819 animals (Waring et al. 2013). Lawson and Gosselin (2009) provided an abundance estimate of 1,507 white-sided dolphins for Newfoundland, based on aerial surveys conducted off the southern and eastern coast; the corrected abundance estimate is 3,384 dolphins (Lawson and Gosselin, unpublished data). Atlantic white-sided dolphins have no status under *SARA* and are considered *not at risk* by COSEWIC.

Atlantic white-sided dolphins occur regularly from spring to fall in offshore areas of Newfoundland and Labrador, but less is known of their winter distribution. The 100-m depth contour over the continental shelf appears to be primary habitat, and white-sided dolphins are sighted more frequently in regions with high relief and where sea surface temperatures and salinities are low (Selzer and Payne 1988). On average, groups of Atlantic white-sided dolphins include 52.4 animals, but range from 2 to 2,500 (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).

Stenson et al. (2011) reported bycatch records of Atlantic white-sided dolphins in the spring for the Newfoundland Basin and the southern Grand Banks. Based on the DFO sightings database, the white-sided dolphin is one of the most frequently sighted odontocete species in the Study Area, particularly during summer months (see Tables 4.10 and 4.11). Most sightings occurred in waters <500 m deep but some were observed in deeper water areas (see Table 4.11; Figure 4.46). Atlantic white-sided dolphins are expected to be regular occupants of the Study Area from spring through fall.

4.5.3.7 White-beaked Dolphin

White-beaked dolphins have a more northerly distribution than most dolphins and occur in cold temperate to sub-polar waters of the North Atlantic (Jefferson et al. 2008). Waring et al. (2013) reported a total of 2,003 individuals in the North Atlantic. Lawson and Gosselin (2009) provided an abundance estimate of 1,842 white-beaked dolphins for Newfoundland, based on aerial surveys conducted off the southern and eastern coast; however, the abundance estimate corrected for perception bias may be as large as 15,625 dolphins (Lawson and Gosselin, unpublished data). White-beaked dolphins have no status under *SARA* and are considered *not at risk* by COSEWIC.

White-beaked dolphins appear to remain at relatively high latitudes during fall and winter, and generally occur in continental shelf and slope areas, although they have also been observed in shallow, coastal waters (Lien et al. 2001). White-beaked dolphins sometimes associate with other cetacean species, and typically form groups of less than 30 animals, although groups of many hundreds have been recorded (Lien et al. 2001). Primary prey items include squid, crustaceans, and a range of small mesopelagic and schooling fishes like herring, cod, haddock, and hake (Jefferson et al. 2008).

There were fewer sightings of white-beaked dolphins in the Study Area than common or Atlantic white-sided dolphins. Based on the DFO sightings database, most sightings occurred in the summer (see Tables 4.10 and 4.11). Sightings occurred most often in the shelf and upper slope regions of the Study Area (see Figure 4.46). Thus, white-beaked dolphins could occur within the Study Area year-round.

4.5.3.8 Striped Dolphin

Striped dolphins are distributed worldwide in warm temperate to tropical waters, but range as far north as the Grand Banks (Lens 1997; Jefferson et al. 2008). In the western North Atlantic they are generally found from Nova Scotia south to the Gulf of Mexico; the best abundance estimate is 46,882 striped dolphins (Waring et al. 2013). In Nova Scotia, striped dolphins are encountered around The Gully, although they are observed less frequently than Atlantic white-sided and common dolphins, and pilot whales (Gowans and Whitehead 1995). Striped dolphins may also occur in waters off southern Newfoundland, but their abundance off Newfoundland is unknown (Baird et al. 1993). Striped dolphins are considered *not at risk* in Canada.

Striped dolphins usually occur in group sizes of several dozen to 500, but can form groups of thousands of animals (Jefferson et al. 2008). They apparently feed in pelagic and benthopelagic zones along the continental slope or just outside in oceanic waters. Striped dolphins may feed at depths of 200 to 700 m (Archer and Perrin 1999). Small, mid-water fishes and squids are likely their primary prey. They are primarily a pelagic species, apparently preferring waters offshore of the continental shelf and typically over the continental slope in waters associated with upwelling or convergence zones (Au and Perryman 1985).

Striped dolphins are uncommon in waters off Newfoundland (see Table 4.10). There were only four sightings of striped dolphins in the DFO sighting database, all occurring during the summer and in slope areas (see Table 4.11; Figure 4.46). It is expected that striped dolphins could occur in the Study Area during any month, particularly during the summer and in offshore areas.

4.5.3.9 Risso's Dolphin

In the Northwest Atlantic, Risso's dolphins are distributed from southern Newfoundland and Labrador to the Gulf of Mexico and Caribbean Sea (Jefferson et al. 2014). They appear to be primarily associated with steeper portions of the continental slope and outer shelf waters (Jefferson et al. 2014) where their cephalopod prey may concentrate (Baumgartner 1997). However, they are considered rare in Atlantic Canada (Baird and Stacey 1991). The best abundance estimate for Risso's dolphins in the western North Atlantic is 15,197 (Waring et al. 2013).

Risso's dolphins tend to occur in groups of 10 to 100 animals, but have been reported in groups of up to 4,000 (Jefferson et al. 2008). They commonly associate with other cetacean species, and may be deep divers with dive times up to 30 min recorded (Jefferson et al. 2008). Risso's dolphins apparently prefer squid, but also forage on crustaceans and other cephalopods.

The DFO sighting database contained six sightings of Risso's dolphins within the Study Area, all in offshore deep areas during the summer (see Table 4.11; Figure 4.46). Risso's dolphins may occur in low densities within the Study Area at any time of the year, although they may be more common in the summer.

4.5.3.10 Harbour Porpoise

In the Northwest Atlantic, harbour porpoises are found from southern Baffin Island to the U.S. northeast coast (Jefferson et al. 2008). There are at least three populations recognized in the Northwest Atlantic: eastern Newfoundland and Labrador, the Gulf of St. Lawrence, and the Gulf of Maine/Bay of Fundy (Palka et al. 1996). Lawson and Gosselin (2009) provided an abundance estimate of 1,195 harbour porpoises for Newfoundland, based on aerial surveys conducted off the southern and eastern coast; the corrected abundance estimate is 3,326 porpoises (Lawson and Gosselin, unpublished data). In the Atlantic, harbour porpoises are considered *threatened* (Schedule 2) by *SARA* and of *special concern* by COSEWIC.

Harbour porpoises tend to remain in relatively cool waters, seldom being found in waters warmer than 17ºC, presumably because these temperatures are preferred by their primary prey, Atlantic herring (Read 1999). They prefer areas with coastal fronts or topographically generated upwellings, and generally occur on the continental shelf, but also have an offshore component to their distribution (Westgate et al. 1998; Read 1999). Bycaught porpoises in Newfoundland appear to primarily consume capelin, Atlantic herring, sand lance, and lantern fish (COSEWIC 2006a). Harbour porpoises typically occur singly or in small groups of up to three individuals, occasionally occurring in larger groups (COSEWIC 2006a).

Little is known about the movements of the Newfoundland and Labrador population of harbour porpoises (COSEWIC 2006a). Lawson et al. (2004) estimated that approximately 1,500 to 3,000 harbour porpoises were incidentally caught during Newfoundland's 2002 nearshore cod fishery, most of which occurred along the south coast around St. Mary's Bay and Placentia Bay. A total of 102 porpoise were bycaught during the Canadian experimental Atlantic salmon driftnet fishery from 1965 to 2001 (Stenson et al. 2011). These bycatch data indicated that porpoise regularly occurred in deep water (>2,000 m) of the Newfoundland Basin during spring, but there were also records for the winter and for the Grand Banks during spring and winter (Stenson et al. 2011).

Harbour porpoise sightings were relatively common in the DFO sighting database (Table 4.10) and occurred in all seasons, but mainly during the spring and summer (see Table 4.11). They occurred primarily in the shelf region of the Study Area (see Figure 4.46). Harbour porpoises are most likely to occur in shallow regions of the Study Area, likely at low densities relative to other toothed cetaceans and possibly at any time of the year. However, they may also occur farther offshore in deeper waters.

4.5.4 True Seals (Phocids)

Four species of seals are known to occur in the Study Area (see Table 4.10). Seals consume a number of fish species (including cod, capelin, sand lance, and halibut) and invertebrates such as squid and shrimp, but diets can vary considerably among years, geographic regions, and seasonally (Hammill and Stenson 2000). None of these species are designated under *SARA*; however, hooded and harp seals are currently considered *mid priority candidate* species by COSEWIC.

4.5.4.1 Harbour Seal

Although generally restricted to nearshore areas, the harbour seal has a widespread distribution in the northern hemisphere (Jefferson et al. 2008). In the western Atlantic, it is distributed from the U.S. east coast to Baffin Island and western Greenland. The estimate for the western North Atlantic stock for 2001 was 99,340 individuals; however, as this estimate is more than eight years old, it is deemed unreliable, and no current abundance estimate is available (Waring et al. 2013). There are few quantitative estimates of abundance for Atlantic Canada (Hammill et al. 2010), but there are an estimated 1,000 animals along Newfoundland's south coast (Sjare et al. 2005; COSEWIC 2007). Harbour seals have no status under *SARA* and are considered *not at risk* by COSEWIC.

Harbour seals occur in coastal waters and are rarely seen more than 20 km from shore; they often use bays, estuaries, and inlets, and sometimes follow anadromous prey upstream in coastal rivers (Baird 2001). Primary prey items in Newfoundland waters include winter flounder, cod, and sculpins (Sjare et al. 2005). Over 50% of dives by harbour seals tagged in the Gulf of St. Lawrence were to depths <4 m, and the rest of the dives could be categorized into five types based on descriptive characteristics like dive depth, ascent and descent rates, and bottom time; the deepest dives average ~20 m (Lesage et al. 1999). Pupping occurs in the spring, primarily in May or June, and pups are nursed for ~24 days (Bowen et al. 2001).

Harbour seals are considered year-round residents of coastal Newfoundland, with populations along the south coast (including near Burgeo, St. Pierre and Miquelon, Point May, Pass Island near Hermitage Bay, and the entirety of Placentia Bay) potentially declining in numbers (Sjare et al. 2005). However, there have not been recent surveys along most of the south coast. Meltzer Research and Consulting (1996) and JW (2007) also mapped the distribution of harbour seals along the south coast of Newfoundland, primarily in estuaries from Rose Blanche to Ramea. It is expected that small numbers of harbour seals occur within the Study Area year-round, but are generally restricted to nearshore waters.

4.5.4.2 Grey Seal

Grey seals are found in cold temperate to sub-arctic waters of the North Atlantic, occurring in the Gulf of St. Lawrence, off Nova Scotia and Newfoundland within Canadian waters (Jefferson et al. 2008). Grey seals have no status under *SARA* and are considered *not at risk* by COSEWIC. Over the last several decades, the Northwest Atlantic population has increased dramatically (Bowen 2011); the population estimates in 2010 ranged from 348,900 seals (Thomas et al. 2011) to 402,700 (Hammill and Stenson 2011). The majority of seals breed during the winter on Sable Island, Nova Scotia, but pups are also born in the southern Gulf of St. Lawrence, and along the coast of Nova Scotia (DFO 2010c). Grey seals disperse widely after breeding but return for a spring moult (Lesage and Hammill 2001). An unknown number range into eastern Newfoundland and Labrador.

The grey seal is primarily a coastal species, and foraging appears to be restricted to the continental shelf regions (Lesage and Hammill 2001). Foraging grey seals tagged on Sable Island nearly always remained within the 100-m isobath and mostly over offshore banks (Austin et al. 2006). Along the east coast of Newfoundland, their diet seems to be dominated by capelin and winter flounder, although other fish species including Atlantic cod, sculpins, and sand lance are also taken (Hammill et al. 2013a).

Meltzer Research and Consulting (1996) described grey seal distribution as being continuous along the southern Newfoundland coast and up to 50 km offshore, with concentrations off the southwestern tip of the Island and near the northeastern portion of the Miquelon Islands. Based on their abundance and local distribution, grey seals are likely to be uncommon within the Study Area; they are generally more concentrated on the Scotian Shelf and in the Gulf of St. Lawrence. Nonetheless, grey seals may occur year-round in coastal and shelf regions of the Study Area, although they are likely more common during summer months.

4.5.4.3 Hooded Seal

Hooded seals are found in the North Atlantic, ranging from Nova Scotia to the high Arctic in Canada (Jefferson et al. 2008). There are an estimated 593,500 individuals in the Canadian Atlantic, the majority of which (~535,800 animals) whelp and breed in the pack ice off northeast Newfoundland/southern Labrador in late winter-early spring (Hammill and Stenson 2006). Hooded seals have no status under *SARA* and are considered *not at risk* by COSEWIC; however, they are currently a *mid priority candidate* species (see Table 4.13 in Section 4.6).

Four primary spring pupping and mating areas occur in the North Atlantic and include northeast Newfoundland/southern Labrador, the Gulf of St. Lawrence, Davis Strait, and northeast Greenland (Jefferson et al. 2008). Hooded seals aggregate in eastern Greenland to moult during early summer before dispersing to Davis Strait or the Greenland Sea for late summer and fall (see Hammill and Stenson 2006). Less is known about winter distribution, although there have been winter sightings on the Grand Banks; recent telemetry data suggests that hooded seals move along the continental shelf edge after leaving Greenland moulting grounds to Davis Strait and Baffin Bay followed by southerly migrations into the Labrador Sea during winter (Andersen et al. 2009). There is also some indication that post-breeding adult hooded seals use the north slope of the Laurentian Channel for 1.5 to 2 months before leaving the Gulf of St. Lawrence through Cabot Strait in late May or early June (Meltzer Research and Consulting 1996). Hooded seals appear to prefer deeper water and occur farther offshore than harp seals (Lavigne and Kovacs 1988), where topography and oceanographic process create good foraging areas (Andersen et al. 2013a). Based on data from satellite tag studies in the Northwest Atlantic, hooded seals can dive to depths of 1.6 km for up to 57 min (Andersen et al. 2013b). Hooded seals consume benthic invertebrates like shrimp, Greenland halibut, redfish, Arctic cod, and squid (Hammill and Stenson 2000).

Although uncommon on the Grand Banks hooded seals may be found in the Study Area in low densities, particularly during late winter or spring (see Andersen et al. 2009, 2013a).

4.5.4.4 Harp Seal

Harp seals have a widespread distribution in the Arctic and cold waters of the North Atlantic (Jefferson et al. 2008). They are the most abundant seal in the North Atlantic. Based on survey data, the population size for eastern Canada was estimated at 8.3 million harp seals for 2008 (DFO 2012c). Reproductive rates declined after 2008, and the population size for 2012 was estimated at 7.1 million (Hammill et al. 2013b). Harp seal abundance off Newfoundland's south coast is not known. COSEWIC is considering the harp seals as a *mid priority candidate* species, but it does not have a status under *SARA* (see Table 4.13 in Section 4.6).

Harp seals are common during spring off northeast Newfoundland and southern Labrador where they congregate to breed and pup on the pack ice; the majority of the Northwest Atlantic population uses this region while the small remainder uses the Gulf of St. Lawrence (Lavigne and Kovacs 1988). Large concentrations are found on the sea ice off northeastern Newfoundland where they moult during April and May (DFO 2012c). Harp seals migrate to Arctic and Greenland waters during summer, but some harp seals remain in southern waters (DFO 2012c). Offshore areas of southern Labrador and eastern Newfoundland appear to be major wintering areas (Stenson and Sjare 1997; Lacoste and Stenson 2000). Off Newfoundland and Labrador, harp seal diets are composed of capelin, Arctic cod, sand lance, herring, Atlantic cod, redfish, and Greenland halibut (Hammill and Stenson 2000). On the Grand Banks, capelin appears to be the most important prey species followed by sand lance, Greenland halibut, and other flatfish (Wallace and Lawson 1997; Lawson et al. 1998); Atlantic cod does not seem to be an important prey item on the Grand Banks (Hammill and Stenson 2000).

Satellite tagging of harp seals suggests that the Grand Banks is an important wintering area for at least some seals (Stenson and Sjare 1997), and that they are also likely to occur south and west of the Grand Banks. They are also incidentally caught in the south coast lumpfish fishery (Walsh et al. 2000 *in* JWEL 2003). Harp seals are likely uncommon within the Study Area during spring through early fall. They may be associated with ice leaving the Gulf of St. Lawrence, post-breeding adults may exit the Gulf of St. Lawrence through Cabot Strait in the spring, or adults could be found in pelagic areas, particularly in late winter to early spring.

4.5.5 Sea Turtles

Four species have been reported in or near the Study Area including leatherback, loggerhead, green, and Kemp's ridley sea turtles (Table 4.12). There is limited information on the degree of occurrence of these species within the Study Area, although the leatherback turtle is the more commonly reported of the four. The leatherback sea turtle is listed as *endangered* on Schedule 1 of *SARA* and is discussed in Section 4.6. The loggerhead sea turtle is designated as *endangered* by COSEWIC, but it has no status under *SARA*; Kemp's ridley and the green sea turtle have no status under *SARA* and have not been considered by COSEWIC.

Table 4.12 Sea Turtles Known to Occur within the Study Area.

Species	*SARA* Status[a]	COSEWIC Status[b]	Occurrence	Season
Leatherback sea turtle (*Dermochelys coriacea*)	Endangered, Schedule 1	Endangered	Uncommon	Summer/Fall
Loggerhead sea turtle (*Caretta caretta*)	No Status	Endangered	Uncommon	Summer/Fall
Kemp's ridley sea turtle (*Lepidochelys kempii*)	No Status	Not considered	Very Rare	Summer/Fall
Green sea turtle (*Chelonia mydas*)	No Status	Not considered	Very Rare	Summer/Fall

Notes: [a] Species designation under the *Species at Risk Act* (http://www.sararegistry.gc.ca)
[b] Species designation under COSEWIC (http://www.cosewic.gc.ca)

4.5.5.1 Loggerhead Sea Turtle

Loggerhead sea turtles are found in temperate and tropical areas of the Atlantic, Pacific, and Indian Oceans, with the majority of nesting occurring along the western rims of the mid- and equatorial Atlantic and Indian Oceans (Spotila 2004). Nesting in the western Atlantic occurs from late April to early September, and major nesting areas include beaches in the southeastern U.S. (Spotila 2004). Globally, Spotila (2004) estimated that there are 43,320 to 44,560 nesting females. Shoop and Kenney (1992) estimated that at least 8,000 to 11,000 loggerheads occur in northeastern U.S. waters each summer. The loggerhead turtle is the most common sea turtle in North American waters, but it prefers water temperatures between 20–25°C (DFO 2010d). There are no current population estimates for loggerhead turtles in Atlantic Canada (DFO 2010d), but they are likely rare off Newfoundland.

Adult loggerheads make considerable migrations between nesting beaches in the tropics to temperate foraging areas (Hawkes et al. 2007). Loggerheads appear to move with the Gulf Stream into eastern Canada waters during summer, especially the Scotian Shelf, Georges Bank and Grand Banks from July through October (Smith 2001, 2002 *in* Brazner and McMillan 2008; Javitech 2002, 2003 *in* Brazner and McMillan 2008). In the Northwest Atlantic, thousands of mostly immature loggerheads have been bycaught in the Canadian pelagic longline fishery since 1999 (Brazner and McMillan 2008; Paul et al. 2010). Thus, there appears to be a seasonal population of juvenile loggerheads in Atlantic Canada (COSEWIC 2010b). Loggerheads that appear in Canadian waters generally have a smaller body size than those found in the coastal U.S. waters, suggesting that they may be younger individuals (Witzell 1999). Loggerheads may be seen in the open seas during migration and foraging (e.g., Mansfield et al. 2009). While foraging at sea, loggerheads likely consume gelatinous zooplankton and squid (Spotila 2004).

Using observer data from the U.S. pelagic longline fishery, that ranges from the Caribbean to Labrador, Witzell (1999) estimated that 70% of incidentally caught loggerheads between 1992 and 1995 were captured on or east of the 200-m contour of the Grand Banks. They were caught from June to November, but captures peaked in September; however, loggerhead captures mirrored the distribution of fishing effort. There were numerous bycatch records of loggerhead turtles in the Canadian swordfish and tuna longline fishery during 2002-2008; turtles were bycaught along the southern slope of the Grand Banks and south of the Flemish Cap (Paul et al. 2010).

Based on the DFO sightings database, there is one record of a loggerhead turtle within the Study Area; it was sighted in the month of July in the northeastern part of the Study Area where water depth >4,000 m (Figure 4.47). Loggerhead sea turtles may occur in the Study Area, particularly during summer through fall.

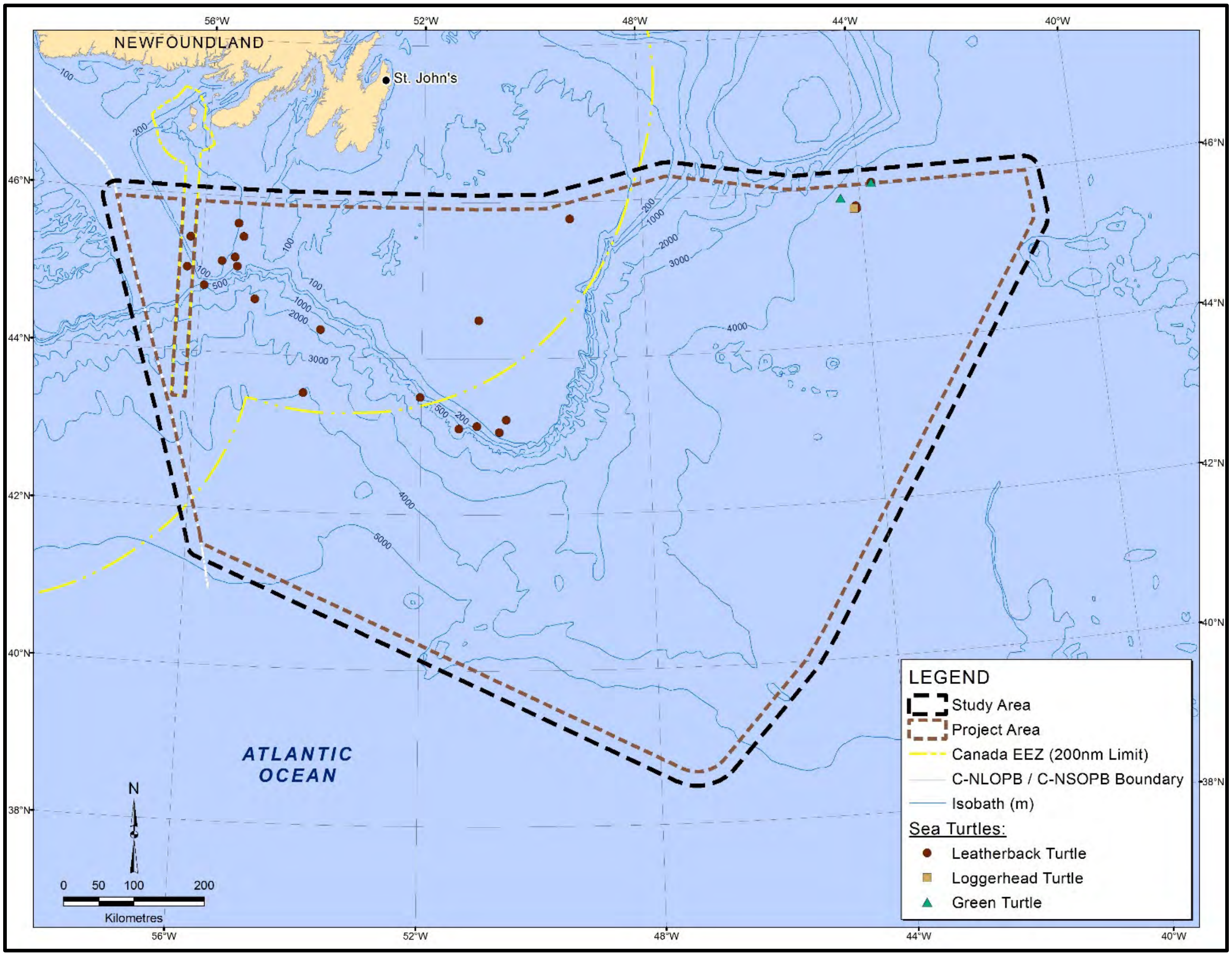


Figure 4.47 Sea Turtle Sightings in the Study Area.

4.5.5.2 Green Sea Turtle

The green turtle is widely distributed in tropical and subtropical waters near continental coasts and around islands, although they have been recorded 500–800 miles from shore in some regions (Eckert 1993 *in* NMFS 2002). The worldwide green turtle population, estimated at 88,520 nesting females, has declined 50–70% since 1900 (Spotila 2004). The most important nesting beaches in the northern Atlantic are in Costa Rica; the Yucatan Peninsula, Surinam, and eastern Florida south of Cape Canaveral, where they nest primarily between May and August (Thompson 1988; Spotila 2004). Hatchlings are epipelagic (surface dwelling in the open sea) for ~1–3 or more years; subsequently, they live in bays and along protected shorelines, feeding during the day on seagrass and algae (Bjorndal 1982). Juvenile and sub-adult green turtles may travel thousands of kilometers before they return to breeding and nesting grounds (Carr et al. 1978).

Green sea turtles are expected to be rare in the Study Area. Nonetheless, based on the DFO sightings database, there were two records of green turtles within the Study during the month of July in the northeastern part of the Study Area where water depth >4,000 m (see Figure 4.47).

4.5.5.3 Kemp's Ridley Sea Turtle

Kemp's ridley sea turtles have a more restricted distribution than other sea turtles, with adults primarily located in the Gulf of Mexico and some juveniles also feeding along the U.S. east coast, sometimes ranging into the Canadian Atlantic (Spotila 2004). There are an estimated ~5,000 nesting females worldwide (Spotila 2004). McAlpine et al. (2007) reported that there are records of Kemp's Ridley turtle for Nova Scotia, but that its presence off Newfoundland has not been confirmed. However, Cook (1984) noted that juveniles have been sighted near St. Mary's Bay along the southeast coast of Newfoundland. Nesting occurs primarily within a small region along the central and southern Gulf of Mexico coast during May to late July (Morreale et al. 2007). Following nesting, female Kemp's ridley turtles travel to foraging areas along the coast of the Gulf of Mexico, typically in waters <50 m deep and ranging from Mexico's Yucatan Peninsula to southern Florida; males tend to stay nearby nesting beaches in the central Gulf of Mexico year-round (Morreale et al. 2007). Only juvenile and immature Kemp's ridley turtles appear to move beyond the Gulf of Mexico into more northerly waters. Musick et al. (1994) suggested that juvenile and immature Kemp's ridley turtles that migrate northward of Cape Hatteras, North Carolina, probably do so in April and return southward in November. There are historical summer sightings and strandings of Kemp's ridley turtles from Massachusetts into the Gulf of Maine, with a peak during summer and fall (Lazell 1980). It is expected that only very rarely would Kemp's ridley turtles occur within the Study Area, and summer or fall occurrence would be most likely.

4.6 Species at Risk

The *Species at Risk Act* (*SARA*) was assented to in December 2002 with certain provisions coming into force in June 2003 (e.g., independent assessments of species by COSEWIC) and June 2004 (e.g., prohibitions against harming or harassing listed *endangered* or *threatened* species or damaging or destroying their critical habitat). The information provided in this section is current as of February 2014 on the websites for *SARA* (http://www.sararegistry.gc.ca/default_e.cfm) and COSEWIC (http://www.cosepac.gc.ca/index.htm).

Species are listed under *SARA* on Schedules 1 to 3 with only those with either *endangered* or *threatened* status on Schedule 1 having immediate legal implications. Nonetheless, attention must be paid to all of the *SARA*-listed species because of their sensitivities to perturbation and the potential for status upgrades. Schedule 1 is the official list of wildlife Species at Risk in Canada. Once a species/ population has status on Schedule 1, measures to protect it and promote its recovery are implemented. The four cetacean species/populations, one sea turtle species, and three fish species/populations that are legally protected under *SARA* and have potential to occur in the Study Area between May and November are listed in Table 4.13.

Table 4.13 *SARA* Schedule 1 and COSEWIC-listed Marine Species with Reasonable Likelihood of Occurrence in the Study Area.

Species		*SARA* Schedule 1			COSEWIC			
Common Name	**Scientific Name**	***Endangered***	***Threatened***	***Special Concern***	***Endangered***	***Threatened***	***Special Concern***	***Candidate Species***
Right whale	*Eubalaena glacialis*	X			X			
Blue whale	*Balaenoptera musculus*	X			X			
Northern bottlenose whale (Scotian Shelf population)	*Hyperoodon ampullatus*	X			X			
Leatherback sea turtle	*Dermochelys coriacea*	X			X			
White shark	*Carcharodon carcharias*	X			X			
Beluga whale (St. Lawrence population)	*Delphinapterus leucas*		X			X		
Northern wolffish	*Anarhichas denticulatus*		X			X		
Spotted wolffish	*Anarhichas minor*		X			X		
Atlantic wolffish	*Anarhichas lupus*			X			X	
Fin whale (Atlantic population)	*Balaenoptera physalus*			X			X	
Sowerby's beaked whale	*Misoplodon bidens*			X			X	
Loggerhead sea turtle	*Caretta caretta*				X			
Atlantic cod (Newfoundland and Labrador population)	*Gadus morhua*				X			
Porbeagle shark	*Lamna nasus*				X			
Roundnose grenadier	*Coryphaenoides rupestris*				X			
Atlantic salmon (various populations)	*Salmo salar*				X	X	X	
Cusk	*Brosme brosme*				X			
American plaice (NL[a] population)	*Hippoglossoides platessoides*					X		
American eel	*Anguilla rostrata*					X		
Acadian redfish	*Sebastes fasciatus*					X		
Deepwater redfish	*Sebastes mentella*					X		
Harbour porpoise	*Phocoena phocoena*						X	
Killer whale (NW Atlantic/E Arctic populations)	*Orcinus orca*						X	
Blue shark	*Prionace glauca*						X	
Roughhead grenadier	*Macrourus berglax*						X	
Spiny dogfish	*Squalus acanthias*						X	
Ringed seal	*Phoca hispida*							High priority
Lumpfish	*Cyclopterus lumpus*							High priority
Hooded seal	*Cystophora cristata*							Mid priority
Harp seal	*Phoca groenlandica*							Mid priority
Bearded seal	*Erignathus barbatus*							Mid priority
Spinytail skate	*Bathyraja spinicauda*							Mid priority
Pollock	*Pollachius virens*							Mid priority
Greenland shark	*Somniosus microcephalus*							Mid priority
Sperm whale	*Physeter macrocephalus*							Low priority

Sources: *SARA* website (http://www.sararegistry.gc.ca/default_e.cfm) (as of January 2014); COSEWIC website (http://www.cosepac.gc.ca/index.htm) (as of February 2014).

Atlantic wolffish, the Atlantic population of fin whales and Sowerby's beaked whale have *special concern* status on Schedule 1 of *SARA* (see Table 4.13). Schedules 2 and 3 of *SARA* identify species that were designated "at risk" by COSEWIC prior to October 1999 and must be reassessed using revised criteria before they can be considered for addition to Schedule 1. Species that potentially occur in the Study Area and are considered at risk but which have not received specific legal protection (i.e., proscribed penalties and legal requirement for recovery strategies and plans) under *SARA* are also listed in Table 4.13 as are *endangered*, *threatened* or species of *special concern* status under COSEWIC. Other non-*SARA* listed marine species that potentially occur in the Study Area and are listed by COSEWIC as *candidate species* are also included in Table 4.13.

Under *SARA*, a 'recovery strategy' and corresponding 'action plan' must be prepared for *endangered*, *threatened*, and *extirpated* species. A 'management plan' must be prepared for species considered as *special concern*. Final recovery strategies have been prepared for five species currently designated as either *endangered* or *threatened* under Schedule 1 and potentially occurring in the Project Area: (1) the leatherback sea turtle (ALTRT 2006); (2) the spotted wolffish (Kulka et al. 2007), (3) the northern wolffish (Kulka et al. 2007), (4) the blue whale (Beauchamp et al. 2009), and (5) the Scotian Shelf population of the northern bottlenose whale (DFO 2010b). A recovery strategy has been proposed for the St. Lawrence Estuary population of beluga whale (DFO 2011b). In addition, a management plan has been prepared for the Atlantic wolffish (Kulka et al. 2007), currently with *special concern* status on Schedule 1 of *SARA*.

MKI will monitor *SARA* issues through the law gazettes, the Internet and communication with DFO and Environment Canada, and will adaptively manage any issues that may arise in the future. The company will comply with relevant regulations pertaining to *SARA* Recovery Strategies and Action Plans. MKI will continue to exercise due caution to minimize impacts on these species during all of its operations. MKI also understands that other marine species might be designated as *endangered* or *threatened* on Schedule 1 during the course of the Project (2014-2018), and will continue to monitor any status changes.

Species profiles and any related special or sensitive habitats are described in the following sections.

4.6.1 Profiles of *SARA* Schedule 1 Species/Populations

Only those species/populations that have *endangered*, *threatened* or *special concern* status under Schedule 1 of *SARA* are profiled in detail in this section. Many of the other marine animals listed in Table 4.13 are described in Sections 4.2, 4.4 and 4.5.

4.6.1.1 North Atlantic Right Whale

The North Atlantic right whale is listed as *endangered* on Schedule 1 and COSEWIC; it is one of the world's most critically endangered large whale populations (Clapham et al. 1999; IWC 2001). North Atlantic right whale populations were originally severely depleted by commercial whaling. The population is currently estimated below 350 individuals, and the lack of recovery has been attributed to direct and indirect impacts from human activities, especially collisions with ships and entanglement in fishing gear (IWC 2001; Brown et al. 2009). The Canadian Recovery Strategy noted a goal "to achieve an increasing trend in population abundance over three generations" via seven recovery objectives (Brown et al. 2009). Grand Manan Basin in the Bay of Fundy has been delineated as Critical Habitat, and Roseway Basin on the southwestern Scotian Shelf has been designated as a Conservation Area and a proposed Critical habitat area (Brown et al. 2009).

North Atlantic right whales are generally found in continental shelf waters off the eastern U.S. and Canada, but have been known to range as far north and east as Greenland, Iceland, and Norway (Winn et al. 1986; Knowlton et al. 1992). Within Canadian waters, important habitats include summer and fall feeding and nursery grounds in Grand Manan Basin in the lower Bay of Fundy and Roseway Basin on the western Nova Scotian Shelf (Brown et al. 2009). There is a general seasonal north-south migration, but right whales may be seen anywhere within their range throughout the year (Gaskin 1982). Sparse sightings or information from whaling logbooks include a few winter records from the Gulf of St. Lawrence and coasts of Newfoundland and Labrador (Lien et al. 1989; Knowlton et al. 1992). Historical whaling also occurred during summer in waters near the eastern edge of the Grand Banks (Reeves and Mitchell 1986). Animals migrate from northern feeding grounds to calving grounds off the southeastern U.S. in late fall to winter and return northward in late winter to early spring. Peak sightings on Canadian feeding grounds occur from August to early October, coinciding with the abundance of their primary prey, calanoid copepods (Baumgartner et al. 2003). Sightings in very deep, offshore waters of the Northwest Atlantic are rare. Right whales usually occur singly or in small groups, and aggregations are generally associated with feeding (Jefferson et al. 2008). Right whales are slow swimmers and exhibit surface behaviours that make them particularly susceptible to vessel strikes (summarized in Baumgartner and Mate 2003; Brown et al. 2009).

There was a single sighting of a North Atlantic right whale in the entire historical database compiled by DFO (1975-2007) on 28 September 2006 during a DFO aerial survey for marine mammals. The right whale was observed in waters <500 m deep near the northwestern edge of St. Pierre Bank. While right whales may have historically used portions of the Study Area, they are currently likely only very rare visitors.

4.6.1.2 Blue Whale

The blue whale has a cosmopolitan distribution, but tends to be more frequently observed in deep water rather than in coastal environments (Jefferson et al. 2008). Blue whales became severely depleted during industrial whaling and still occur at relatively low densities in the North Atlantic. The Atlantic population of blue whales is considered *endangered* on *SARA* Schedule 1 and by COSEWIC. Blue whales likely number in the low hundreds in the Northwest Atlantic (COSEWIC 2002). Sears et al. (1987) estimated a total of 308 animals from mark-recapture photo-identification studies in the Gulf of St. Lawrence, and NMFS (1998) reported that up to 1,400 animals may occur in the North Atlantic. The recovery strategy for blue whales in the Northwest Atlantic notes a long-term recovery goal of 1,000 mature individuals through the achievement of three 5-year objectives; no Critical Habitat was identified (Beauchamp et al. 2009).

Little else is known about population size of blue whales in the North Atlantic, outside of the Gulf of St. Lawrence (Beauchamp et al. 2009). Foraging blue whale distribution in the Gulf of St. Lawrence has been linked to heterogeneous sub-surface topography and thermal fronts (Doniol-Valcroze et al. 2007).

Most sightings of blue whales in Canadian waters include sightings during spring, summer, and fall in the Gulf of St. Lawrence or eastern Nova Scotia, with peak sightings in June and August; winter sightings are made off southern Newfoundland (Sears 2002; Sears and Calambokidis 2002). In the Gulf of St. Lawrence, blue whales enter the area through Cabot Strait by late March or early April and are commonly encountered from May to December (Sears and Calambokidis 2002). They primarily feed on euphausids that are most common near the 100-m contour (Sears et al. 1987), and their distribution is often associated with areas of upwelling or shelf edges where their prey may concentrate. Blue whales may be most common from spring to fall, but they are likely found within the Study Area throughout the year (Sears and Calambokidis 2002).

Based on acoustical data, blue whales occur on the Grand Banks between August and May, with peak calling activity from September through February (Clark 1995 *in* Beauchamp et al. 2009). Based on the DFO sightings database, blue whales were observed during spring, summer and fall within the Study Area, with peak numbers during the summer (see Table 4.11 in Section 4.5). Sightings were made primarily in upper slope regions, particularly in the area of the St. Pierre Bank and Laurentian Channel (see Figure 4.44 in Section 4.5).

4.6.1.3 Northern Bottlenose Whale (Scotian Shelf Population)

The distribution of northern bottlenose whales is restricted to the North Atlantic, primarily in deep, offshore areas with two regions of concentration: the Gully and adjacent submarine canyons on the eastern Scotian Shelf, and Davis Strait off northern Labrador (Reeves et al. 1993). Nuclear and mitochondrial markers revealed very little interchange between these two populations (Dalebout et al. 2006). The Scotian Shelf population is designated *endangered* under Schedule 1 of *SARA* and by COSEWIC.

Throughout their range, northern bottlenose whales were harvested extensively during industrial whaling, which likely greatly reduced total numbers (COSEWIC 2011). The total abundance of northern bottlenose whales in the North Atlantic is unknown. However, the current estimate for the Scotian Shelf population is 143 individuals (O'Brien and Whitehead 2013). The recovery goal for this population it to "achieve a stable or increasing population and to maintain, at a minimum, current distribution" (DFO 2010e). The Scotian Shelf population appears to be highly concentrated in a small region of the eastern Scotian Shelf around the deep waters of three underwater canyons: The Gully; Shortland Canyon; and Haldimand Canyon (Wimmer and Whitehead 2004). The Gully Marine Protected Area, and areas deeper than 500 m in Haldimand and Shortland Canyons, have been designated as critical habitat (DFO 2010e).

Although most sightings occur during the summer, there are winter occurrences and the population presumably remains within this region year-round (Reeves et al. 1993). The calving season of the Scotian Shelf population peaks in August (Whitehead et al. 1997). Northern bottlenose whales are deep-divers, occurring primarily in deep waters over canyons and the shelf edge; whales tagged on the Scotian Shelf routinely dove to depths over 800 m and remained submerged for over an hour (Hooker and Baird 1999). They forage primarily on large-bodied squid and travel in small groups that may consist of individuals of different age and sex classes, although males appear to form long-term associations with other mature males (Gowans et al. 2001). Foraging apparently occurs at depth, primarily on deep-water squid and fish (COSEWIC 2011; DFO 2011c).

It is unclear to which population animals occurring in Labrador and Newfoundland, including the Study Area, belong (DFO 2011c; Harris et al. 2013). Near the Study Area, northern bottlenose whales have also been detected acoustically between the eastern Scotian Shelf canyons and the Laurentian Channel (Harris et al. 2007). Sighting records also exist for the Grand Banks (Harris et al. 2007; Whitehead and Hooker 2012). Based on the DFO cetacean sightings database, 20 groups of northern bottlenose whales have been sighted (see Table 4.11) in the deeper waters and near the shelf break of the Study Area from March to September (see Figure 4.45). Northern bottlenose whales are expected to, at least, enter the Study Area occasionally, but there is insufficient information to determine to which population whales in the Study Area belong.

4.6.1.4 Beluga (St. Lawrence Estuary Population)

The St. Lawrence Estuary population of beluga whale is listed as *threatened* on Schedule 1 of *SARA* and by COSEWIC. Beluga whales are circumpolar in distribution and found in arctic and sub-arctic regions (Jefferson et al. 2008). Abundance in the Northwest Atlantic is unknown, but just over 1,200 individuals were estimated to comprise the St. Lawrence estuary population in 2005 (Hammill et al. 2007 *in* DFO 2011b). The primary distribution of the St. Lawrence Estuary population is located upstream of the Gulf of St. Lawrence near the outflow of the Saguenay River, but there have been individuals recorded as far away as the Bay of Fundy (COSEWIC 2004). Thus, an occasional beluga could stray into the Study Area at any time of the year. There are no beluga whale sightings for the Study Area in the DFO sightings database.

4.6.1.5 Fin Whale (Atlantic Population)

The fin whale is found in all of the world's oceans, typically offshore in temperate to polar regions (Jefferson et al. 2008). It is designated as *special concern* on Schedule 1 of *SARA* and by COSEWIC. Fin whales were heavily targeted by commercial whalers in Newfoundland and Labrador; the current best estimate for the western North Atlantic is 3,522 individuals (Waring et al. 2013). Lawson and Gosselin (2009) provided an abundance estimate of 890 fin whales for Newfoundland, based on aerial surveys conducted off the southern and eastern coast; the corrected abundance estimate is 1,555 whales (Lawson and Gosselin, unpublished data).

Fin whales can be found as individuals or groups of 2 to 7 animals, but can form much larger feeding aggregations, sometimes with humpback and minke whales (Jefferson et al. 2008). Fin whales feed on small schooling fish and krill (Borobia et al. 1995) and tend to be found in areas where these prey concentrate, such as thermal fronts, areas of upwelling, shelf breaks, and banks (Woodley and Gaskin 1996; COSEWIC 2005; Doniol-Valcroze et al. 2007). Fin whales are common in nearshore areas of the Gulf of St. Lawrence and off Nova Scotia during the summer (COSEWIC 2005). During aerial surveys of the Gulf in late August and early September, fin whales were predominantly found along the margins of the Laurentian Channel (Kingsley and Reeves 1998). Seargent (1977) hypothesized that fin whales summering in the Gulf of St. Lawrence migrated to the Laurentian Channel and northern Nova Scotia during winter.

Fin whales have also been commonly observed on the Grand Banks and along Newfoundland's south coast during summer months (Piatt et al. 1989; Meltzer Research and Consulting 1996). Based on the DFO sighting database, fin whales have been seen in the Study Area from spring through fall, with the majority of sightings during the summer (see Table 4.11). Sightings were primarily in waters <500 m deep but also occurred in deeper waters (see Table 4.11; Figure 4.44). Fin whales are expected to commonly occur in the Study Area year-round, although they are likely more common during the summer.

4.6.1.6 Sowerby's Beaked Whale

The Sowerby's beaked whale is designated as *special concern* (Schedule 1) by *SARA* and COSEWIC. It is a small beaked whale found only in the North Atlantic, primarily in deep, offshore temperate to subarctic waters (COSEWIC 2006b). It is the most northerly distributed of the *Mesoplodon* spp., with all but one record occurring in the Northwest Atlantic between New England and Labrador (MacLeod 2000; MacLeod et al. 2006). There are an unknown number of Sowerby's beaked whales in the North Atlantic, but they are only rarely encountered offshore of eastern Newfoundland and Labrador. They are most often observed in deep water, along the shelf edge and slope. One sighting of four individuals was made during a seismic survey in Orphan Basin in 2005 (Moulton et al. 2006b). It is unclear if Sowerby's beaked whales are uncommon or poorly surveyed because of their deep-diving behaviour, small size, and offshore habitat. Observations most frequently occur during the summer, but observer effort is considerably increased during this season in offshore areas of Newfoundland and Labrador (COSEWIC 2006b). Based on analysis of stomach contents, they appear to prefer mid- to deep-water fish and squid (MacLeod et al. 2003; Pereira et al. 2011; Wenzel et al. 2013). Despite the paucity of confirmed sightings, Sowerby's beaked whales may occur in low densities in deep areas in offshore waters of Newfoundland.

4.6.1.7 Leatherback Sea Turtle

The largest and most widely ranging of sea turtles, the leatherback sea turtle, is distributed from sub-polar and cool temperate foraging grounds to tropical and sub-tropical nesting areas in all of the world's oceans (Spotila 2004). Exhibiting wide-ranging oceanic movements, leatherbacks occur in pelagic regions of the North Atlantic to forage on gelatinous zooplankton (Hays et al. 2006). Leatherback sea turtles forage on jellyfish, such as lion's mane and moon jellyfish, in Atlantic Canadian waters; they consume an average of 330 kg wet mass of jellyfish per day (Heaslip et al. 2012). Three primary habitats, likely used as foraging areas by leatherback turtles in Atlantic Canada, were identified using satellite tracking data: (1) the area near Georges Bank, (2) southeastern Gulf of St. Lawrence and waters east of Cape Breton, and (3) waters south and east of Burin Peninsula, Newfoundland (DFO 2011d). These areas may be used to identify critical habitat in the forthcoming amendment to the 2006 leatherback sea turtle recovery plan (DFO 2013j). Genetic analysis on leatherback turtles captured off Nova Scotia revealed that the majority originated from natal beaches in Trinidad, followed by French Guiana, Costa Rica, St. Croix, and Florida (Stewart et al. 2013).

There are an estimated 34,000 to 94,000 leatherback adults in the North Atlantic (TEWG 2007), but there is no current estimate of the number of leatherbacks using eastern Canadian waters (COSEWIC 2012). Nonetheless, James et al. (2006) suggested that Canadian waters support high densities of leatherbacks during the summer and fall, and that Canadian waters should be considered critical foraging habitat for this species. Even though the species appears to be virtually absent during the winter months (James 2000), leatherback turtles have been sighted off the east coast of Canada, and off Newfoundland, during the winter (McAlpine et al. 2007).

The leatherback sea turtle is designated as *endangered* (Schedule 1) by *SARA* and COSEWIC. In the recovery strategy for leatherback sea turtle in the Canadian Atlantic Ocean, the recovery goal is to "achieve the long-term viability of the leatherback turtle populations frequenting Atlantic Canadian waters" (ALTRT 2006). Adult leatherbacks are considered regular summer visitors to eastern Newfoundland, with observations occurring from ~July to October, with a peak in August and September (Goff and Lien 1988). Most sea turtles migrate southward by mid-October (James et al. 2007; Sherrill-Mix et al. 2008). James et al. (2006) noted that increasing sea surface temperatures in Canadian waters result in a significant increase in turtle sightings. Most leatherbacks that occur in Atlantic Canadian waters are large sub-adults and adults, with a female-biased sex ratio among mature turtles (James et al. 2007).

DFO Newfoundland Region has maintained a database of leatherback turtle sightings and entanglements in Newfoundland and Labrador (J. Lawson, DFO Research Scientist, pers. comm., 2013). There are 21 records of leatherback turtles within the Study Area (see Figure 4.47) in the DFO database; most sightings were made during July and August.

4.6.1.8 White Shark

Worldwide, this species is rare but does occur with some predictability in certain areas. The white shark is widely distributed in sub-polar to tropical seas of both hemispheres, but it is most frequently observed and captured in inshore waters over the continental shelves of the northwest Atlantic, Mediterranean Sea, southern Africa, southern Australia, New Zealand, and the eastern north Pacific. The species is not found in cold polar waters (*SARA* website accessed February 2014). The status of the Atlantic population of the white shark for both Schedule 1 of *SARA* and COSEWIC is *endangered*.

Off Atlantic Canada, the white shark has been recorded from the northeastern Newfoundland Shelf, the Strait of Belle Isle, the St. Pierre Bank, Placentia Bay, Sable Island Bank, the Forchu Misaine Bank, in St. Margaret's Bay, off Cape La Have, in Passamaquoddy Bay, in the Bay of Fundy, in the Northumberland Strait, and in the Laurentian Channel as far inland as the Portneuf River Estuary. In recent years, numerous white sharks have been tagged by OCEARCH, a non-profit organization devoted to global-scale research on white sharks and other large apex predators, providing open source, near-real time data (including satellite tracks) through the Global Shark Tracker (www.ocearch.org/tracker). An adult female, 'Lydia,' originally tagged in March 2013 off Jackson, Florida, was noted within and/or in the immediate vicinity of the Study Area from October 2013 through February 2014 (Global Shark Tracker accessed 18 February 2014). The species is highly mobile, and individuals in Atlantic Canada are likely seasonal migrants belonging to a widespread northwest Atlantic population. It occurs in both inshore and offshore waters, ranging in depth from just below the surface to just above the bottom, down to a depth of at least 1,280 m (*SARA* website accessed February 2014).

With respect to reproduction, the female produces eggs which remain in her body until they are ready to hatch. When the young emerge, they are born live. Gestation period is unknown, but may be about 14 months. Litter size varies, with an average of 7 pups. Length at birth is assumed to be between 109 and 165 cm. Possible white shark pupping areas on the west and east coasts of North America include off southern California and the Mid-Atlantic Bight, respectively (*SARA* website accessed February 2014).

The white shark is an apex predator with a wide prey base, feeding primarily on many types of fish, marine mammals, squid, molluscs, crustaceans, marine birds, and reptiles. There has, however, been one recorded occurrence of an orca preying on a white shark (*SARA* website accessed February 2014).

4.6.1.9 Wolffishes

Three species of wolffish (i.e., northern, spotted, and Atlantic) are the only marine fishes currently listed under Schedule 1 of *SARA*. Both the northern and spotted wolffishes are currently listed as *threatened* on Schedule 1 of *SARA* and under COSEWIC. The Atlantic wolffish is currently considered as *special concern* on Schedule 1 of *SARA* and under COSEWIC. The combined recovery strategy for northern and spotted wolffishes and management plan for Atlantic wolffish was finalized in 2008 (Kulka et al. 2007). Recently, a report on the progress of the implementation of the recovery strategy and management plan was published (DFO 2013k). It reports that the recovery strategy (Kulka et al. 2007) is presently being updated and will include identified critical habitat for both northern and spotted wolffish. The progress report also states that the status of each of the three wolffish species was re-assessed by COSEWIC in November 2012 and that the recommendation was to retain the current designations. At a 2010 meeting for the Zonal Advisory Process for the Pre-COSEWIC Assessment of these three wolffish species, it was stated that there have not been any significant advances in DFO's understanding of life history characteristics of the three species in recent times (DFO 2011e).

Northern Wolffish

The northern wolffish is a deepwater fish of cold northern seas that has been caught at depths ranging from 38 to 1,504 m, with observed densest concentrations between 500 and 1,000 m at water temperatures of 2 to 5°C. During 1980-1984, this species was most concentrated on the northeast Newfoundland and Labrador shelf and banks, the southwest and southeast slopes of the Grand Banks, and along the Laurentian Channel. Between 1995 and 2003, the area occupied and density within the area was considerably reduced compared to results of earlier surveys. Northern wolffish are known to inhabit a wide range of bottom substrate types, including mud, sand, pebbles, small rock and hard bottom, with highest concentrations observed over sand and shell hash in the fall, and coarse sand in the spring. Unlike other wolffish species, both juvenile and adult stages of this species have been found a considerable distance above the bottom, as indicated by diet (Kulka et al. 2007).

Prey of northern wolffish are primarily bathypelagic (>200 m depth) biota such as ctenophores and medusa, but also include mesopelagic biota (<200 m depth) and benthic invertebrates. Pelagic fish represent the largest percentage of stomach contents on the basis of volume. Tagging studies have suggested limited migratory behaviour by these wolffish. Northern wolffish typically spawn late in the year on rocky bottom. Cohesive masses of fertilized eggs are laid in crevices but are unattached to the substrate. Pelagic larvae hatch after an undetermined egg incubation time, and typically feed on crustaceans, fish larvae and fish eggs (Kulka et al. 2007).

During DFO RV surveys conducted in the Study Area during 2007-2011, 283 northern wolffish were caught (see Table 4.4 in Section 4.3.7). Most of the northern wolfish were caught in the central and northern parts of the Study Area, primarily along the upper slope where water depths ranged from 200-1,000 m (see Figure 4.41 in Section 4.3.7).

Spotted Wolffish

The life history of the spotted wolffish is very similar to that of the northern wolffish except that it seldom inhabits the deepest areas used by the northern wolffish. Although spotted wolffish have been caught at depths ranging from 56 to 1,046 m, the observed densest concentrations occur between 200 and 750 m at water temperatures of 1.5 to 5°C. During 1980-1984, spotted wolffish were most concentrated on the northeast Newfoundland and Labrador shelf and banks, the southwest and southeast slopes of the Grand Banks, along the Laurentian Channel, and in the Gulf of St. Lawrence. Between 1995 and 2003, the area occupied and density within the area was considerably reduced compared to results of earlier surveys. As with northern wolffish, spotted wolffish also inhabit a wide range of bottom substrate types, including mud, sand, pebbles, small rock and hard bottom, with highest concentrations observed over sand and shell hash in the fall, and coarse sand in the spring (Kulka et al. 2007).

Prey of spotted wolffish are primarily benthic (>75%), typically including echinoderms, crustaceans, and molluscs associated with both sandy and hard bottom substrates. This species is referred to as an echinoderm specialist (i.e., benthivore) (DFO 2011e). Fish also constitutes part of the spotted wolffish diet (<25%). Tagging studies indicate the spotted wolffish migrations are local and limited. Spotted wolffish reproduction includes internal fertilization. In Newfoundland and Labrador waters, this typically occurs in July and August on stony bottom. Cohesive masses of eggs are deposited in crevices, remaining unattached to the substrate. After an undetermined incubation time, pelagic larvae hatch and start to feed on crustaceans, fish larvae and fish eggs within a few days of hatching (Kulka et al. 2007).

During DFO RV surveys conducted in the Study Area during 2007-2011, 155 spotted wolffish were caught (see Table 4.4 in Section 4.3.7). Most of the spotted wolfish were caught in the central and northern parts of the Study Area, primarily along the upper slope where water depths ranged from 200-1,000 m (see Figure 4.41 in Section 4.3.7).

Atlantic Wolffish

Atlantic wolffish is primarily demersal and inhabit shallower areas than the northern and spotted wolffishes. This species has been observed from near shore to a depth of 918 m at water temperatures ranging from -1 to 10°C, but are most common at water depths of 150 to 350 m with water temperatures ranging from 1.5 to 4°C. During 1980-1984, this species was most concentrated in the same areas as the northern wolffish, with additional concentrations on the southern Grand Banks and the Gulf of St. Lawrence. More recently, the area occupied and density within the area was considerably reduced in the northern part of its confirmed range, but has remained relatively constant in the Gulf of St. Lawrence.

Unlike the northern and spotted wolffishes, Atlantic wolffish are often observed by divers close to shore, and they form dense concentrations offshore. During its feeding period, this wolffish species appear to prefer complex reliefs of rocks without algal growth and sand. Shelters in these rock reliefs are typically situated on 15-30° slopes with good water circulation. There is some indication that Atlantic wolffish form colonial settlements during the feeding period (Kulka et al. 2007).

Prey of Atlantic wolffish are primarily benthic (>85%), typically including echinoderms (e.g., sea urchins), crustaceans (e.g., crabs) and molluscs (e.g., scallops) associated with both sandy and hard bottom substrates. This species is referred to as a mollusc specialist (i.e., benthivore) (DFO 2011e). Fish also constitutes part of the spotted wolffish diet (<15%) (e.g., redfish). Migration by Atlantic wolffish is also limited, with seasonal inshore movement in the spring when mature fish are found in areas with water depths <15 m. These wolffish seem to prefer stony bottom substrate for spawning in September and October in Newfoundland and Labrador waters. After internal fertilization, cohesive masses of eggs are deposited in crevices on the bottom, remaining unattached to the substrate. The egg mass is guarded and maintained by the male Atlantic wolffish for the 7 to 9 month incubation time, after which pelagic larvae hatch and commence to feed on crustaceans, fish larvae and fish eggs within a few days of hatching (Kulka et al. 2007).

During DFO RV surveys conducted in the Study Area during 2007-2011, 2,837 Atlantic wolffish were caught (see Table 4.4 in Section 4.3.7). Atlantic wolfish catches were distributed throughout the shelf region of the Study Area, with highest catches recorded along the eastern slope of the Southern Grand Bank, and in the areas of St. Pierre Bank, Halibut Channel and Haddock Channel where water depths range from <200-1,000 m (see Figure 4.42 in Section 4.3.7).

4.7 Sensitive Areas

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

Provincial parks are administered under the *Provincial Parks Act* (1970), while sensitive areas such as ecological reserves are administered under the provincial *Wilderness and Ecological Reserves Act* (1980). National parks are administered under the *National Parks Act* (2000) and National Marine Conservation Areas (NCMAs) is established under the *Canada National Marine Conservation Areas Act* (2002). Marine Protected Areas (MPAs) are administered under the *Oceans Act* (1996).

The 19 sensitive areas that either overlap or are proximate to (within 20 km) the Study Area are discussed in the following sections (see Figure 4.48).

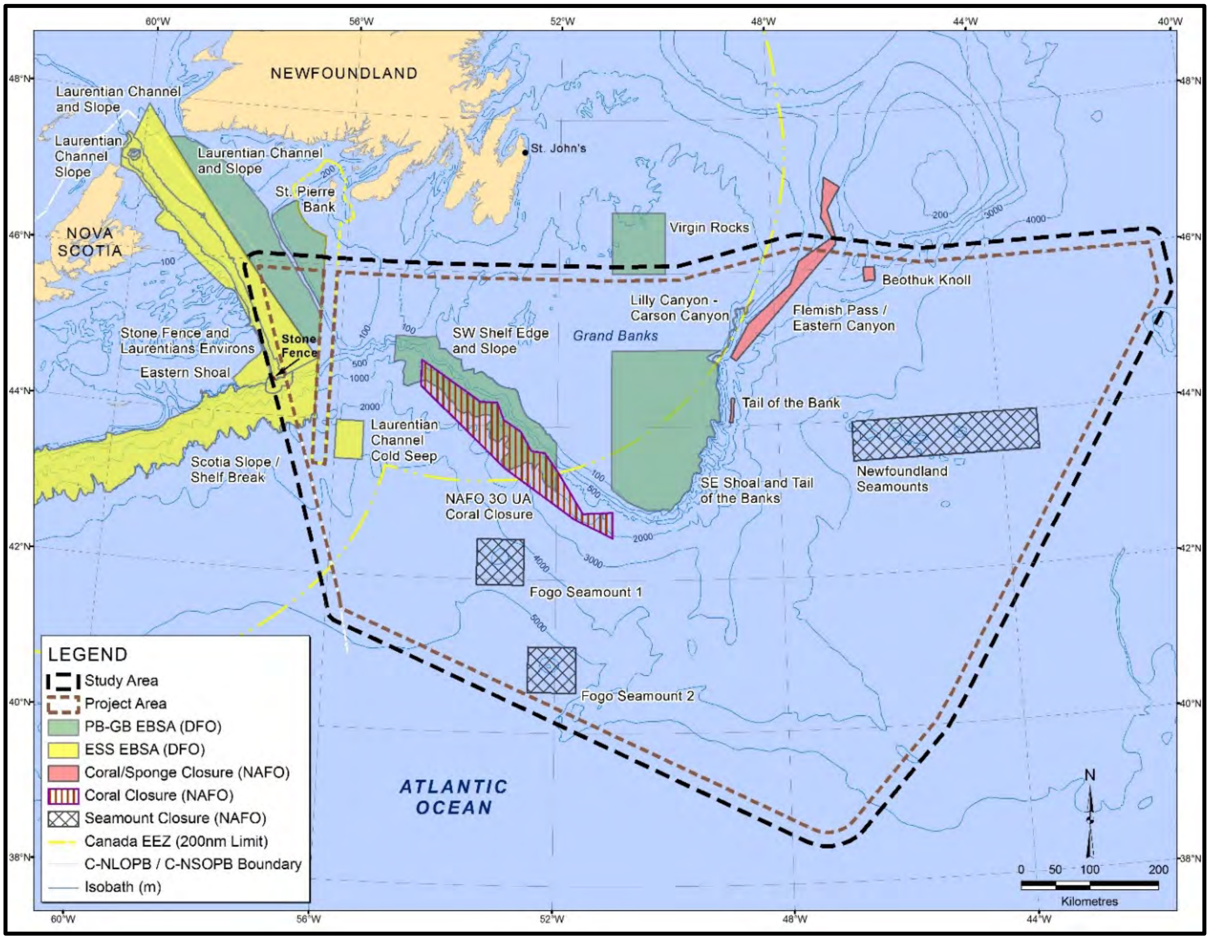


Figure 4.48 Sensitive Areas either Overlapping or Proximate to the Study Area.

4.7.1 Ecologically and Biologically Significant Areas (EBSAs)

There are 12 EBSAs associated with either the Placentia Bay-Grand Banks Large Ocean Management Area (PB-GB LOMA) (DFO 2012d) or the Eastern Scotia Shelf (ESS) (Doherty and Horsman 2007) that are relevant to this EA.

4.7.1.1 Placentia Bay-Grand Banks Large Ocean Management Area

The six PB-GB LOMA EBSAs that either overlap or are proximate to the Study Area are as follow:

- The Southeast Shoal and Tail of the Banks EBSA;
- The Southwest Shelf Edge and Slope EBSA;
- St. Pierre Bank EBSA;
- Laurentian Channel and Slope EBSA;
- Virgin Rocks EBSA; and
- Lilly Canyon-Carson Canyon EBSA.

The key attributes of the six PB-GB LOMA EBSAs are presented in Table 4.14 (DFO 2007b).

Table 4.14 Key Attributes of PB-GB LOMA EBSAs either Overlapping or Proximate to the Study Area.

EBSA	Key Attributes
Southeast Shoal and Tail of the Banks	• Only known offshore spawning site for capelin; • Single nursery area for all yellowtail flounder; • Highest benthic biomass on the Grand Bank; • Relict populations of blue mussels and wedge clams; • Spawning location for sand lance; • Spawning location for yellowtail flounder, American plaice and Atlantic cod; • Important nursery area for Atlantic cod and American plaice; • Aggregations of humpback and northern bottlenose; whales, and seabirds in response to presence of forage species; • Area of high primary productivity; and • Highest concentration of Atlantic wolffish
Southwest Shelf Edge and Slope	• Highest density of pelagic seabird feeding within the PB-GB LOMA; • Northernmost population of haddock in the northwest Atlantic Ocean; • High concentration of cold-water corals; • Greatest number of groundfish species on the Grand Banks; • High productivity; • Area of aggregation of marine mammals and sea turtles, particularly in summer; • Area of aggregation for Atlantic halibut in the spring; • Area of aggregation for feeding monkfish, pollock and white hake, particularly in spring; • Important spawning area for redfish; and • Migration route for cod
St. Pierre Bank	• Highest concentration of sea scallops on the Grand Banks; • Highest concentration of spiny dogfish; and • Feeding area for a number of overwintering and migrating cetaceans
Laurentian Channel and Slope	• Only pupping grounds for black dogfish off Canada; • Important migratory corridor for marine mammals moving in and out of the Gulf of St. Lawrence; • Enhanced year-round productivity due to upwelling; • Important nursery area for smooth skate; • Area of aggregation for feeding monkfish, pollock and white hake, particularly in spring; • Important migratory corridoe for various fishes
Virgin Rocks	• Aggregation area for capelin and feeding seabirds; • Spawning location for various groundfish, including Atlantic cod, American plaice and yellowtail flounder
Lilly Canyon-Carson Canyon	• Important to the feeding and productivity of Iceland scallops • Year-round aggregations of marine mammals feeding and overwintering

Source: DFO 2007b.

4.7.1.2 Eastern Scotia Shelf (ESS) (Doherty and Horsman 2007)

The six ESS EBSAs that either overlap or are proximate to the Study Area are as follows:

- Eastern Shoal EBSA;
- Stone Fence and Laurentian Environs EBSA;
- Laurentian Channel and Slope EBSA;
- Laurentian Channel Slope EBSA;
- Laurentian Channel Cold Seep EBSA; and
- Scotia Slope/Shelf Break EBSA.

The key attributes of the six ESS EBSAs are presented in Table 4.15.

Table 4.15 Key Attributes of ESS EBSAs either Overlapping or Proximate to the Study Area.

EBSA	Key Attributes
Eastern Shoal	• Aggregation of surf clams, sand lance, scallops and quahogs; • Significant area for plankton
Stone Fence and Laurentian Environs	• Only confirmed location of the coral *Lophelia* pertusa on the Scotian Shelf; • Location for many other corals as well; • Potentially important area for juvenile fishes; • High diversity of cetaceans
Laurentian Channel and Slope	• Overwintering area for 4VS cod, white hake, Dover sole, Greenland halibut, redfish and Greenland shark; • Important migration route in and out of the Gulf of St. Lawrence
Laurentian Channel Slope	• Area of high demersal, pelagic and mesopelagic fish diversity; • Portion of important mating area for porbeagle sharks; • Primary overwintering area for 4T cod and white hake; • Important krill aggregation area; • Important overwintering area for *Calanus*
Laurentian Channel Cold Seep	• Large dense chemosynthetic communities of vesicomyid and thyasind clams, gastropods and galatheid crabs; • Occurrence of unique polychaete species
Scotia Slope/Shelf Break EBSA	• High finfish diversity; • Primary residence for mesopelagic fishes; • Occurrence of corals, whales, porbeagle shark, tuna and swordfish; • Primary migratory route for large pelagic fishes; • Migratory route for whales and leatherback sea turtles; • High diversity of squids; • Overwintering area for Atlantic halibut and lobster; • Seabird feeding and overwintering area; and • Occurrence of Greenland shark

Source: Doherty and Horsman 2007.

4.7.2 Canada-NAFO 3O Coral Closure Area

A CAD-NAFO Coral Protection Zone currently exists as a mandatory temporary closure on the slope of the Grand Bank in NAFO Div. 3O between 800 and 2,000 m (see Figure 4.48) (NAFO 2014). The protection zone, which encompasses an area of 14,040 km2, was initiated by the Canadian-NAFO Working Group and implemented by NAFO. The purpose of the closure is to protect corals found in the area and 'freeze the footprint' of fishing activities in deeper waters (Wareham 2009). This area is closed to all bottom fishing activities until at least 31 December 2014.

4.7.3 NAFO Seamount Closure Areas

The term 'Vulnerable Marine Ecosystem (VME) Element' refers to topographical, hydrophysical or geological features which potentially support VMEs including slopes, summits and flanks of seamounts and knolls, and canyons. Three NAFO seamount closure areas occur entirely within the Study Area: (1) Fogo Seamount 1; (2) Fogo Seamount 2; and (3) Newfoundland Seamounts (see Figure 4.48). These areas are closed to all bottom fishing activities until at least 31 December 2014 (NAFO 2014).

4.7.4 NAFO Coral/Sponge Closure Areas

In 2008 and 2009, the NAFO Scientific Council identified areas of significant coral and sponge concentrations within the NAFO Regulatory Area. Based on these identifications, areas for closure to fishing with bottom contact gear were delineated. Figure 4.48 shows the locations of three of these areas that occur either entirely or partially within the Study Area. Implementation date of the closures was 1 January 2010. These areas are closed to all bottom fishing activities until at least 31 December 2014 (NAFO 2014).