4.0 Biological Environment

The biological environment in and near the Study Area has been recently described in the Southern and Eastern Newfoundland SEAs (C-NLOPB 2010, 2014), and in an EA of the southern Grand Banks area prepared for MKI (LGL 2014a). In addition to updated information, overviews of relevant information are presented in the following subsections for fish and fish habitat, fisheries, seabirds, marine mammals, sea turtles, species at risk and sensitive areas.

4.1 Ecosystem

An ecosystem is an inter-related complex of physical, chemical, geological, and biological components that can be defined at many different scales from a relatively small area that may only contain one habitat type (e.g., a shelf) to a relatively large regional area ecosystem which is topographically and oceanographically complex with shelves, slopes, valleys and several major water masses and currents (e.g., the NW Atlantic). This EA focuses on components of the ecosystem such as selected species and stages of fish, seabirds and marine mammals that are important ecologically, economically, and/or socially, with potential to interact with the Project. This is the VEC approach to environmental assessment which is detailed in Section 5.0. The VECs and/or their respective groups are 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

As noted earlier, water depth within the Study Area ranges from just under 100 m to >5,000 m (see Figure 1.1). Bathymetric features of the Study Area were presented in Section 3.1 of this EA.

4.2.1.2 Surficial Sediment

The surficial geology of portions of the Study Area was discussed in LGL (2009a,b, 2014), and subsequently summarized in the Southern Newfoundland SEA (C-NLOPB 2010). The following information was obtained from the Southern Newfoundland SEA (C-NLOPB 2010).

As noted earlier, five surficial sedimentary formations are recognized within the SEA Area and they consist of glacial tills, proglacial silts, sublittoral sands, recent mud, and basal transgressive sand and gravel. Descriptions of these sedimentary formations are provided below (Fader et al. 1982; Brown 1990; Piper et al. 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 Study Area, Downing Silt is exposed primarily 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 Study Area, this unit is found at the base of the Halibut Channel. Iceberg furrows occur across many areas of Adolphus Sand. 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 in 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 dominant species in the fall bloom 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 which has been reviewed extensively in the Southern Newfoundland SEA (C-NLOPB 2010) is summarized briefly in this 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 Study 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 slope and shelf of the southwest Grand Bank.

- 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 2014a). The AZMP findings in relation to oceanographic conditions in the Study Area for 2013 are summarized below.

- Sea-surface temperatures were at record highs in September 2013 on the Grand Banks, and generally above normal during ice-free months, across the zone. Bottom temperatures were generally above normal across the zone.

- Nitrate inventories in both surface and subsurface waters were below normal on the Newfoundland and Labrador Shelf and Grand Banks.

- Overall abundance of phytoplankton was near the long-term (1999-2010) average throughout much of the Atlantic Zone in 2013. Chlorophyll anomalies have been below normal across much of the Newfoundland and Labrador Shelf since 2011 but increased slightly on the Grand Banks in 2013.

- 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 Newfoundland shelf and Grand Banks in 2013.

- 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 and 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 inter-annual 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).

Because planktonic organisms are so ubiquitous and abundant, and many have such rapid generation times, 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 Newfoundland SEA (C-NLOPB 2010) and in Section 4.2.2.2 of this EA.

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 (C-NLOPB 2010) 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 North Atlantic Fisheries Organization (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, and 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*.

Also, in a study conducted by Houston and Haedrich (1984), grab samples were taken in the vicinity of Carson Canyon (continental edge and slope) on the southeastern Grand Banks that revealed communities dominated by polychaetes, hooded shrimp, sipunculid worms, amphipods, echinoderms, isopods and bivalves. The relative dominance of these taxa depended on the substrate, although polychaetes were among the top four abundant taxa in each of sand, gravel and silt (Houston and Haedrich 1984).

LGL analysis of DFO RV data for 2008-2012 indicated that sponges accounted for the second highest catch weight of benthic invertebrates during this period and the twelfth highest catch weight of all biota caught during the RV surveys in that five year period. Other invertebrate benthos with relatively high catch weights included sea cucumbers, polar sea stars, and snow crab (see Table 4.8 in Section 4.3.7 of this EA).

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 coral (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 and 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 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 between 2008 and 2012, 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 4.60 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 4.59 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*)). Some of the 'incidental catch' species are also discussed in this section.

Macroinvertebrates

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 2014b). Snow crab distribution is widespread and continuous in waters off Newfoundland and southern Labrador. Generally, during development, snow crabs undertake a migration from shallow cold areas with hard substrates to warmer deeper areas with soft substrates. Large males are most commonly found on mud or mud/sand, while smaller crabs are more common on harder substrates (DFO 2014b).

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 2014b). 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 2014b).

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 2014b).

Snow crab landings in NAFO Div. 3LNO (offshore) between 2009 and 2013 have increased by 20% while landings in NAFO Div. 3Ps (offshore) declined by 16% between 2011 and 2013 (DFO 2014b). Long-term recruitment prospects in these NAFO Divisions are considered unfavourable due to a recent warming oceanic regime (DFO 2014b).

In the commercial fishery conducted within the Study Area between 2005 and 2013, snow crab catches were most concentrated along the eastern and southern shelf edge of the Southern Grand Bank (NAFO UAs 3Lt, 3Nb, 3Nd, 3Ne and 3Nf), in the northwestern part of the Study Area in the Halibut and Haddock Channels and at a few locations on the inner shelf of the Southern Grand Banks. Most of the snow crab catches in the Study Area during 2005-2012 occurred at locations with water depths <200 m (see Figures 4.15 to 4.18 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 2013a). 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 2013a).

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 2013a). Spawning takes place between late spring or summer and late autumn, depending on location (DFO 2003, DFO 2013a). 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 2013a). 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 2013a). 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. The 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 2013a). The fishery runs from April 1 to September 30 (DFO 2013a). 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 2013a).

In the commercial fishery conducted within the Study Area between 2005 and 2013, whelk catches were most concentrated in the northwestern part of the Study Area on St. Pierre Bank. The whelk catches in the Study Area during 2005-2013 occurred at locations with water depths <200 m (see Figures 4.31 to 4.34 in Section 4.3.3.2).

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).

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 1997and Born et al. 2003 *in* Christian et al. 2010).

In the commercial fishery conducted within the Study Area between 2005 and 2011, cockle catches were reported in the north-central part of the Study Area on the eastern portion of the Southern Grand Bank. The cockle catches in the Study Area during 2005-2011 occurred both on the shelf (<200 m depth) and on the slope (>200 m depth) (see Figures 4.27 and 4.28 in Section 4.3.3.2).

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, which does not have a high exploitation

rate, is thought to be relatively healthy. The fishery typically takes place in areas with water depths of 45 to 65 m (Roddick 2013).

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 2013b). Larger individuals generally occur in deeper waters (DFO 2013c). 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 2013c).

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 2013b). 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 2013c). 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 2013c).

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 (*Pagophilus groenlandicus*). Northern shrimp are vulnerable to these predators regardless of whether they have a soft shell or not (DFO 2013b).

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 4,300 t by 2014 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 only one country 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 2014). 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. Recent assessments for Northern shrimp, in waters beyond the Canadian EEZ, indicate that stocks are at (Div. 3LNO) or below (Div. 3M) the biomass limit reference point and therefore directed fisheries have not been advised by NAFO (NAFO 2014a).

Fishes

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 2013d). The northern limit of commercial concentrations extends to the Grand Banks off the east coast of Newfoundland. Mark and recapture data indicate 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 2006). 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 farther north is also slower with maturity occurring by age 4-6 compared to age 2-3 in the southern range (DFO 2013d).

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 2013d).

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 2006). 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).

In the commercial fishery conducted within the Study Area between 2005 and 2013, yellowtail flounder catches were reported in the north-central part of the Study Area in the region of the Southeast Shoal. Yellowtail catches in the Study Area during 2005-2013 occurred on the shelf (<200 m depth) (see Figures 4.21 to 4.24 in Section 4.3.3.2).

During DFO RV surveys conducted between 2008 and 2012, yellowtail flounder were caught primarily on the shelf areas of the Southern Grand Bank and St. Pierre Bank (see Figure 4.55 in Section 4.3.7).

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). 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 and Paz 2014a) 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).

In the commercial fishery conducted within the Study Area between 2005 and 2012, redfish catches were reported along the slope of the Southern Grand Bank on both its west and east sides (see Figures 4.37 to 4.39 in Section 4.3.3.2).

During DFO RV surveys conducted between 2008 and 2012, redfish were caught primarily along the slope of the Southern Grand Bank (see Figure 4.54 in Section 4.3.7).

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 five 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), (4) southern Newfoundland cod (3Ps), and (5) northern Gulf cod (4RS3Pn). 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 the commercial fishery conducted within the Study Area between 2005 and 2013, Atlantic cod catches were reported in the central and western parts of the Study Area, both on the shelf and along the slope of the Southern Grand Bank (see Figures 4.42 to 4.45 in Section 4.3.3.2).

During DFO RV surveys conducted between 2008 and 2012, Atlantic cod were caught primarily towards the outer shelf and slope areas of the Southern Grand Bank and St. Pierre Bank (see Figure 4.57 in Section 4.3.7).

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 2013 for white hake in Div. 3NO indicate that biomass has been increasing in recent years but remains at very low levels (González-Troncoso and Paz 2014b).

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 eat krill and some fishes (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 et al. 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).

During DFO RV surveys conducted between 2008 and 2012, American plaice were caught primarily towards the outer shelf and slope areas of the Southern Grand Bank and St. Pierre Bank (see Figure 4.56 in Section 4.3.7).

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 2014c).

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 2014c), still possess problems with regard to bycatch in the pelagic longline fishery.

Atlantic Wolffish

The Atlantic wolffish is primarily demersal and it inhabits 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 2011b). 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).

DFO RV data collected during the 2008 to 2012 period indicated that 2,352 individual Atlantic wolffish were caught within the Study Area (see Table 4.8 in Section 4.3.7). The most concentrated Atlantic wolffish catches occurred in the central (Southeast Shoal) and northwestern portions of the Study Area, both on the shelf and along the slope (see Figure 4.61 in Section 4.3.7).

4.2.2.2 Macroinvertebrate and Fish Reproduction in the Study Area

Temporal and spatial reproduction specifics for macro-invertebrates 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
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
Whelks	Eggs deposited in masses on bottom	May to July	No planktonic stage
Greenland Cockle	Eastern Grand Banks	Uncertain	Uncertain
Stimpson's Surf Clam	Eastern Grand Banks	Fall	4 to 8 weeks
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
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
Redfish	Primarily along edge of shelf and banks, in slope waters, and in deep channels	Mating in late winter and release of young between April and July (peak in April)	No planktonic stage
Atlantic Cod	Spawn along outer slopes of the shelf in depths from tens to hundreds of metres	March to June	10 to 12 weeks
American Plaice	Spawning generally occurs throughout the range the population inhabits.	April to May	12 to 16 weeks
Swordfish	NW Atlantic population believed to spawn in the Caribbean Sea, Gulf of Mexico, and off Florida.	Year-round	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 2005–2013. Figure 4.1 shows the locations of the Study, Project and 2015 2D Survey areas in relation to regional fisheries management areas. As the figure indicates, the Study Area comprises portions of NAFO Divisions 3LMNO, 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 Section 4.2 on fish and fish habitat.

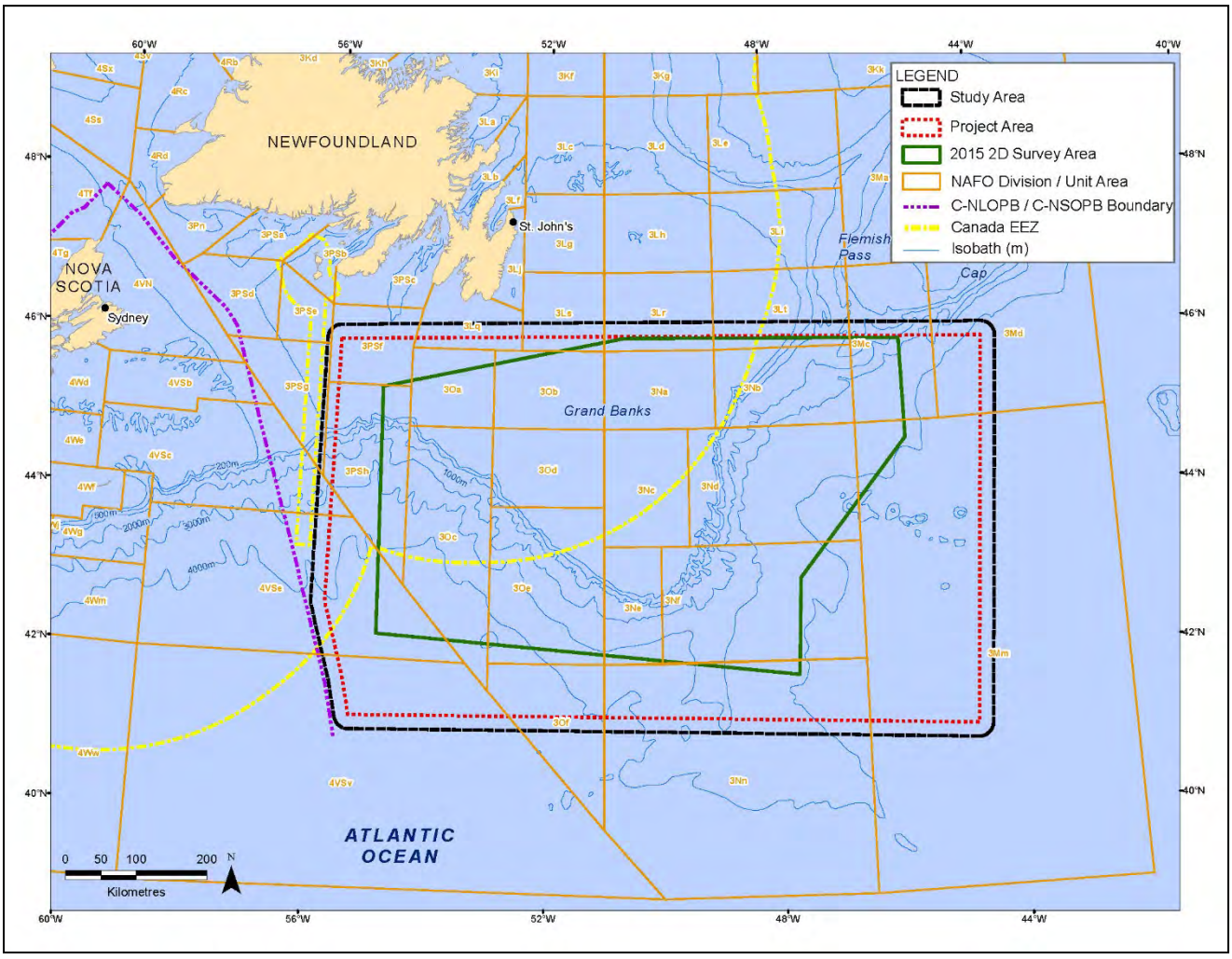


Figure 4.1 Study Area, Project Area, and 2015 2D Survey Area in Relation to Regional Fisheries Management Areas (NAFO Divisions and Unit Areas).

4.3.1 Information Sources

The primary fisheries data analyses use all DFO Atlantic Regions georeferenced landings data for the 2005–2010 time period. The 2011, 2012 and 2013 landings data were provided as ranges of catch weight and catch value within 6 min x 6 min cells (latitude x longitude). Figures based on the 2005-2013 commercial fishery databases are included in this section. The DFO datasets record domestic harvest landed in Canada.

The 2005–2010 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, generally fished by larger vessels, tend to have a greater proportion of their catches georeferenced than those closer to shore. Certain inshore species (e.g., lobster) are not georeferenced. While much of the data have associated latitude and longitude information, virtually all the data have 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 2005–2010 fishing seasons.

The maps in this section show harvesting locations for 2005–2010, based on the latitude and longitude (lat/long) data, as dark points. The data coordinates provided are those recorded in the vessel's fishing log, and is reported in the DFO datasets by degree and minute of lat/long; 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 during consultations conducted for previous EAs. They have proven to be particularly useful in understanding the likely location of gear concentrations and timing of fisheries in order to minimize potential conflict between the fishers and other marine users. DFO catch data for 2011, 2012 and 2013, 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 to calculate compensation.

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 (see Figure 4.1). The NAFO data are derived from the STATLANT 21 data set for 2005–2013. 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 3LMNO, 3Ps and 4Vs (see Figure 4.1).

Various groups were involved in consultations that included discussions related to fisheries (see Section 5.1.1). One purpose of the consultations was to gather both spatial and temporal information about fisheries and to determine any issues or concerns to be considered in the EA. In addition, the consultations provided a means for discussion about potential mitigations meant to minimize the potential impacts of activities 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, the Southern and Eastern Newfoundland SEAs (C-NLOPB 2010, 214).

4.3.2 Regional NAFO Fisheries

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), yellowtail flounder (3LNO stocks), witch flounder (3L, 3NO stocks), white hake (3NO stock), capelin (3NO stock), skates (3LNO stock), Greenland halibut (3LMNO stock), squid (*Illex* sp.; 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.

As noted previously, most of the Study Area occurs outside of Canada's 200 nm EEZ. The Study Area overlaps portions of NAFO Divisions 3LMNO, 3Ps and 4Vs (see Figure 4.1). During the 2005–2013 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 (13%; exclusively in Divisions 3L and 3M; primarily in 3L), Atlantic redfishes (11%; primarily in 3M and 3O), surf clam (10%; primarily in 4Vs), Atlantic cod (8%; primarily in 3Ps), capelin (7%; primarily in 3L), and Greenland halibut (6%; primarily in 3L). The highest catch weights during the nine-year period were taken in NAFO Division 3L (38%), followed by 4Vs (16%), 3Ps (15%), 3M (13%), 3N (11%) and 3O (7%). Canadian vessels accounted for 71% of the commercial catch weight reported for this area during 2005–2013. Only in Division 3M did foreign vessels dominate catches (>99% of total catch weight in this Division). Catches by Canadian and foreign vessels were approximately equal in Divisions 3N and 3O. Catches in 3M were dominated by northern shrimp, Atlantic redfishes, Atlantic cod, and Greenland halibut. Catches in 3N were dominated by yellowtail flounder, skates, snow crab, and unidentified marine molluscs. Catches in 3O were dominated by Atlantic redfishes, snow crab, and yellowtail flounder.

4.3.3 Domestic Fisheries

This section provides an overview of the domestic 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 section

provides recent information for the georeferenced (lat/long) data recorded specifically within the Study Area for 2005–2010 and gridded cell (6 min x 6 min) data for 2011, 2012 and 2013. Statistical summaries of the commercial catch data are provided for the Study, Project and 2015 2D Survey Areas.

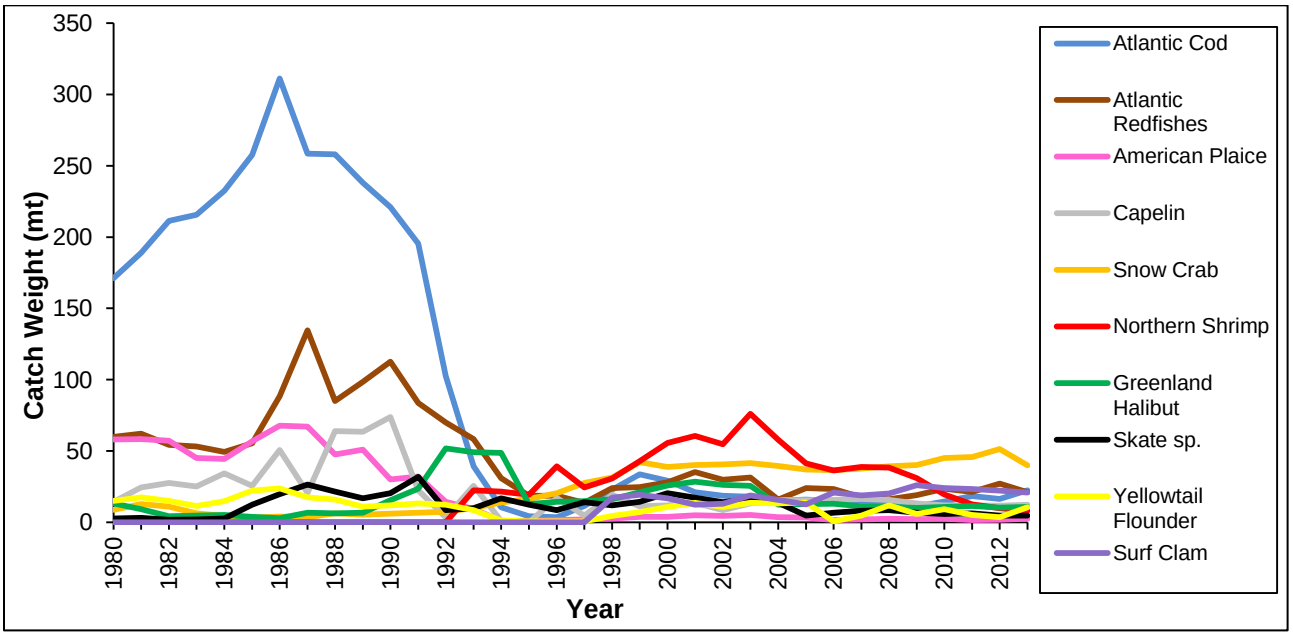
4.3.3.1 Historical Fisheries

A historical overview of fisheries was given in Section 3.3.1.1 of the Southern Grand Banks SEA (C-NLOPB 2010) and Section 4.3.4.2 of the Eastern Newfoundland SEA (C-NLOPB 2014). Commercial fish harvesting in many parts of Newfoundland and Labrador has changed considerably over the last two decades, shifting from a groundfish-based to a shellfish-based industry. In the early 1990s, a harvesting moratorium was imposed on several commercially important groundfish species so that directed fisheries for Atlantic cod and other groundfish were no longer permitted in most areas. The shifting environmental conditions were favourable for crustaceans (e.g., colder water temperature) and rapid declines in Newfoundland and Labrador's groundfish stocks resulted in the rapid growth of crustacean populations such as northern shrimp and snow crab. All fish have physiological limits within which they can survive, such as sea temperatures and salinities (Rose 2005). Frank et al. (1990) analyzed the effects of changes in oceanographic conditions induced by a global increase in atmospheric CO_2, and their models predicted a general warming and freshening of the continental shelf waters, leading to shifts in the geographic distribution of important commercial groundfish stocks, earlier arrival and later departures times for highly migratory large pelagics, and, in combination with increased water column stratification, decreased organic material reaching the seabed. Rose (2005) inferred that capelin and Atlantic herring react strongly and quickly to climate change, owing to their physiological limits and potential for fast population growth. This was verified through examination of historical data from Icelandic and Greenland waters, which warmed considerably during 1920 to 1940, resulting in capelin, Atlantic herring, Atlantic cod, and other species quickly shifting northwards.

The Study Area fisheries were not exceptions to this trend away from groundfish and towards crustaceans (e.g., Buchanan et al. 2006; LGL 2009a, 2014; C-NLOPB 2010). In the late 1980s, the fisheries in NAFO Divisions 3LMNO, 3Ps and 4Vs largely targeted Atlantic cod, redfishes, American plaice and capelin (Figure 4.2). 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 (Figure 4.2). Since the early 1990s, much lower quotas have been allowed, based on scientific advice and other considerations. Atlantic cod and American plaice remain priority species for Canada in a number of NAFO Divisions, and Integrated Fisheries Management Plans (IFMPs) are currently in place for these and several other species in the Newfoundland and Labrador region, including several groundfish species, northern shrimp, snow crab, yellowtail flounder, Atlantic mackerel, Atlantic swordfish and various tunas (DFO 2014d). Today, there is limited directed fishery for Atlantic cod and only a modest by-catch is allowed (DFO 2013).

Overall, the Study Area groundfish fishery has become greatly reduced while the invertebrate fisheries have grown in importance. Invertebrate catches, most notably snow crab and northern shrimp, have become increasingly important within the Study Area, particularly since the mid-1990s. However, northern shrimp stocks have recently begun to decline, with poor recruitment and drastic declines in

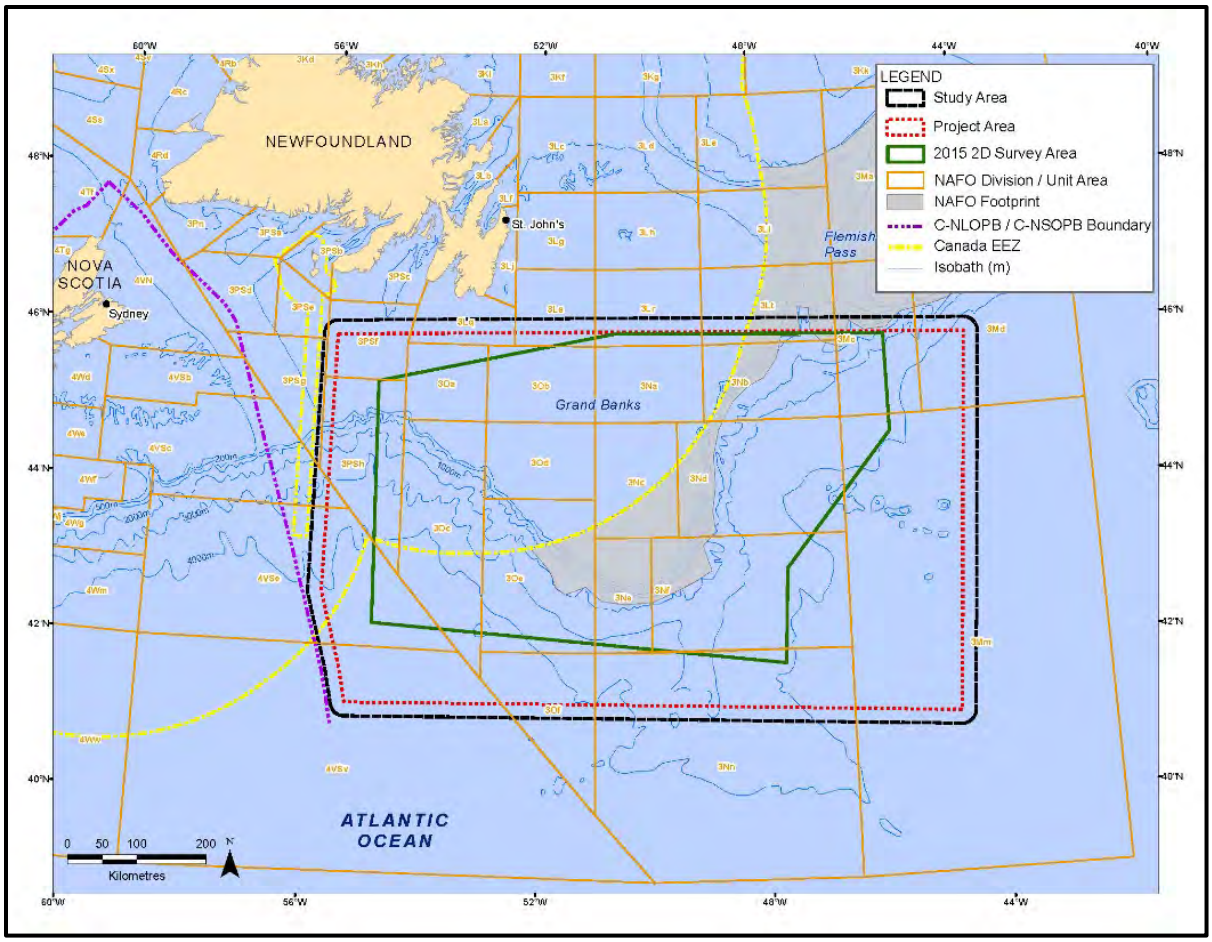
shrimp biomass in NAFO Divisions 3M and 3LNO since 2007 (NAFO 2013). There has been a moratorium on the shrimp fishery in Division 3M since 2010 (NAFO 2014b), and there will be no shrimp fishery permitted within Division 3L in 2015 (NAFO 2015a). The decrease in shrimp biomass in 3M has been correlated with an increase in the cod stock in that Division. However, it is currently unclear whether this relationship is causal and/or the result of other environmental factors (NAFO 2013).



Source: NAFO STATLANT 21A Data Extraction Tool.

Figure 4.2 Historical Catch Weights for Predominant Species in the Commercial Fisheries in NAFO Divisions 3LMNO, 3Ps and 4Vs, All Countries, 1980–2013.

In 2007, the United Nations General Assembly (UNGA 2007 *in* NAFO 2009) requested Regional Fisheries Management Organizations to "regulate bottom fisheries that cause a significant adverse impact on vulnerable marine ecosystems" (NAFO 2009). Implementation guidelines drafted by the Food and Agriculture Organization of the United Nations (FAO) in 2007–2009 called for the mapping of existing bottom fisheries (FAO 2009 *in* NAFO 2009). Participant Flag-states (ten in total) were called upon to submit maps identifying bottom fishing areas within NAFO's Regulatory Area (NRA) from 1987–2007, with priority given to trawl activity (NCEM 2009 *in* NAFO 2009). From these data, NAFO's bottom fishing footprint was developed. It includes the most highly bottom-fished areas beyond Canada's EEZ (Figure 4.3). Note that the footprint does not represent harvesting areas that are used every year, rather an aggregate of harvesting areas during the 20-year period. The footprint may be revised regularly to incorporate any new relevant information (NAFO 2012). The NAFO footprint currently has an area of 120,048 km^2, of which ~5.4% is closed to bottom fishing (includes portions of the 3O Coral and Sponge Protection Zone and Coral and Sponge Closures; see Section 4.7).



Source: NAFO 2015b.

Figure 4.3 Location of the NAFO Fisheries Footprint, 1987–2007.

4.3.3.2 Study Area Catch Analysis, 2005-2013

The Study Area, Project Area and 2015 2D Survey Area domestic harvests during May-November 2005-2010 are shown in Table 4.2. Domestic harvests from within the Study Area during May-November 2011–2013 are shown in Tables 4.3–4.5. As indicated, the principal fisheries (by catch weight and value in order of descending importance) were for snow crab, yellowtail flounder, cockles, whelks, redfish and Atlantic cod during May–November 2005–2010. These six species accounted for >77% of the average annual catch weight in the Study Area during this period. The principal species caught during May–November 2011-2013 were snow crab, Atlantic halibut, and Atlantic cod. Other notable commercial during this same time period included yellowtail flounder, cockles, whelks, redfish, and American plaice. The Study Area total annual commercial fisheries catch weights of all species combined during May–November decreased after 2005 and remained relatively constant from 2006-2010 (~17,000–23,000 mt) (Figure 4.4). The lists of species harvested in the Study Area were similar during May–November, 2005–2013, with the following exceptions:

- Fewer species recorded in 2011–2013 as compared to 2005–2010;
- Fewer species recorded (and lower catch weights – see Figure 4.4) in each consecutive year from 2011–2013;
- Fewer total catch counts recorded in 2013 than 2011 or 2012;
- The following species had recorded harvests during 2005–2010 but not during 2011–2013: argentine, basking shark, blue marlin, blue shark, catfish, dogfish, herring, *Illex* squid, mackerel, northern shrimp, pelagic sp., propeller clams, sand tiger shark, sea cucumber, and thresher shark;
- The following species had recorded harvests during 2005–2012 but not in 2013: albacore tuna, Atlantic wolffish, bigeye tuna, cusk, dolphinfish, mako shark, monkfish, pollock, porbeagle shark, redfish, roughhead and roundnose grenadier, shark sp., skate sp., white hake, white marlin, witch flounder, and yellowfin tuna; and
- The following species had recorded harvests sporadically during 2005–2013: cockles (2005-2011), flounder sp. (2005–2010 and 2012), groundfish sp. (2005–2011), Icelandic scallops (2005–2010 and 2012), sea scallops (2005–2011), Stimpson's surf clam (2005–2011 and 2013), winter flounder (2005–2011), and rock crab (2011–2012).

Table 4.2 Study Area, Project Area, and 2015 2D Survey Area Average Annual Catch Weight and Value by Species, May–November, 2005–2010.

Species	Study Area				Project Area				2015 2D Survey Area			
	Quantity		Value		Quantity		Value		Quantity		Value	
	mt	% of Total	$	% of Total	mt	% of Total	$	% of Total	mt	% of Total	$	% of Total
Snow Crab	6,026	28.0	18,397,195	52.8	5,448	28.6	16,629,565	53.6	3,836	26.1	11,668,943	51.6
Yellowtail Flounder	4,294	19.9	2,487,620	7.1	4,247	22.3	2,456,993	7.9	4,237	28.9	2,450,558	10.8
Cockles	1,724	8.0	1,913,031	5.5	1,724	9.1	1,913,031	6.2	1,724	11.8	1,913,031	8.5
Whelks	1,683	7.8	1,619,628	4.6	517	2.7	502,677	1.6	2	<0.1	2,562	<0.1
Redfish	1,604	7.4	914,781	2.6	1,560	8.2	892,947	2.9	1,411	9.6	796,586	3.5
Atlantic Cod	1,399	6.5	1,814,233	5.2	913	4.8	1,184,760	3.8	187	1.3	228,060	1.0
White Hake	1,110	5.1	777,740	2.2	1,097	5.8	769,861	2.5	696	4.7	481,969	2.1
Stimpson's Surf Clam	731	3.4	1,029,378	3.0	731	3.8	1,029,378	3.3	731	5.0	1,029,378	4.6
American Plaice	666	3.1	371,930	1.1	638	3.3	352,361	1.1	614	4.2	333,996	1.5
Pollock	400	1.9	243,769	0.7	392	2.1	239,058	0.8	47	0.3	28,745	0.1
Monkfish	370	1.7	529,535	1.5	362	1.9	518,317	1.7	335	2.3	478,906	2.1
Skate sp.	352	1.6	114,038	0.3	307	1.6	98,627	0.3	153	1.0	45,126	0.2
Hagfish	233	1.1	367,905	1.1	233	1.2	367,724	1.2	125	0.9	206,908	0.9
Atlantic Halibut	210	1.0	1,836,600	5.3	206	1.1	1,799,284	5.8	126	0.9	1,047,755	4.6
Swordfish	195	0.9	1,509,853	4.3	194	1.0	1,501,320	4.8	191	1.3	1,478,344	6.5
Haddock	156	0.7	151,128	0.4	153	0.8	148,151	0.5	53	0.4	47,964	0.2
Sea Scallops	99	0.5	165,308	0.5	48	0.3	80,376	0.3	<0.1	<0.1	99	<0.1
Icelandic Scallops	84	0.4	122,349	0.4	78	0.4	113,082	0.4	74	0.5	105,309	0.5
Greenland Halibut	74	0.3	140,923	0.4	65	0.3	123,334	0.4	33	0.2	59,894	0.3
Witch Flounder	31	0.1	21,150	0.1	31	0.2	21,019	0.1	30	0.2	20,428	0.1
Herring	25	0.1	5,444	<0.1	19	0.1	4,133	<0.1	0.1	<0.1	32	<0.1
Propeller Clams	24	0.1	15,147	<0.1	24	0.1	15,147	<0.1	24	0.2	15,147	0.1

Species	Study Area				Project Area				2015 2D Survey Area			
	Quantity		Value		Quantity		Value		Quantity		Value	
	mt	% of Total	$	% of Total	mt	% of Total	$	% of Total	mt	% of Total	$	% of Total
Bluefin Tuna	20	0.1	199,563	0.6	19	0.1	193,270	0.6	11	0.1	111,978	0.5
Mako Shark	7	<0.1	8,800	<0.1	6	<0.1	8,432	<0.1	6	<0.1	7,675	<0.1
Bigeye Tuna	6	<0.1	58,431	0.2	5	<0.1	54,467	0.2	4	<0.1	40,961	0.2
Northern Shrimp	5	<0.1	4,533	<0.1	4	<0.1	3,809	<0.1	4	<0.1	3,361	<0.1
Cusk	5	<0.1	3,573	<0.1	5	<0.1	3,523	<0.1	2	<0.1	1,817	<0.1
Sea Cucumber	5	<0.1	2,663	<0.1	5	<0.1	2,663	<0.1	0	0.0	0	0.0
Mackerel	5	<0.1	1,470	<0.1	5	<0.1	1,470	<0.1	5	<0.1	1,470	<0.1
Catfish	3	<0.1	1,624	<0.1	3	<0.1	1,624	<0.1	3	<0.1	1,579	<0.1
Porbeagle Shark	3	<0.1	2,996	<0.1	3	<0.1	2,861	<0.1	1	<0.1	1,420	<0.1
Roundnose Grenadier	2	<0.1	1,749	<0.1	2	<0.1	1,741	<0.1	2	<0.1	1,717	<0.1
Blue Shark	2	<0.1	1,932	<0.1	2	<0.1	1,930	<0.1	2	<0.1	1,916	<0.1
Albacore Tuna	1	<0.1	5,743	<0.1	1	<0.1	5,581	<0.1	1	<0.1	4,833	<0.1
Roughhead Grenadier	1	<0.1	348	<0.1	1	<0.1	342	<0.1	1	<0.1	333	<0.1
Dolphinfish	0.4	<0.1	978	<0.1	0.4	<0.1	957	<0.1	0.3	<0.1	915	<0.1
Atlantic Wolffish	0.2	<0.1	69	<0.1	0.2	<0.1	66	<0.1	0.1	<0.1	32	<0.1
Argentine	0.2	<0.1	18	<0.1	0.2	<0.1	18	<0.1	0.2	<0.1	18	<0.1
Shark sp.	0.2	<0.1	115	<0.1	0.1	<0.1	88	<0.1	0.1	<0.1	64	<0.1
Yellowfin Tuna	0.1	<0.1	916	<0.1	0.1	<0.1	786	<0.1	0.1	<0.1	511	<0.1
Flounder sp.	0.1	<0.1	164	<0.1	0.1	<0.1	163	<0.1	0.1	<0.1	145	<0.1
Thresher Shark	0.1	<0.1	90	<0.1	0.1	<0.1	90	<0.1	0.1	<0.1	90	<0.1
Groundfish sp.	<0.1	<0.1	0.3	<0.1	<0.1	<0.1	0.3	<0.1	0.0	0.0	0	0.0
Pelagic sp.	<0.1	<0.1	38	<0.1	<0.1	<0.1	38	<0.1	<0.1	<0.1	15	<0.1
White Marlin	<0.1	<0.1	38	<0.1	<0.1	<0.1	38	<0.1	<0.1	<0.1	38	<0.1
Sand Tiger Shark	<0.1	<0.1	10	<0.1	<0.1	<0.1	10	<0.1	0.0	0.0	0	0.0
Dogfish	<0.1	<0.1	3	<0.1	0	0.0	0	0.0	0.0	0.0	0	0.0
Blue Marlin	<0.1	<0.1	2	<0.1	<0.1	<0.1	2	<0.1	<0.1	<0.1	2	<0.1
Basking Shark	<0.1	<0.1	5	<0.1	<0.1	<0.1	5	<0.1	<0.1	<0.1	5	<0.1
Winter Flounder	<0.1	<0.1	1	<0.1	<0.1	<0.1	1	<0.1	0.0	0.0	0	0.0
Illex Squid	<0.1	<0.1	1	<0.1	<0.1	<0.1	1	<0.1	<0.1	<0.1	1	<0.1
Total	**21,555**	**100**	**34,844,560**	**100**	**19,049**	**100**	**31,045,120**	**100**	**14,670**	**100**	**22,620,639**	**100**

Source: DFO commercial landings database, 2005–2010.

Table 4.3 Commercial Catch Weights and Values in the Study Area, May–November, 2011 (values indicate the frequency of catch weight and value quartile codes (i.e., 1–4) attributed to each species).

Species	Catch Weight Quartile Code Counts [a]				Catch Value Quartile Code Counts [b]				Total Counts [c]
	1	2	3	4	1	2	3	4	
Snow Crab	79	251	404	83	53	189	368	207	817
Atlantic Halibut	94	98	62	17	79	152	39	1	271
Atlantic Cod	49	62	83	56	71	105	58	16	250
American Plaice	24	69	79	37	89	78	36	6	209
Yellowtail Flounder	20	56	58	29	75	61	22	5	163
Haddock	23	37	41	33	53	48	29	4	134
White Hake	37	47	38	11	40	64	28	1	133
Monkfish	19	56	44	13	37	64	27	4	132
Whelks	7	24	36	52	20	28	44	27	119
Skate sp.	15	52	39	1	29	61	17	0	107
Witch Flounder	7	26	32	11	31	34	9	2	76
Greenland Halibut	39	28	9	0	20	45	11	0	76
Bluefin Tuna	42	10	3	7	23	28	7	4	62
Redfish	4	19	27	6	20	26	10	0	56
Pollock	7	18	13	17	20	18	15	2	55
Swordfish	36	15	1	0	20	28	4	0	52
Cusk	23	12	2	0	6	28	3	0	37
Mako Shark	13	8	1	0	7	12	3	0	22
Hagfish	1	2	9	2	3	9	2	0	14
Cockles	1	5	1	3	3	4	0	3	10
Roundnose Grenadier	4	3	0	0	0	7	0	0	7
Bigeye Tuna	5	2	0	0	4	3	0	0	7
Roughhead Grenadier	3	3	0	0	0	6	0	0	6
Stimpson's Surf Clam	0	2	0	3	0	2	0	3	5
Atlantic Wolffish	3	0	0	0	2	1	0	0	3
Yellowfin Tuna	3	0	0	0	2	1	0	0	3
Albacore Tuna	2	0	1	0	1	1	1	0	3
Porbeagle Shark	3	0	0	0	2	1	0	0	3
Shark sp.	1	0	0	1	1	0	1	0	2
Rock Crab	2	0	0	0	2	0	0	0	2
Dolphinfish	2	0	0	0	2	0	0	0	2
White Marlin	1	0	0	0	1	0	0	0	1
Groundfish sp.	1	0	0	0	1	0	0	0	1
Sea Scallops	1	0	0	0	1	0	0	0	1
Winter Flounder	1	0	0	0	1	0	0	0	1
Total	**572**	**905**	**983**	**382**	**719**	**1,104**	**734**	**285**	**2,842**

Source: DFO commercial landings database, All Atlantic Regions (2011).

[a] Quartile code ranges provided by DFO (quartile code ranges calculated annually by DFO based on total catch weights in a given year, all species combined). 2011 quartile code ranges: 1 = 0 – 2,377 kg, 2 = 2,378 – 11,045 kg, 3 = 11,046 – 45,183 kg, 4 = ≥ 45,184 kg.

[b] Quartile code ranges provided by DFO (quartile code ranges calculated annually by DFO based on total catch values in a given year, all species combined). 2011 quartile code ranges: 1 = $0 – $7,281, 2 = $7,282 – $32,789, 3 = $32,790 – $126,294, 4 = ≥ $126,295.

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

Table 4.4 Commercial Catch Weights and Values in the Study Area, May–November, 2012 (values indicate the frequency of catch weight and value quartile codes (i.e., 1–4) attributed to each species).

Species	Catch Weight Quartile Code Counts [a]				Catch Value Quartile Code Counts [b]				Total Counts [c]
	1	2	3	4	1	2	3	4	
Snow Crab	117	280	270	46	88	217	297	111	713
Atlantic Halibut	110	100	48	1	100	121	37	1	259
Atlantic Cod	58	59	66	32	86	73	50	6	215
White Hake	39	66	48	4	48	73	34	2	157
American Plaice	40	39	47	19	81	41	19	4	145
Monkfish	23	64	42	9	40	65	32	1	138
Yellowtail Flounder	39	33	37	15	75	34	13	2	124
Whelks	8	18	35	42	15	22	50	16	103
Greenland Halibut	36	50	16	0	38	48	16	0	102
Skate sp.	19	49	27	5	29	48	23	0	100
Haddock	18	27	29	9	32	35	16	0	83
Redfish	24	32	17	0	38	24	11	0	73
Bluefin Tuna	44	6	11	2	34	15	14	0	63
Swordfish	22	34	4	0	9	35	16	0	60
Pollock	4	23	24	0	20	19	12	0	51
Cusk	23	11	10	0	10	23	10	1	44
Mako Shark	11	22	2	0	5	17	13	0	35
Witch Flounder	11	9	7	1	22	6	0	0	28
Porbeagle Shark	19	4	0	0	7	13	3	0	23
Hagfish	1	5	9	0	4	6	5	0	15
Roundnose Grenadier	11	3	0	0	6	6	2	0	14
Roughhead Grenadier	8	1	1	4	9	4	1	0	14
Albacore Tuna	7	4	0	0	5	4	2	0	11
Bigeye Tuna	7	4	0	0	4	6	1	0	11
Dolphinfish	4	5	0	0	3	3	3	0	9
White Marlin	0	5	0	0	0	2	3	0	5
Yellowfin Tuna	3	0	0	0	2	1	0	0	3
Flounder sp.	0	1	2	0	0	1	2	0	3
Icelandic Scallops	1	1	0	0	1	1	0	0	2
Shark sp.	0	1	0	1	0	1	1	0	2
Atlantic Wolffish	0	1	0	0	0	0	1	0	1
Rock Crab	1	0	0	0	1	0	0	0	1
Total	**708**	**957**	**752**	**190**	**812**	**964**	**687**	**144**	**2,607**

Source: DFO commercial landings database, All Atlantic Regions (2012).

[a] Quartile code ranges provided by DFO (quartile code ranges calculated annually by DFO based on total catch weights in a given year, all species combined). 2012 quartile code ranges: 1 = 0 – 2,618 kg, 2 = 2,619 – 12,233 kg, 3 = 12,234 – 47,739 kg, 4 = ≥ 47,740 kg.

[b] Quartile code ranges provided by DFO (quartile code ranges calculated annually by DFO based on total catch values in a given year, all species combined). 2012 quartile code ranges: 1 = $0 – $8,240, 2 = $8,241 – $35,022, 3 = $35,023 – $130,732, 4 = ≥ $130,733.

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

Table 4.5 Commercial Catch Weights and Values in the Study Area, May–November, 2013 (values indicate the frequency of catch weight and value quartile codes (i.e., 1–4) attributed to each species).

Species	Catch Weight Quartile Code Counts [a]				Catch Value Quartile Code Counts [b]				Total Counts [c]
	1	2	3	4	1	2	3	4	
Snow Crab	41	90	37	6	33	78	47	16	174
Atlantic Cod	39	51	21	9	46	50	21	3	120
Atlantic Halibut	33	16	2	0	30	18	3	0	51
Whelks	4	7	11	0	7	12	3	0	22
American Plaice	6	12	2	1	13	6	2	0	21
Haddock	4	1	0	0	4	1	0	0	5
Greenland Halibut	3	1	0	0	2	2	0	0	4
Bluefin Tuna	2	0	0	0	1	1	0	0	2
Hagfish	0	0	1	0	0	1	0	0	1
Yellowtail Flounder	0	1	0	0	1	0	0	0	1
Swordfish	1	0	0	0	1	0	0	0	1
Stimpson's Surf Clam	0	0	1	0	0	1	0	0	1
Total	**133**	**179**	**75**	**16**	**138**	**170**	**76**	**19**	**403**

Source: DFO commercial landings database, All Atlantic Regions (2013).

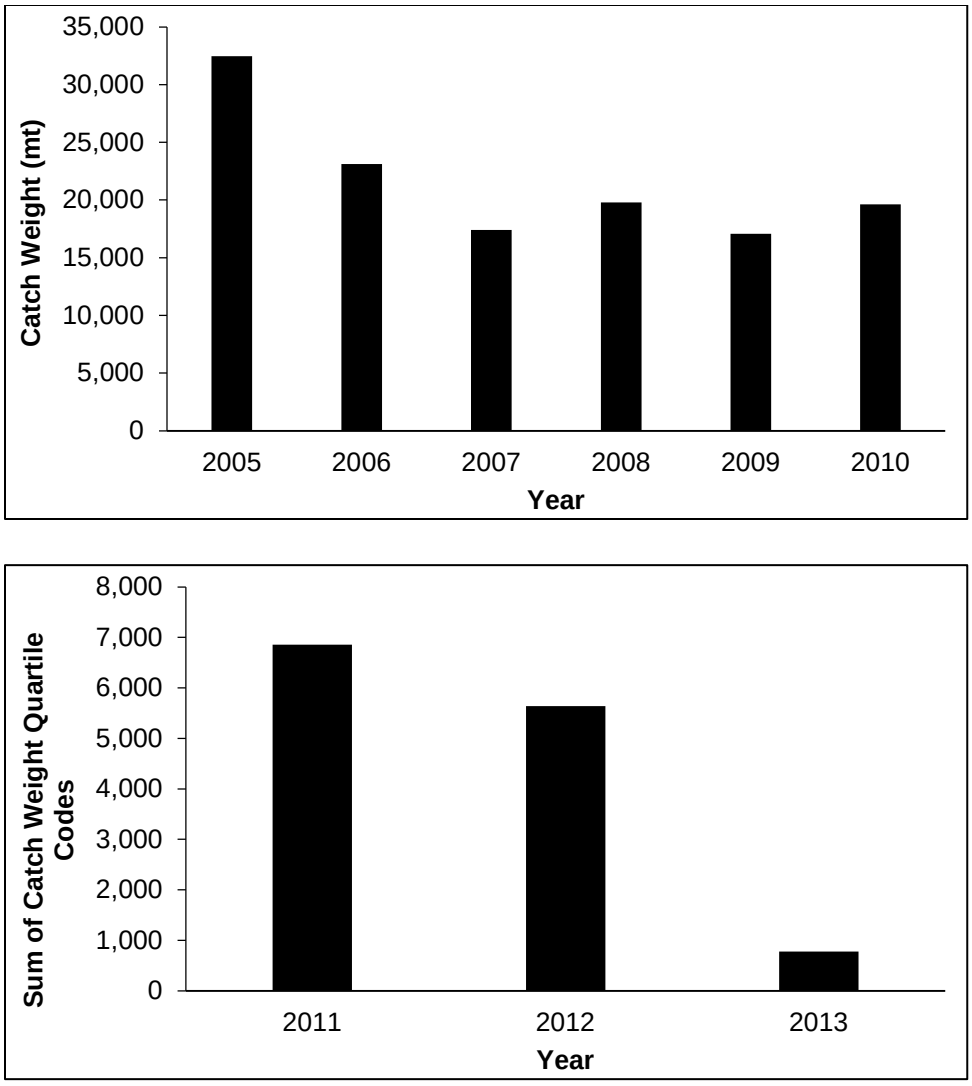
[a] Quartile code ranges provided by DFO (quartile code ranges calculated annually by DFO based on total catch weights in a given year, all species combined). 2013 quartile code ranges: 1 = 0 – 2,565 kg, 2 = 2,566 – 11,872 kg, 3 = 11,873 – 48,585 kg, 4 = ≥ 48,586 kg.

[b] Quartile code ranges provided by DFO (quartile code ranges calculated annually by DFO based on total catch values in a given year, all species combined). 2013 quartile code ranges: 1 = $0 – $8,934, 2 = $8,395 – $35,699, 3 = $35,700 – $125,728, 4 = ≥ $125,729.

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

Commercial Harvest Locations in the Study Area

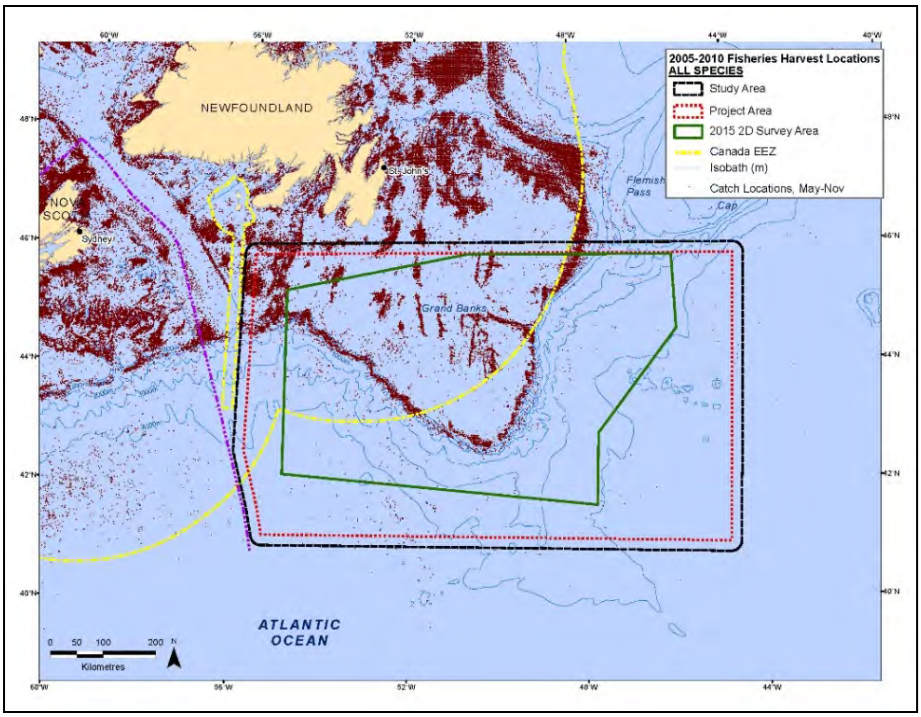
Figure 4.5 shows georeferenced May-November harvest locations and Figures 4.6–4.8 show May-November harvest locations in 6 x 6 minute cells in relation to the Study, Project, and 2015 2D Seismic Survey Areas for all species in 2005–2010, 2011, 2012 and 2013, respectively. As Figures 4.5-4.8 indicate, most of the fish harvesting occurs in the northwestern part of the Study and Project areas, and in the central portion of the shelf and along the slope of the Grand Banks to the 1,000 m isobath in the 2015 2D Survey Area. A comparison with fisheries maps in the Southern and Eastern Newfoundland SEAs (C-NLOPB 2010, 2014) indicates that these locations are generally consistent from year to year.



Source: DFO commercial landings database, 2005–2013.

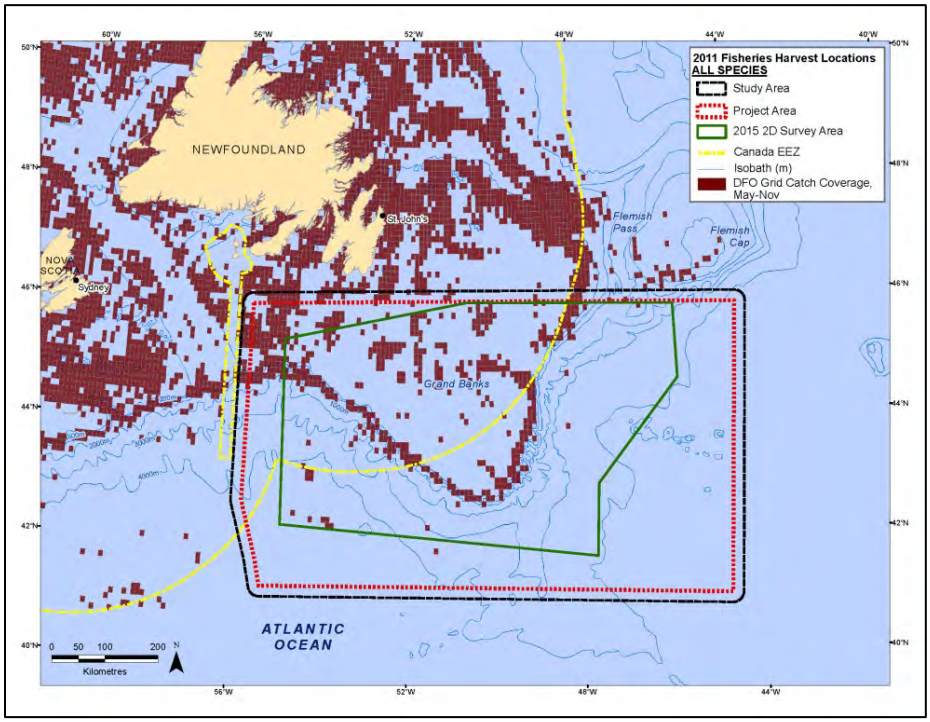
Note: Sum of catch weight quartile codes is the summation of quartile codes (i.e., 1–4) for all catch records for all species; the greater the sum of quartile code counts, the greater the catch weight for a given year.

Figure 4.4 Annual Total Catch Weight, May–November, 2005–2010 (top), and Annual Sum of Catch Weight Quartile Codes, May–November, 2011–2013 (bottom) (all species within the Study Area).



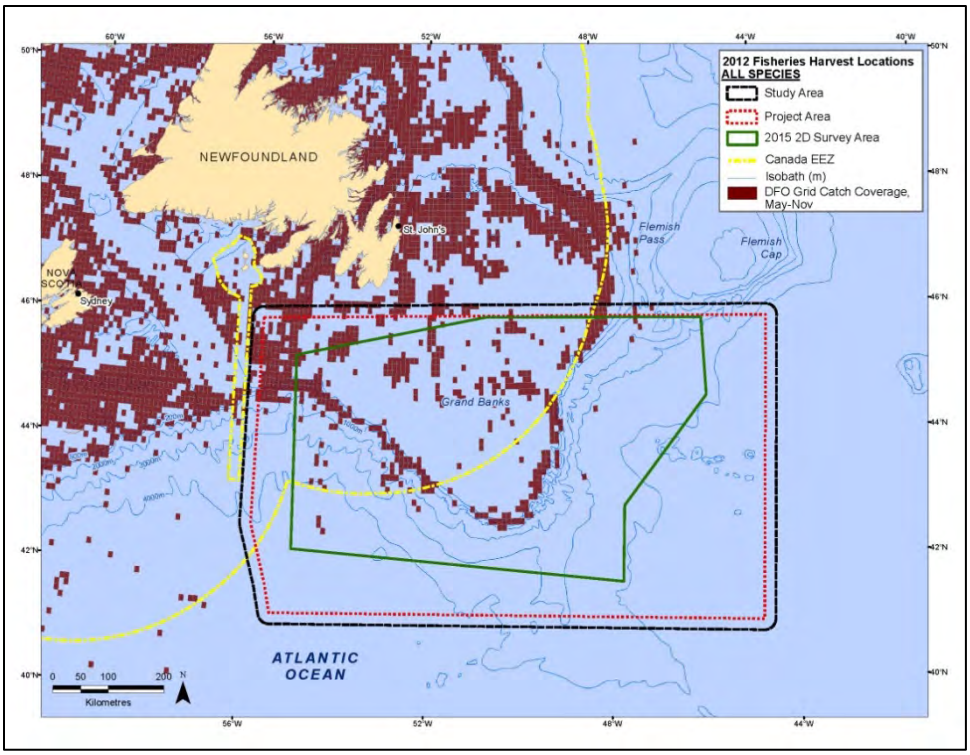
Source: DFO commercial landings database, 2005–2010.

Figure 4.5 Distribution of Harvest Locations, All Species Combined, May–November, 2005–2010.



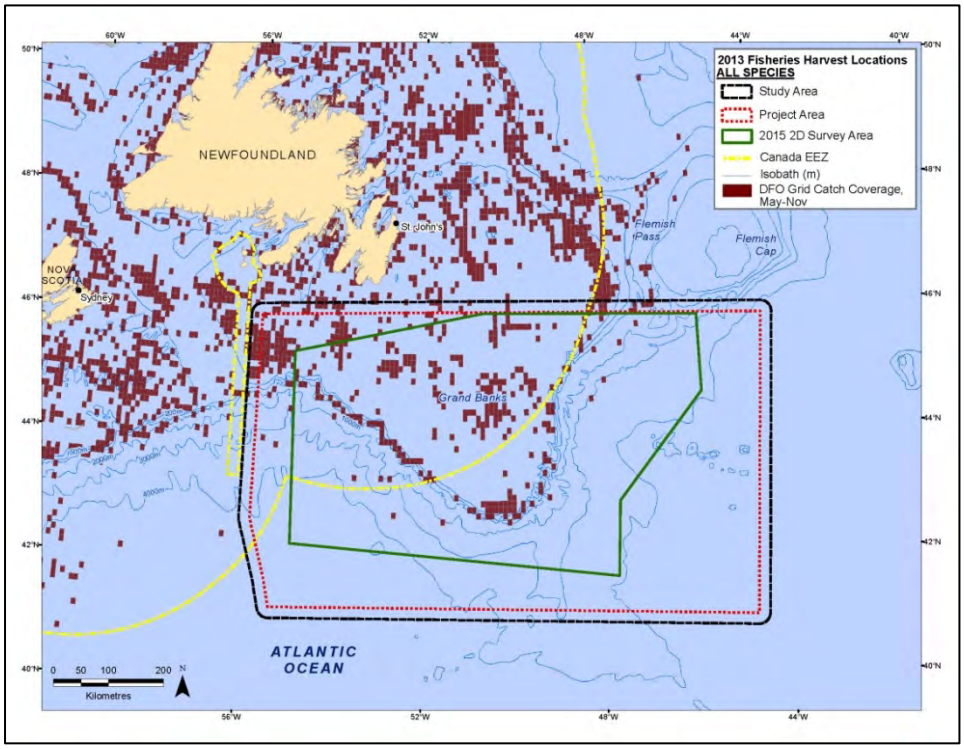
Source: DFO commercial landings database, 2011.

Figure 4.6 Distribution of Harvest Locations, All Species Combined, May–November, 2011.



Source: DFO commercial landings database, 2012.

Figure 4.7 Distribution of Harvest Locations, All Species Combined, May–November, 2012.



Source: DFO commercial landings database, 2013.

Figure 4.8 Distribution of Harvest Locations, All Species Combined, May–November, 2013.

Fishing Gear in the Study Area

Various types of fishing gear were used in the Study Area during May–November 2005–2013. Snow crab were primarily caught using pots, yellowtail flounder using gillnets and trawls, cockles using dredges, whelks using gillnets and pots, redfish using gillnets, longlines and trawls, and Atlantic cod and Atlantic halibut using gillnets, longlines, pots and trawls. Atlantic cod were also harvested using hand lines (Table 4.6). Bottom otter trawls (mobile gear) accounted for 32% of the average total catch weight of all species in the Study Area between May–November 2005–2010. Pots (fixed gear) accounted for ~36% of the average total catch weight during this same period. Overall, mobile and fixed gears each accounted for ~45 and 55% of the catches, respectively (Table 4.6).

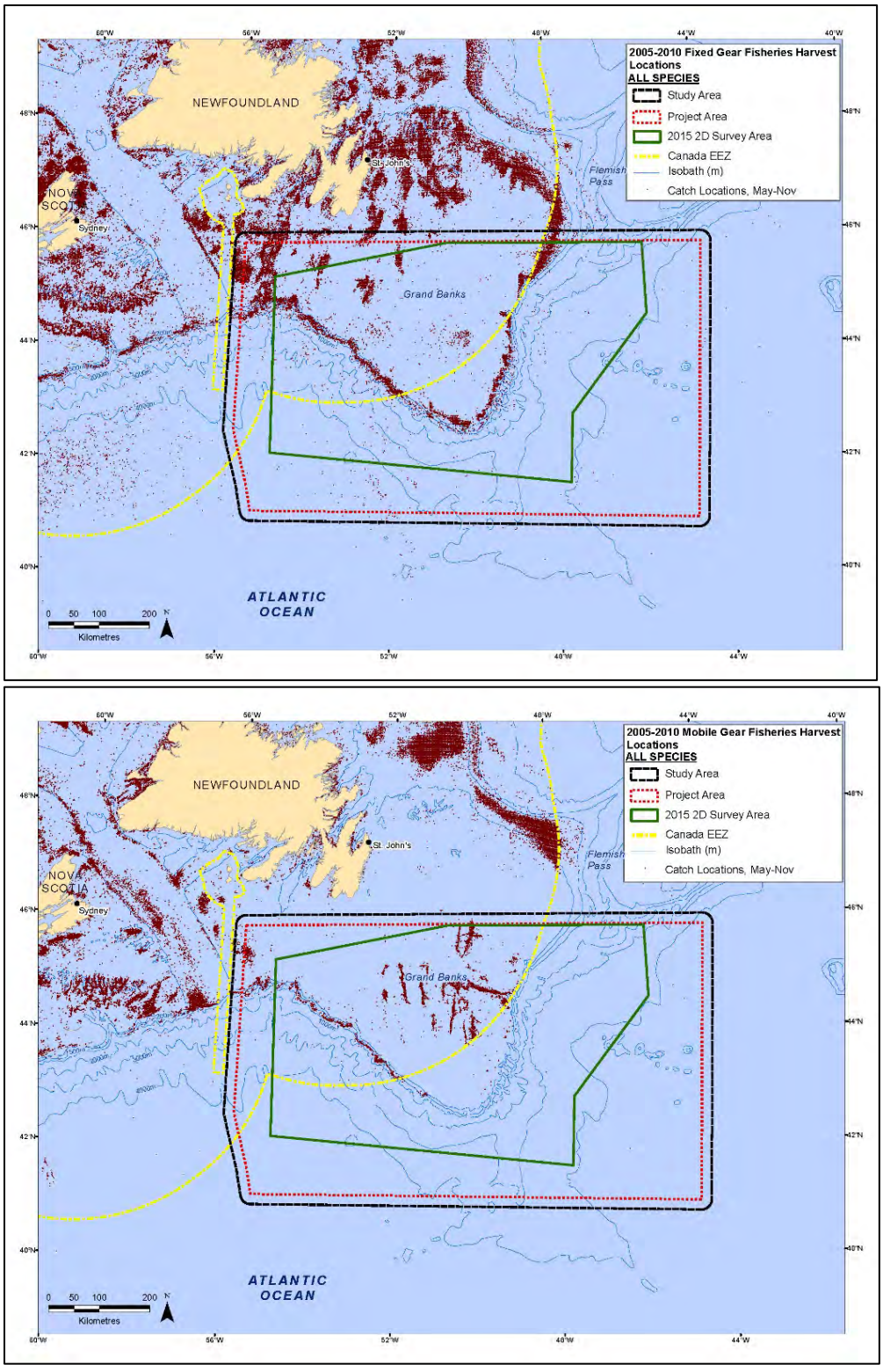
Fishing gears and harvest locations by gear type typically used in the Study Area are provided in Table 3.5 of the Southern Newfoundland SEA (C-NLOPB 2010), and in Table 4.119 and Figure 4.137 of the Eastern Newfoundland SEA (C-NLOPB 2014). Generally, the fixed gears have greater potential for interacting 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 4.9–4.12 show locations of mobile and fixed gear harvesting locations during 2005–2013.

Table 4.6 Average Annual Study Area Catch Weight by Gear Type, May–November, 2005-2010.

Species	Fixed Gear		Mobile Gear	
	mt	% of Total	mt	% of Total
Snow Crab	6,026	28.0	0	0.0
Yellowtail Flounder	2	<0.1	4,292	19.9
Cockles	0	0.0	1,724	8.0
Whelks	1,683	7.8	0	0.0
Redfish	8	<0.1	1,596	7.4
Atlantic Cod	1,092	5.1	307	1.4
White Hake	1,092	5.1	18	0.1
Stimpson's Surf Clam	0	0.0	731	3.4
American Plaice	40	0.2	626	2.9
Pollock	386	1.8	14	0.1
Monkfish	366	1.7	4	<0.1
Skate sp.	309	1.4	42	0.2
Hagfish	233	1.1	0	0.0
Atlantic Halibut	205	1.0	6	<0.1
Swordfish	195	0.9	<0.1	<0.1
Haddock	137	0.6	19	0.1
Sea Scallops	0	0.0	99	0.5
Icelandic Scallops	0	0.0	84	0.4
Greenland Halibut	74	0.3	1	0.0
Witch Flounder	0.1	<0.1	31	0.1
Herring	9	<0.1	16	0.1

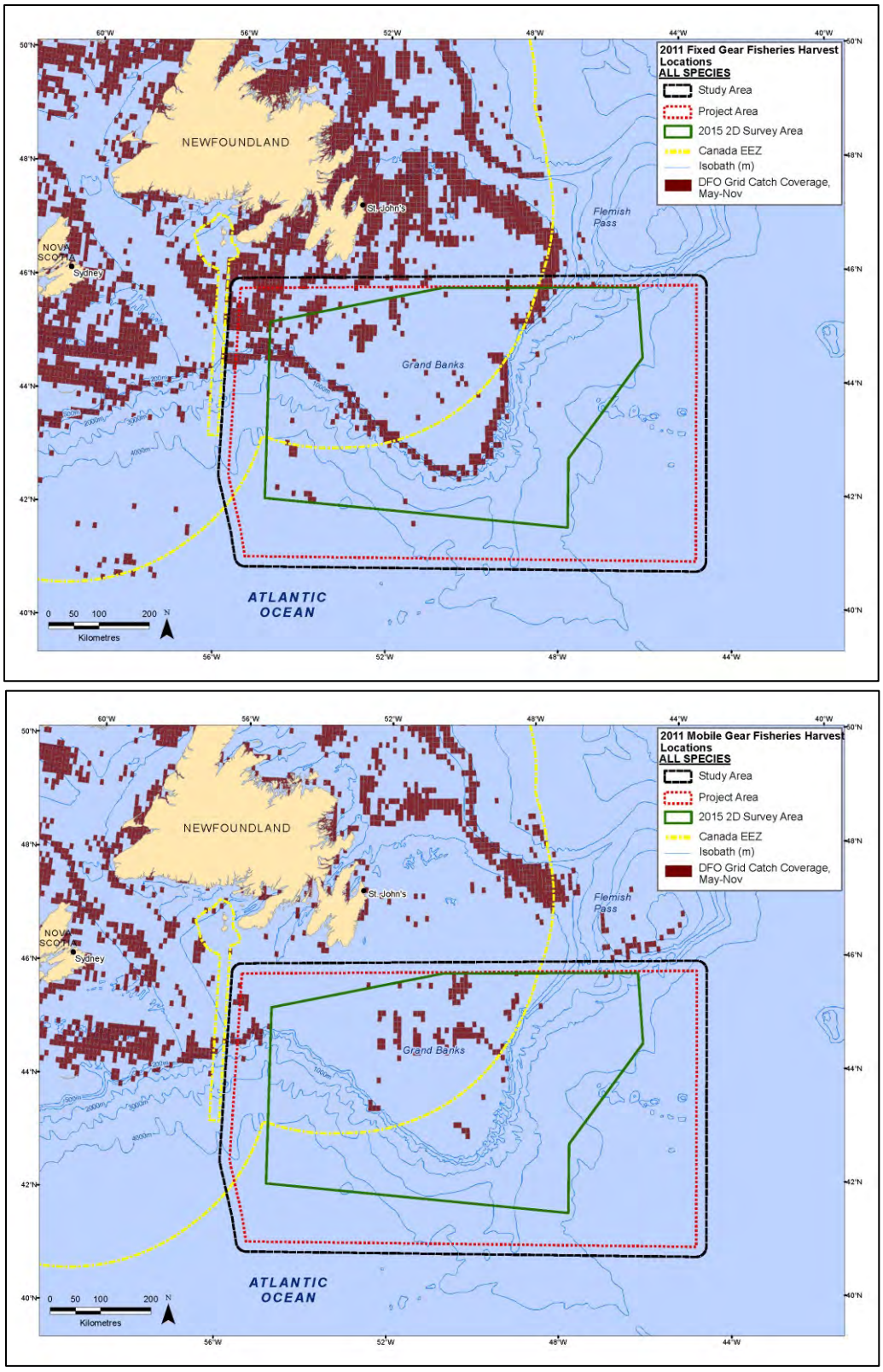
Species	Fixed Gear		Mobile Gear	
	mt	% of Total	mt	% of Total
Propeller Clams	0	0.0	24	0.1
Bluefin Tuna	5	<0.1	15	0.1
Mako Shark	7	<0.1	0	0.0
Bigeye Tuna	6	<0.1	<0.1	<0.1
Northern Shrimp	0	0.0	5	<0.1
Cusk	5	<0.1	0	0.0
Sea Cucumber	0	0.0	5	<0.1
Mackerel	0	0.0	5	<0.1
Catfish	3	<0.1	<0.1	<0.1
Porbeagle Shark	3	<0.1	0.2	<0.1
Roundnose Grenadier	2	<0.1	0.0	0.0
Blue Shark	2	<0.1	0.0	0.0
Albacore Tuna	1	<0.1	0.0	0.0
Roughhead Grenadier	1	<0.1	0.1	<0.1
Dolphinfish	0.4	<0.1	0.0	0.0
Atlantic Wolffish	0.2	<0.1	0.0	0.0
Argentine	0.0	0.0	0.2	<0.1
Shark sp.	0.2	<0.1	0.0	0.0
Yellowfin Tuna	0.1	<0.1	0.0	0.0
Flounder sp.	<0.1	<0.1	0.1	<0.1
Thresher Shark	0.1	<0.1	0.0	0.0
Groundfish sp.	<0.1	<0.1	0.0	0.0
Pelagic sp.	<0.1	<0.1	0.0	0.0
White Marlin	<0.1	<0.1	0.0	0.0
Sand Tiger Shark	<0.1	<0.1	0.0	0.0
Dogfish	<0.1	<0.1	0.0	0.0
Blue Marlin	<0.1	<0.1	0.0	0.0
Basking Shark	<0.1	<0.1	0.0	0.0
Winter Flounder	<0.1	<0.1	0.0	0.0
Illex Squid	0.0	0.0	<0.1	<0.1
Subtotal	**11,892**	**55.2**	**9,663**	**44.8**
Grand Total (mt)	**21,555**			

Source: DFO commercial landings database, 2005–2010.



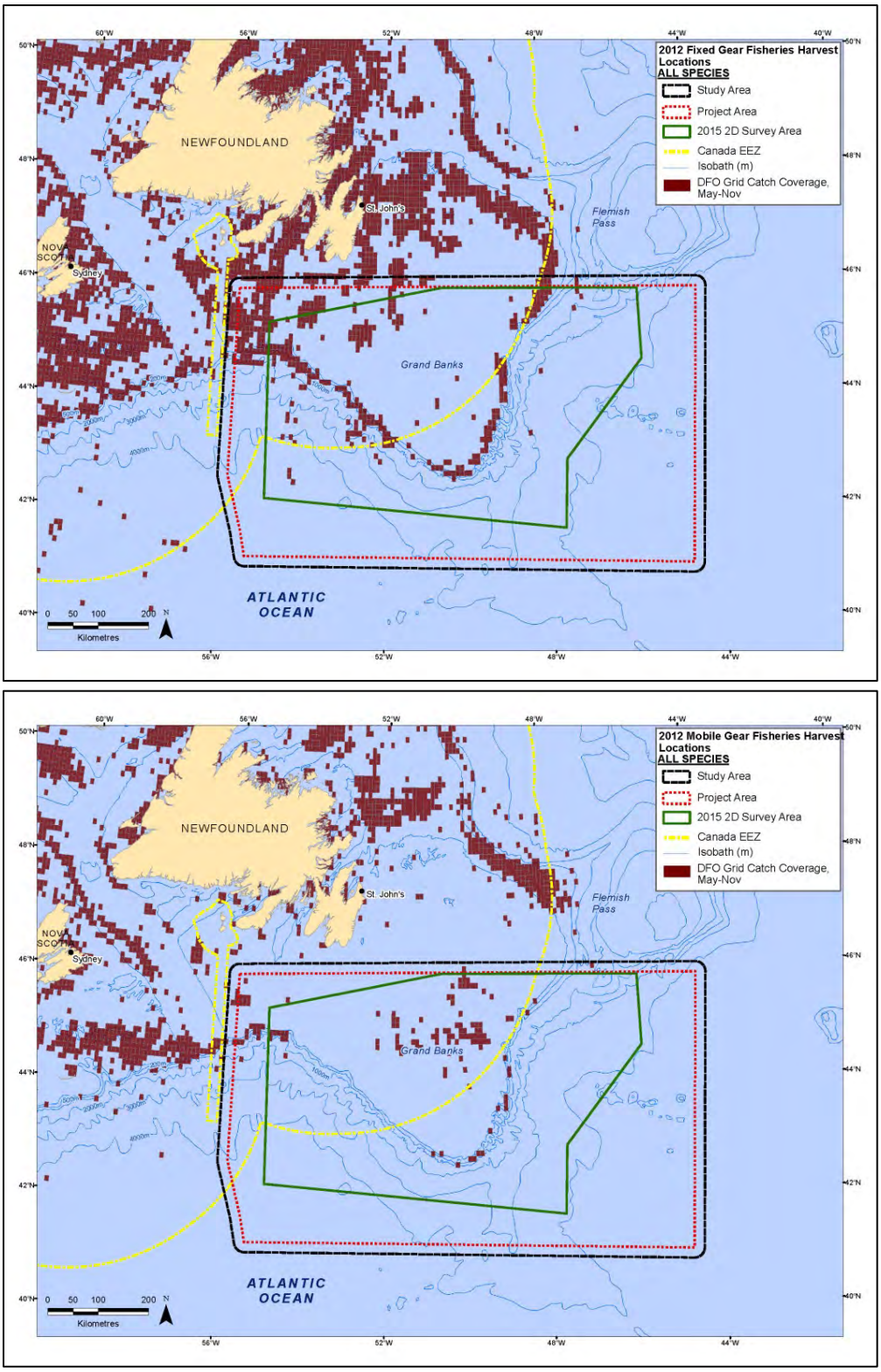
Source: DFO commercial landings database, 2005–2010.

Figure 4.9 Fixed (top) and Mobile (bottom) Gear Harvesting Locations, May–November, 2005-2010.



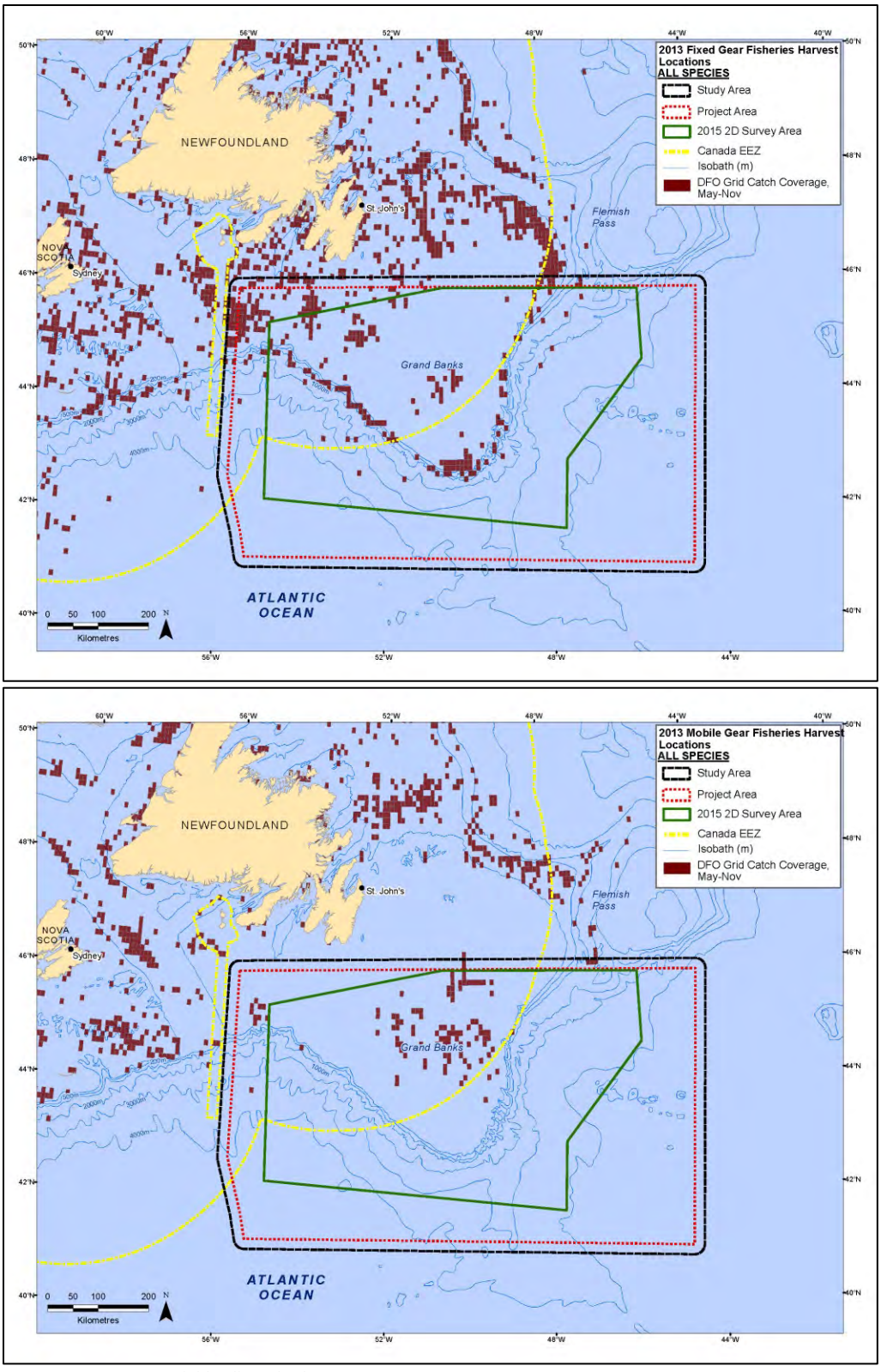
Source: DFO commercial landings database, 2011.

Figure 4.10 Fixed (top) and Mobile (bottom) Gear Harvesting Locations, May–November, 2011.



Source: DFO commercial landings database, 2012.

Figure 4.11 Fixed (top) and Mobile (bottom) Gear Harvesting Locations, May–November, 2012.



Source: DFO commercial landings database, 2013.

Figure 4.12 Fixed (top) and Mobile (bottom) Gear Harvesting Locations, May–November, 2013.

Harvest Timing in the Study Area

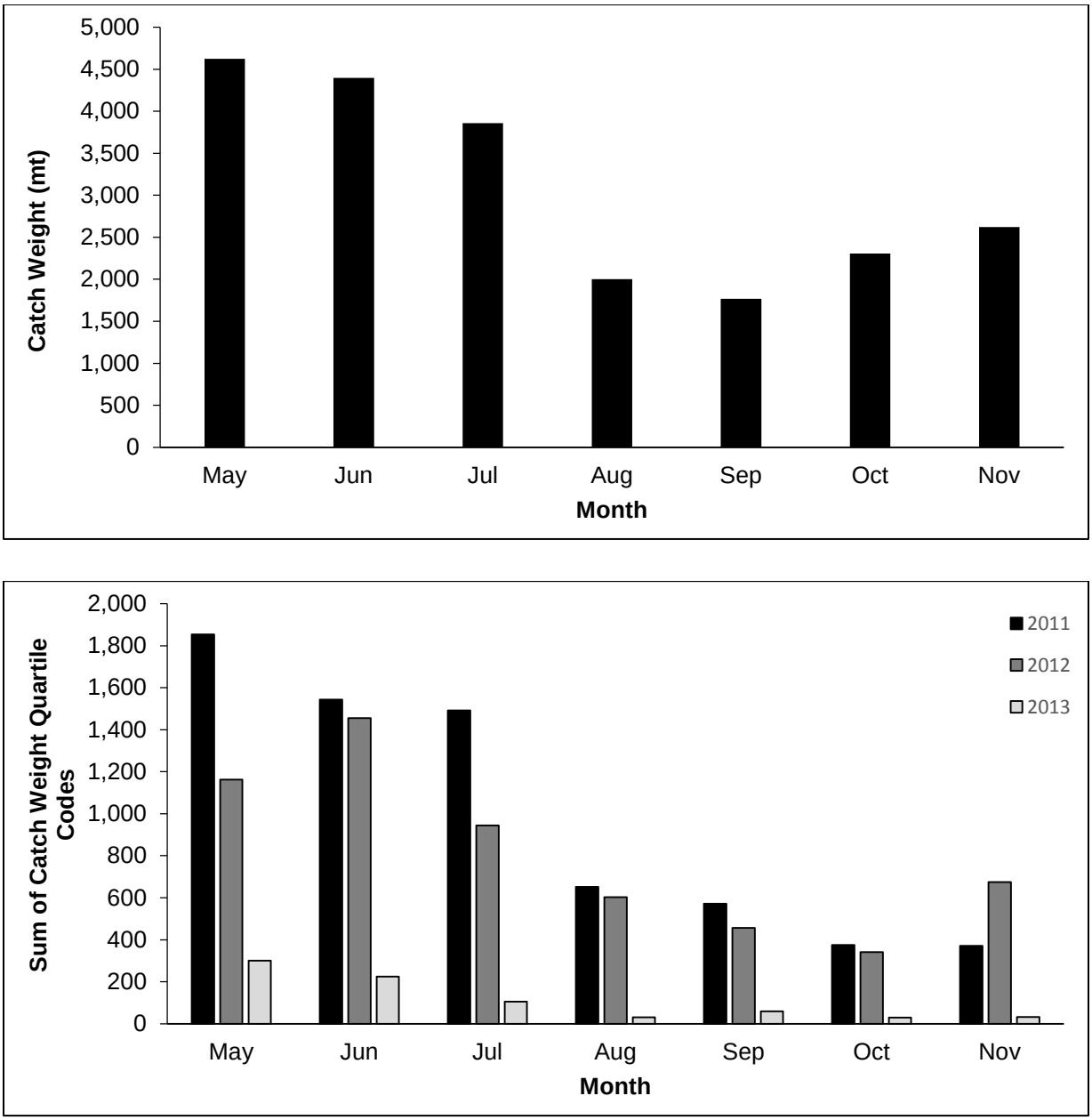
Table 4.7 provides an indication of when the various species were harvested within the Study Area during 2005-2013. Average monthly catch weights of all species within the Study Area for May-November 2005–2010, and total sum of monthly catch weight quartile codes for May–November 2011–2013, are indicated in Figure 4.13. Monthly catch weight was highest May–July and lowest Aug-November. Note that the timing of the harvests can vary from year to year depending on resource availability, fisheries management plans, and enterprise harvesting strategies.

Table 4.7 Summary of Gear Type Used and Timing of the Commercial Fishery in the Study Area, May–November, 2005–2013.

Species	Month Caught				Gear Type	
	2005–2010	2011	2012	2013	Fixed	Mobile
Snow Crab	May–Sep; Nov	May–Aug	May–Aug	May–Aug	Pot	-
Yellowtail Flounder	May–Nov	May–Jul; Oct–Nov	May–Jun; Oct–Nov	Nov	Gillnet	Trawl
Cockles	May–Nov	Oct	-	-	-	Dredge
Whelks	May–Nov	May–Aug	May–Aug	May–Jul	Gillnet; Pot	-
Redfish	May–Nov	Jun–Nov	Jun–Oct	-	Gillnet; Longline	Trawl
Atlantic Cod	May–Nov	May–Nov	May–Nov	May–Nov	Gillnet; Longline; Pot	Trawl; Hand Line
White Hake	May–Nov	May–Nov	May–Nov	-	Gillnet; Longline	Trawl
Stimpson's Surf Clam	May–Nov	Oct	-	Nov	-	Dredge
American Plaice	May–Nov	May–Nov	May–Nov	May–Jul; Sep–Nov	Gillnet; Longline; Pot	Trawl
Pollock	May–Nov	Jun–Nov	Jun–Nov	-	Gillnet; Longline	Trawl
Monkfish	May–Nov	Jun–Nov	Jun–Nov	-	Gillnet; Longline; Pot	Trawl
Skate sp.	May–Nov	Jun–Sep; Nov	Jun–Nov	-	Gillnet; Longline; Pot	Trawl
Hagfish	Aug–Nov	Sep–Oct	Sep–Nov	Jun	Trap Net; Hagfish Barrel	-
Atlantic Halibut	May–Nov	May–Nov	May–Nov	May–Oct	Gillnet; Longline; Pot	Trawl
Swordfish	May–Nov	Jul–Nov	Jul–Nov	Aug	Gillnet; Longline	Harpoon
Haddock	May–Nov	May–Nov	Jun–Nov	Jul–Aug	Gillnet; Longline	Trawl
Sea Scallops	May–Nov	May	-	-	-	Dredge
Icelandic Scallops	May–Oct	-	Aug	-	-	Dredge
Greenland Halibut	May–Nov	May–Nov	Jun–Nov	May; Jul	Gillnet; Longline	Trawl
Witch Flounder	May–Nov	May–Aug; Nov	Jun; Aug; Nov	-	Gillnet; Longline	Trawl
Herring	May; Jun; Sep; Nov	-	-	-	Gillnet; Trap Net	Seine
Propeller Clams	May–Nov	-	-	-	-	Dredge

Species	Month Caught				Gear Type	
	2005–2010	2011	2012	2013	Fixed	Mobile
Bluefin Tuna	May–Nov	Jul–Nov	Jul–Nov	Jul; Sep	Longline	Troller Lines; Rod and Reed (Trolling); Electric Harpoon
Mako Shark	May–Nov	Jul–Oct	Jul–Nov	-	Gillnet; Longline	-
Bigeye Tuna	May–Nov	Jul–Sep; Nov	Jul–Sep; Nov	-	Longline	Troller Lines
Northern Shrimp	Jun–Jul; Nov	-	-	-	-	Trawl
Cusk	May–Nov	May–Jul; Sep; Nov	May–Jul; Sep–Nov	-	Gillnet; Longline	Trawl
Sea Cucumber	Jul	-	-	-	-	Dredge
Mackerel	Oct	-	-	-	-	Seine
Catfish	May–Aug; Oct–Nov	-	-	-	Gillnet; Longline	Trawl
Porbeagle Shark	May–Nov	Jul–Aug; Nov	May–Jun; Nov	-	Gillnet; Longline	Trawl
Roundnose Grenadier	May–Sep; Nov	Jul	Jun	-	Longline	-
Blue Shark	Jul–Sep	-	-	-	Gillnet; Longline	-
Albacore Tuna	May–Nov	Jul–Sep	Jul–Sep; Nov	-	Longline	-
Roughhead Grenadier	Jun–Sep; Nov	Jun	Jun; Aug	-	Gillnet; Longline	Trawl
Dolphinfish	Jun–Oct	Jul–Aug	Jul–Aug; Oct	-	Longline	-
Atlantic Wolffish	May–Jul	Jun–Jul	Jun	-	Gillnet; Longline	-
Argentine	Jun–Jul	-	-	-	-	Trawl
Shark sp.	May–Nov	Oct	Nov	-	Gillnet; Longline	-
Yellowfin Tuna	May–Oct	Jul–Aug; Oct	Aug–Sep	-	Longline	-
Flounder sp.	May–Aug; Oct–Nov	-	Sep	-	Gillnet; Longline	Trawl
Thresher Shark	Sep; Nov	-	-	-	Longline	-
Groundfish sp.	May	Jul	-	-	Longline	-
Pelagic sp.	May–Jun; Sep	-	-	-	Longline	-
White Marlin	Jul–Aug	Jul	Aug	-	Longline	-
Sand Tiger Shark	Jun	-	-	-	Longline	-
Dogfish	Jul	-	-	-	Gillnet	-
Blue Marlin	Jul–Aug	-	-	-	Longline	-
Basking Shark	Sep	-	-	-	Longline	-
Winter Flounder	Oct–Nov	Sep	-	-	Gillnet	-
Illex Squid	Aug	-	-	-	-	Trawl
Rock Crab	-	Sep–Oct	Aug	-	Pot	-

Source: DFO commercial landings database, 2005–2013.



Source: DFO commercial landings database, 2005–2013.

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

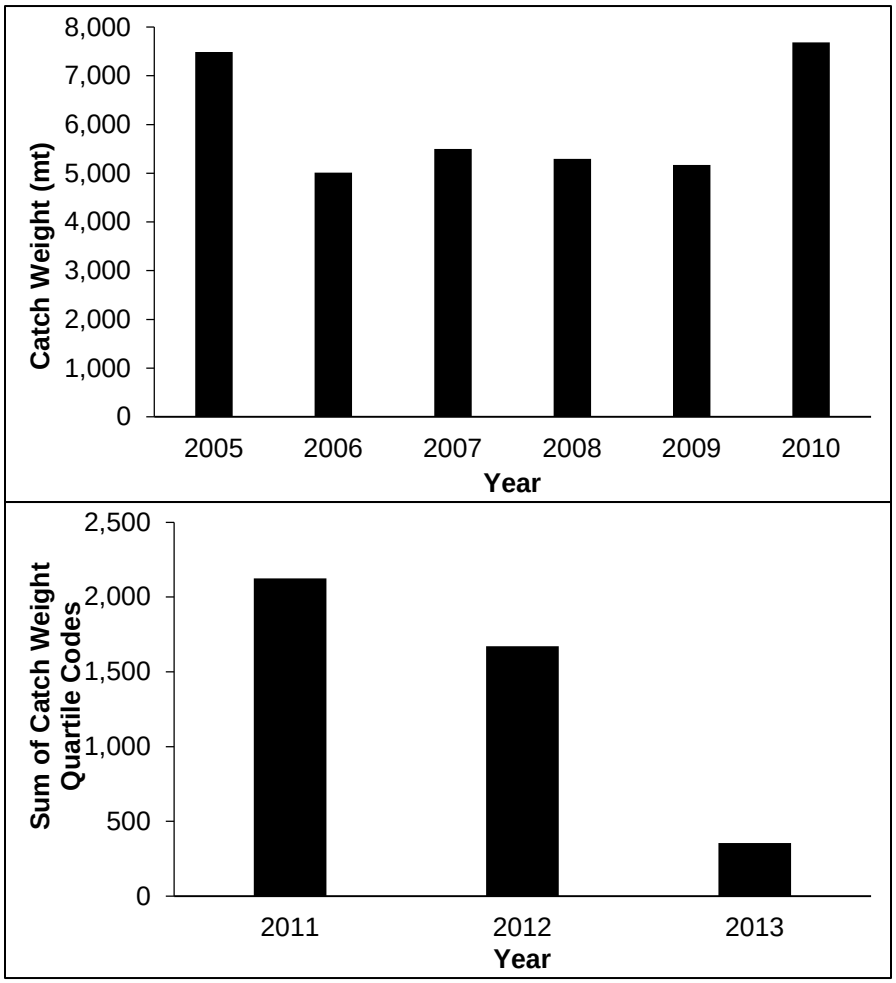
Figure 4.13 Monthly Average Catch Weight, May–November, 2005–2010 (top), and Monthly Sum of Catch Weight Quartile Codes, May–November, 2011–2013 (bottom) for all Species in the Study Area.

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

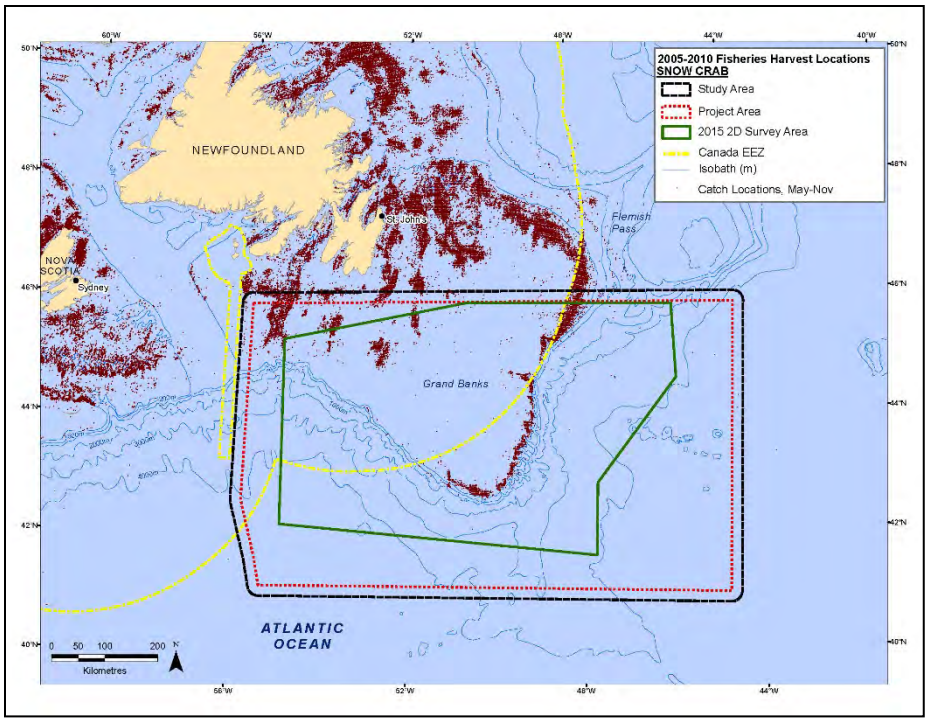
Overall, snow crab is the most important commercial species in the Study Area with respect to quantity and value. The annual total catch weights (2005–2010) and annual sum catch weight quartile codes (2011–2013) for snow crab in the Study Area between May–November are indicated in Figure 4.14. Figure 4.15 shows the snow crab harvest locations for 2005–2010. Figures 4.16–4.18 show harvest location distributions for 2011, 2012 and 2013, respectively. Most of the snow crab were harvested in the northwest portion of the Study, Project and 2015 2D Survey Areas, and the eastern portion of the slope of the Grand Banks in water depths <200 m. The average and total monthly snow crab harvests in the Study Area during the May–November of the 2005–2010 and 2011–2013 periods are shown in Figure 4.19. Most of the snow crab was caught during May–July.



Source: DFO commercial landings database, 2005–2013.

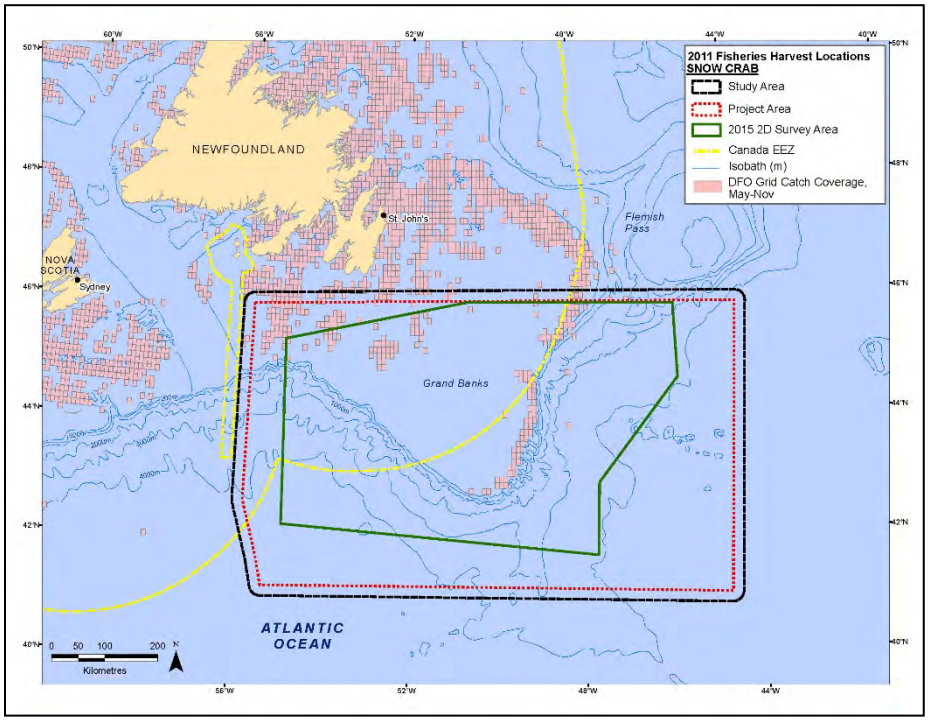
Note: Sum of catch weight quartile codes is the summation of quartile codes (i.e., 1–4) for all catch records for all species; the greater the sum of quartile code counts, the greater the catch weight for a given year.

Figure 4.14 Annual Total Catch Weights, May–November, 2005–2010 (top), and Annual Sum of Catch Weight Quartile Codes, May–November, 2011–2013 (bottom) for Snow Crab in the Study Area.



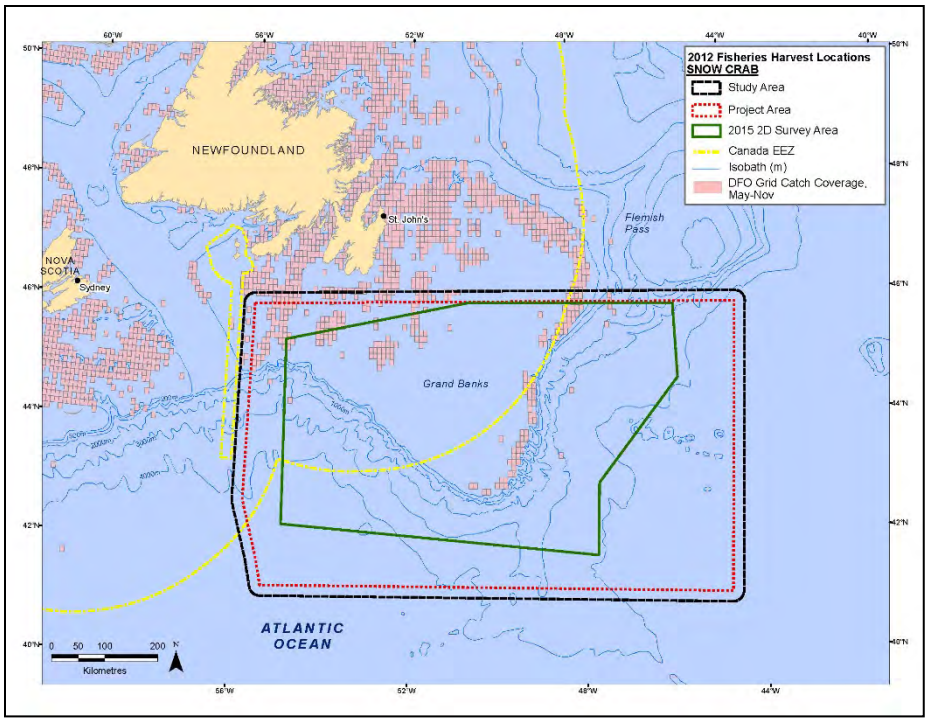
Source: DFO commercial landings database, 2005–2010.

Figure 4.15 Distribution of Commercial Harvest Locations for Snow Crab, May–November, 2005–2010.



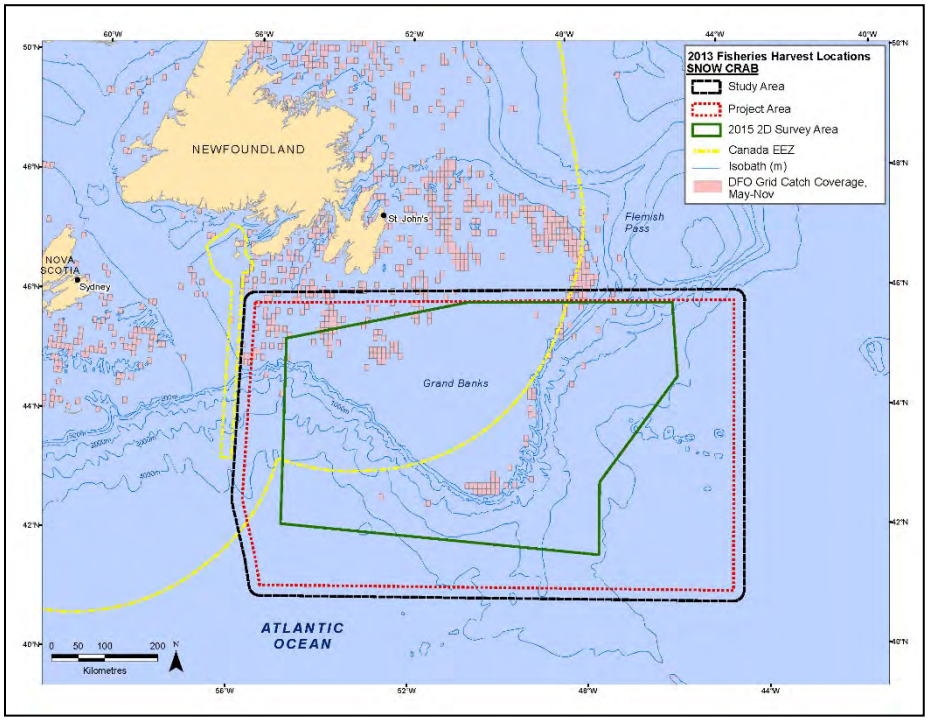
Source: DFO commercial landings database, 2011.

Figure 4.16 Distribution of Commercial Harvest Locations for Snow Crab, May–November, 2011.



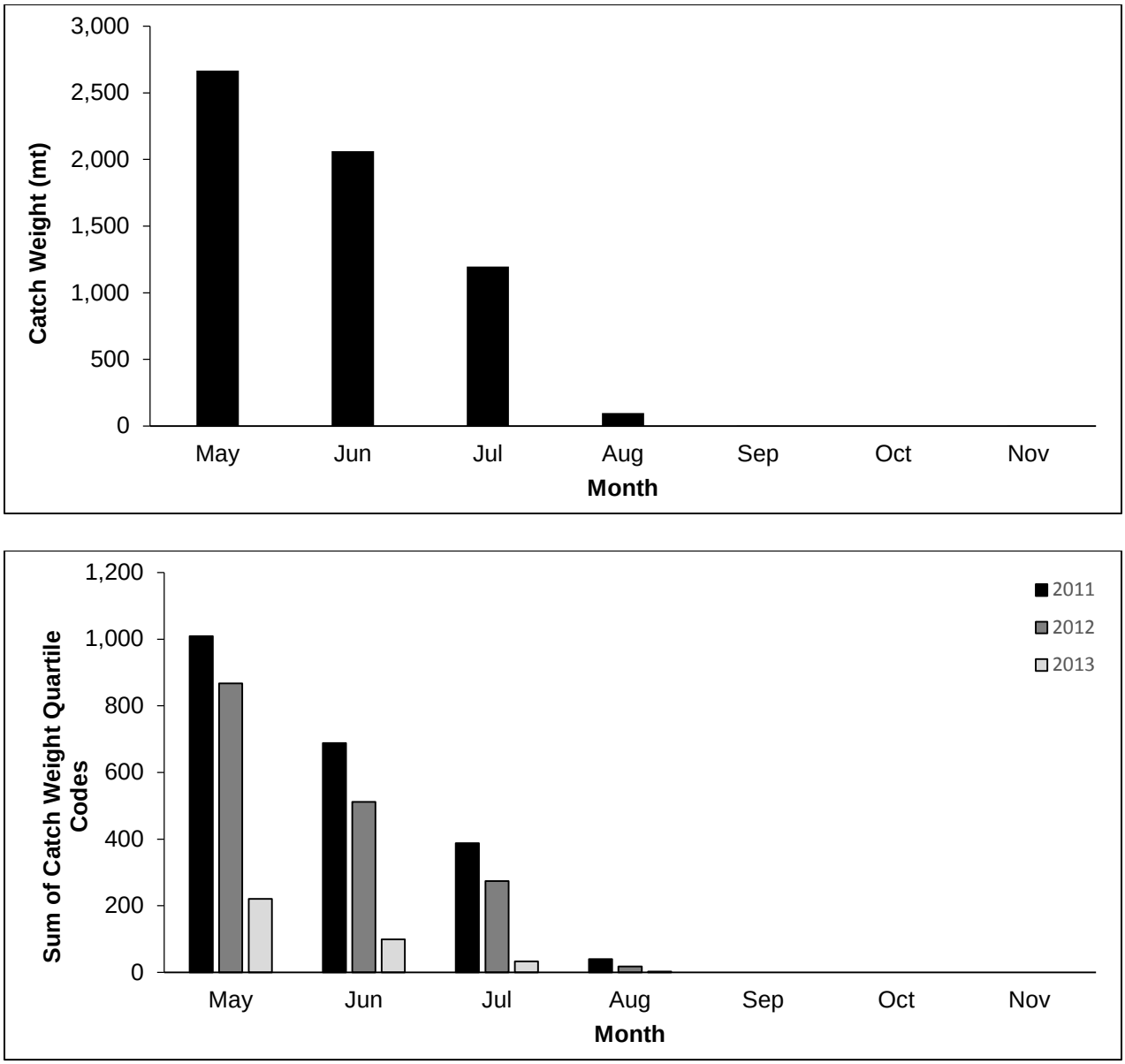
Source: DFO commercial landings database, 2012.

Figure 4.17 Distribution of Commercial Harvest Locations for Snow Crab, May–November, 2012.



Source: DFO commercial landings database, 2013.

Figure 4.18 Distribution of Commercial Harvest Locations for Snow Crab, May–November, 2013.



Source: DFO commercial landings database, 2005–2013.

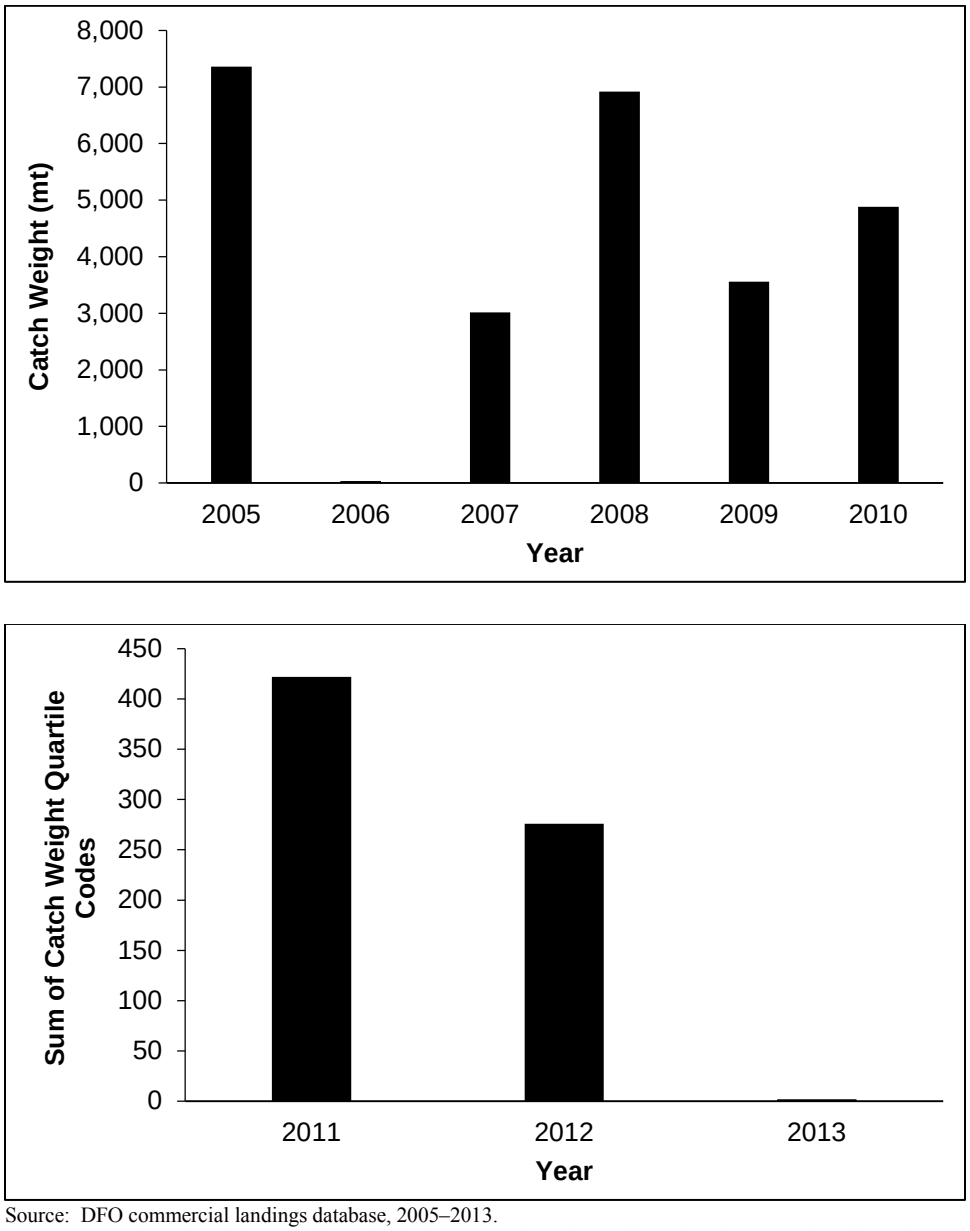
Note: Sum of catch weight quartile codes is the summation of quartile codes (i.e., 1–4) for all catch records for all species; the greater the sum of quartile code counts, the greater the catch weight for a given month.

Figure 4.19 Monthly Average Catch Weights, May–November, 2005–2010 (top), and Monthly Sum of Catch Weight Quartile Codes, May–November, 2011–2013 (bottom), for Snow Crab in the Study Area.

Yellowtail Flounder

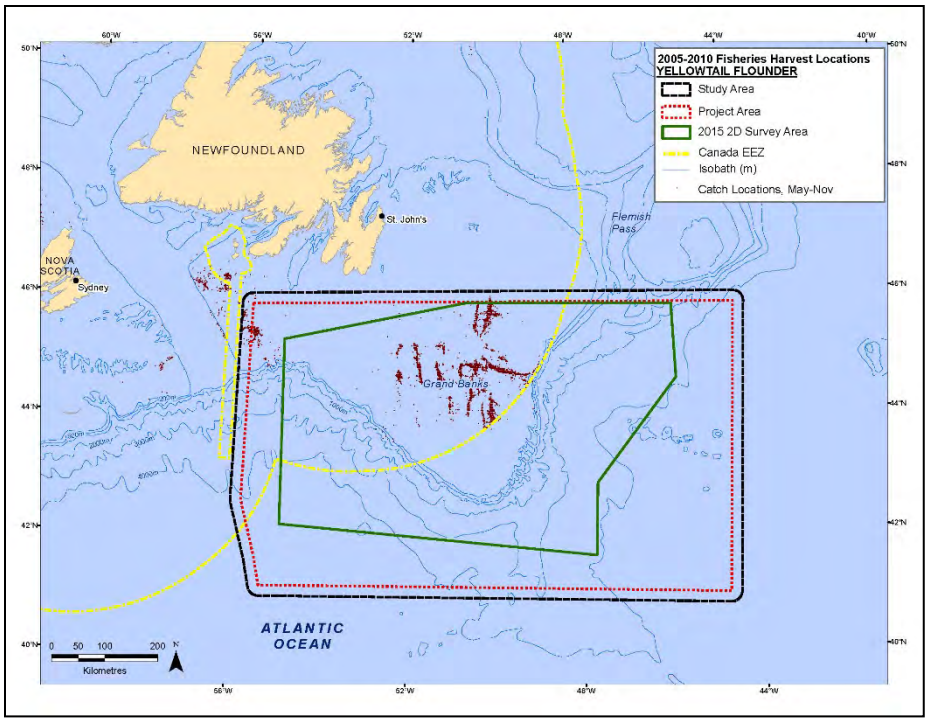
In terms of catch weight, yellowtail flounder was the second most important commercial species and the most important groundfish species in the Study Area during 2005–2010. This flatfish accounted for about 5% of the total commercial catch weight during 2011–2012, but only about 0.2% in 2013, based on coarse analysis using the catch weight quartile codes. Annual total catch weights (2005–2010) and sum of catch weight quartile codes (2011–2013) for yellowtail flounder in the Study Area between

May–November are indicated in Figure 4.20. Figure 4.21 shows the yellowtail flounder harvest locations for 2005–2010 combined. Figures 4.22–4.24 show yellowtail flounder harvesting patterns for 2011, 2012 and 2013, respectively. Yellowtail flounder were virtually exclusively caught in the northwest and north-central portions of the Study Area in water depths <200 m. The monthly average and total yellowtail flounder harvests in the Study Area during the May–November of 2005–2010 and 2011–2013 periods are shown in Figure 4.25. Yellowtail flounder were mainly harvested in spring and fall.



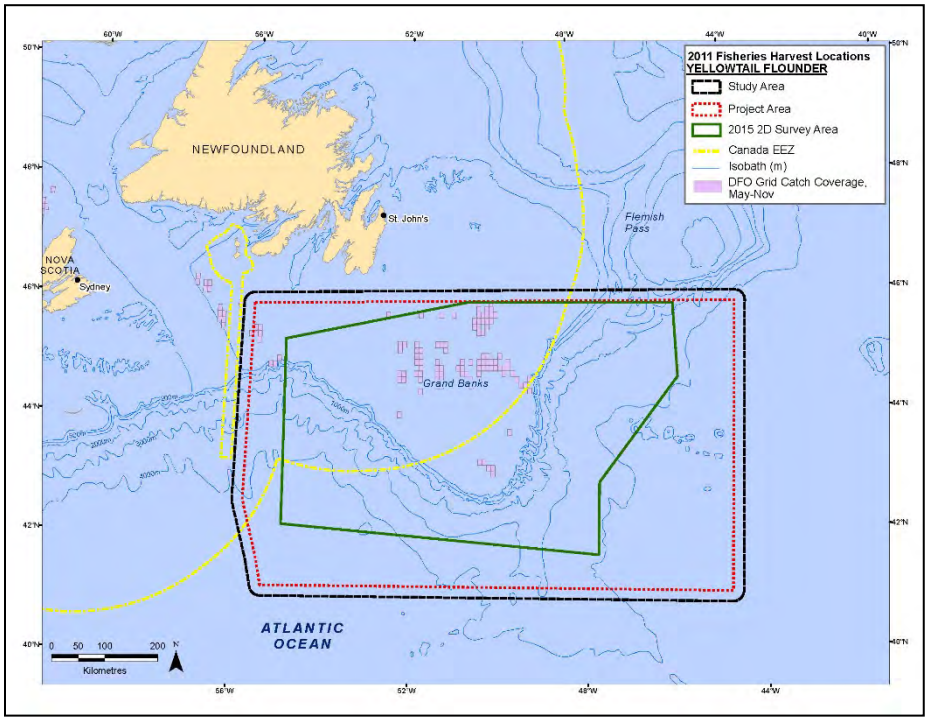
Source: DFO commercial landings database, 2005–2013.
Note: Sum of catch weight quartile codes is the summation of quartile codes (i.e., 1–4) for all catch records for all species; the greater the sum of quartile codes, the greater the catch weight for a given year.

Figure 4.20 Annual Total Catch Weights, May–November, 2005–2010 (top), and Annual Sum of Catch Weight Quartile Codes, May–November, 2011–2013 (bottom), for Yellowtail Flounder in the Study Area.



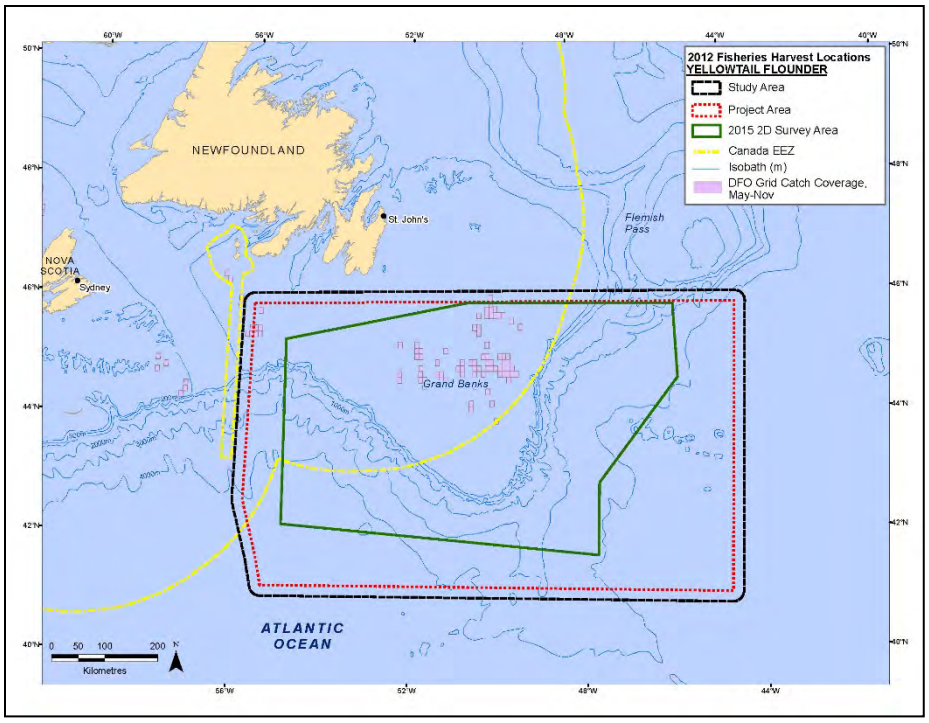
Source: DFO commercial landings database, 2005–2010.

Figure 4.21 Distribution of Commercial Harvest Locations for Yellowtail Flounder, May-November, 2005–2010.



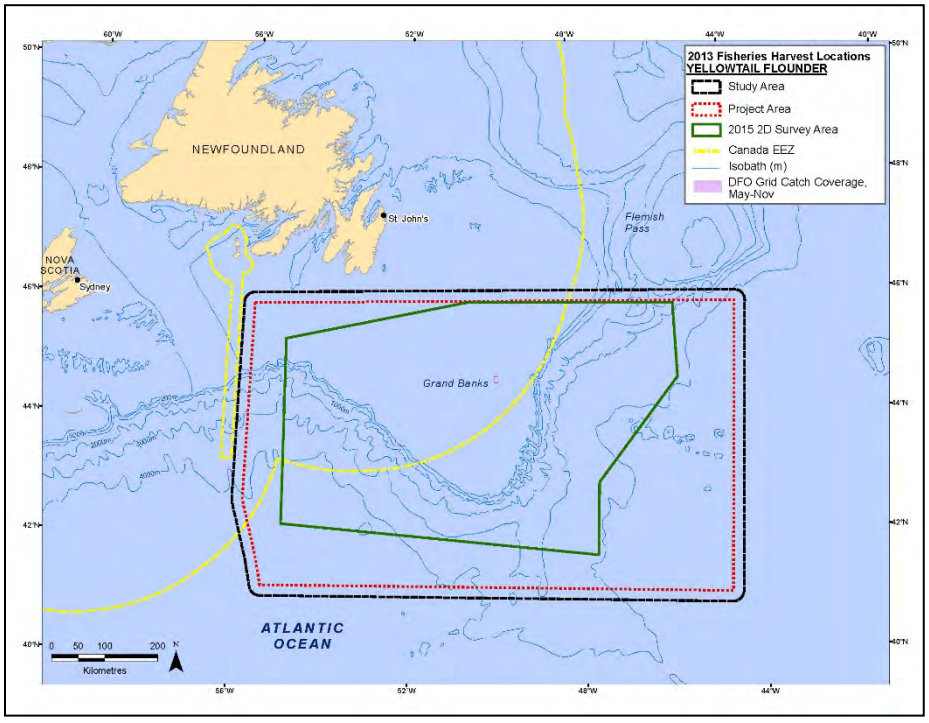
Source: DFO commercial landings database, 2011.

Figure 4.22 Distribution of Commercial Harvest Locations for Yellowtail Flounder, May-November, 2011.



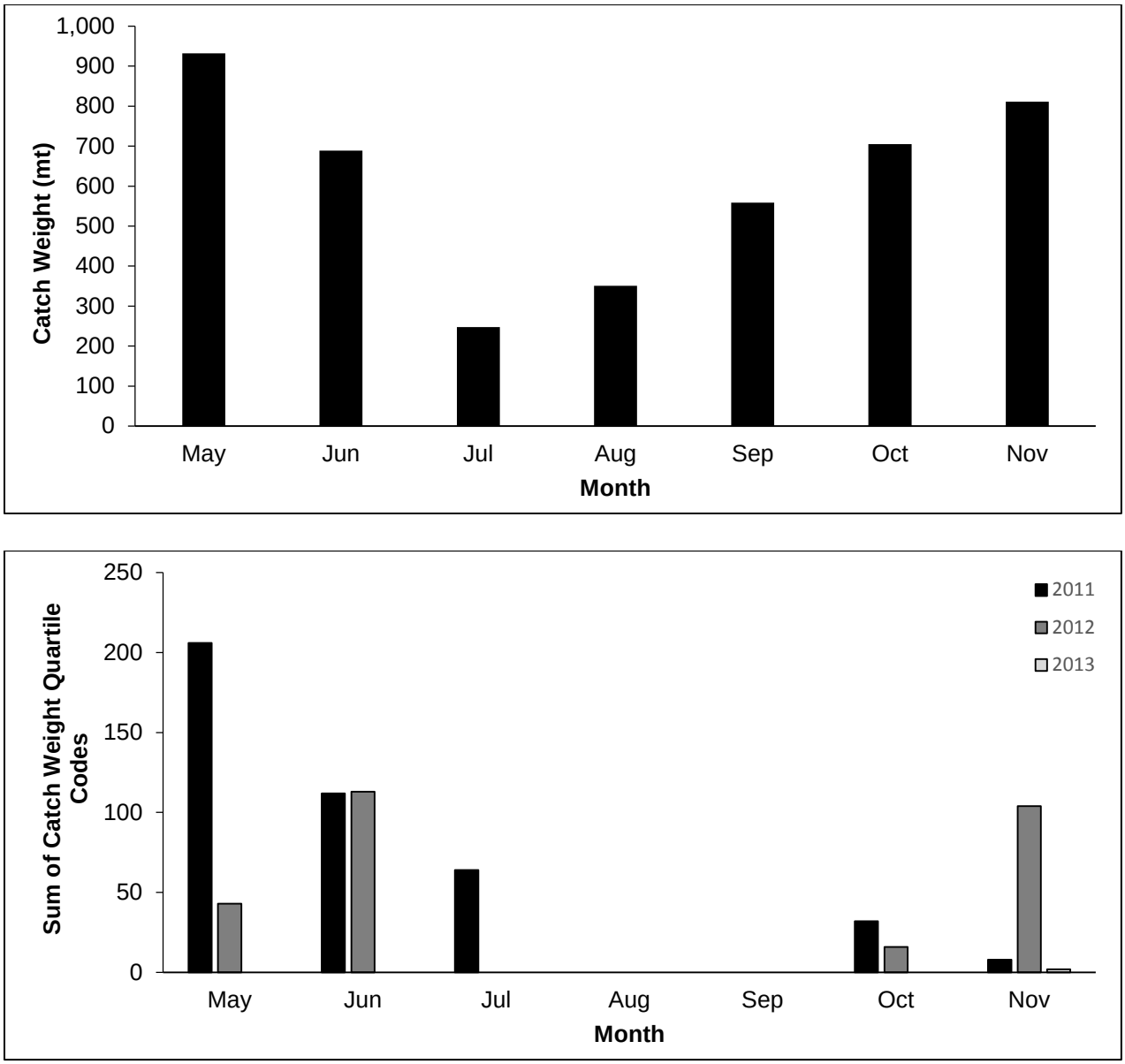
Source: DFO commercial landings database, 2012.

Figure 4.23 Distribution of Commercial Harvest Locations for Yellowtail Flounder, May-November, 2012.



Source: DFO commercial landings database, 2013.

Figure 4.24 Distribution of Commercial Harvest Locations for Yellowtail Flounder, May-November, 2013.



Source: DFO commercial landings database, 2005–2013.

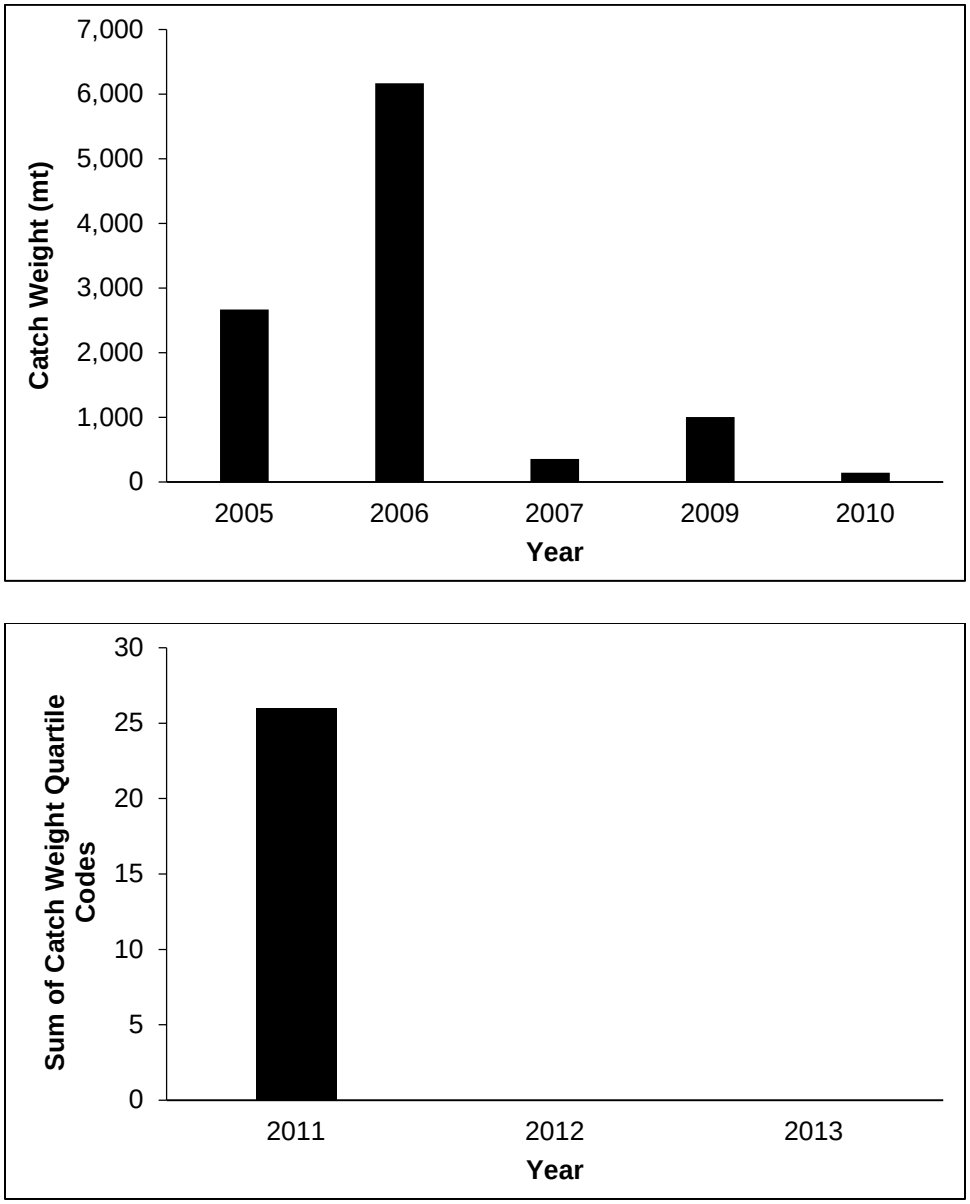
Note: Sum of catch weight quartile codes is the summation of quartile codes (i.e., 1–4) for all catch records for all species; the greater the sum of quartile code counts, the greater the catch weight for a given month.

Figure 4.25 Monthly Average Catch Weights, May–November, 2005–2010 (top), and Monthly Sum of Catch Weight Quartile Codes, May–November, 2011–2013 (bottom), for Yellowtail Flounder in the Study Area.

Cockles

Cockles accounted for the largest proportion of bivalve catches in the Study Area during 2005–2010, and 0.4% of the total catch in 2011, based on coarse analysis using the catch weight quartile codes. There were not any cockle harvests recorded within the Study Area in either 2012 or 2013. Annual total catch weights (2005–2010) and sum of catch weight quartile codes (2011) for cockles in the Study Area between May–November are indicated in Figure 4.26. Figure 4.27 and 4.28 show the cockle harvest

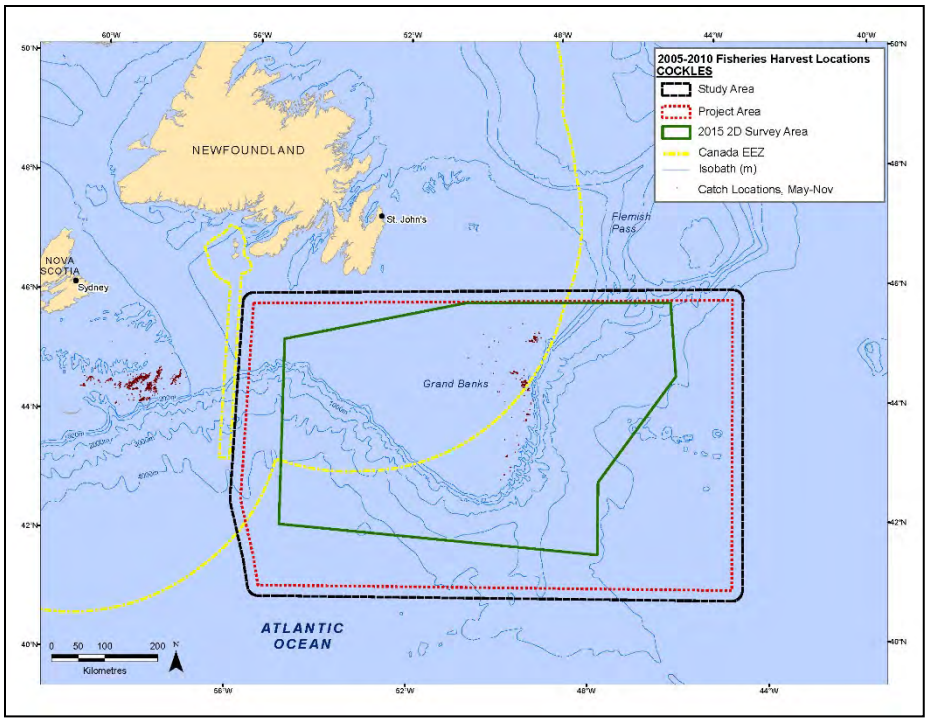
locations for 2005–2010 (combined) and 2011, respectively. The majority of cockles were captured in the eastern portion of the shelf and slope of the Grand Banks in the Study Area, in water depths <200 m. The monthly average and total cockle harvests in the Study Area during the May–November of 2005-2010 and 2011 are shown in Figure 4.29. Cockles were primarily harvested in the Study Area between October–November in 2005–2010, and only in October in 2011.



Source: DFO commercial landings database, 2005–2013.

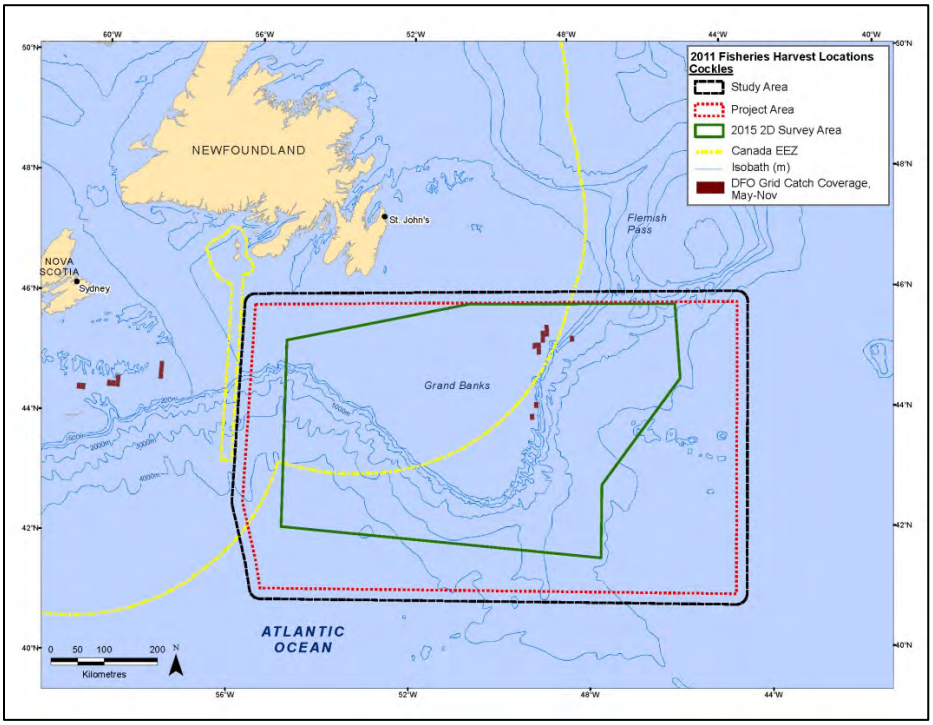
Note: Sum of catch weight quartile codes is the summation of quartile codes (i.e., 1–4) for all catch records for all species; the greater the sum of quartile code counts, the greater the catch weight for a given year.

Figure 4.26 Annual Total Catch Weights, May–November, 2005–2010 (top), and Annual Sum of Catch Weight Quartile Codes, May–November, 2011–2013 (bottom), for Cockles in the Study Area.



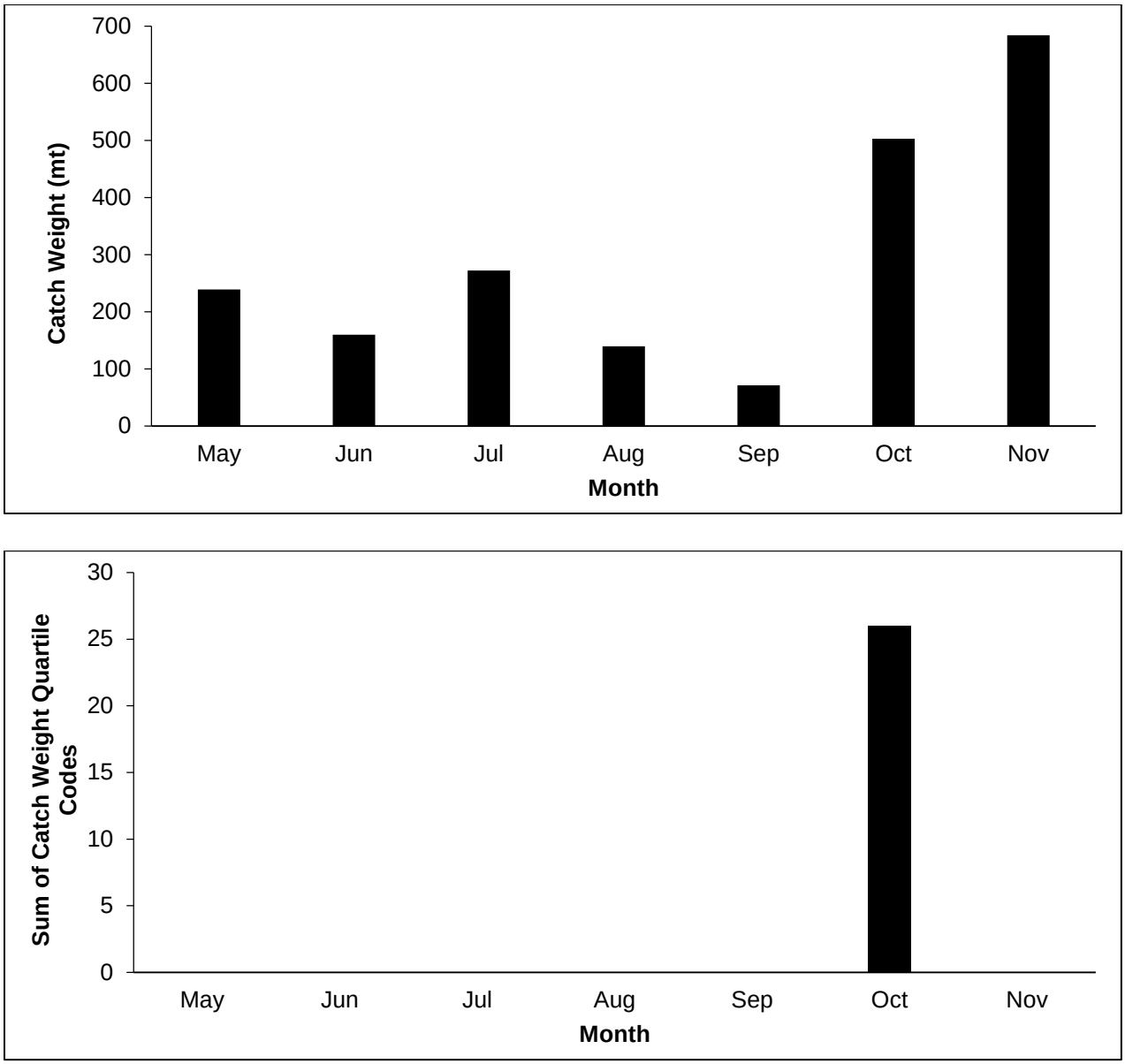
Source: DFO commercial landings database, 2005–2010.

Figure 4.27 Distribution of Commercial Harvest Locations for Cockles, May–November, 2005-2010.



Source: DFO commercial landings database, 2011.

Figure 4.28 Distribution of Commercial Harvest Locations for Cockles, May–November, 2011.



Source: DFO commercial landings database, 2005–2013.

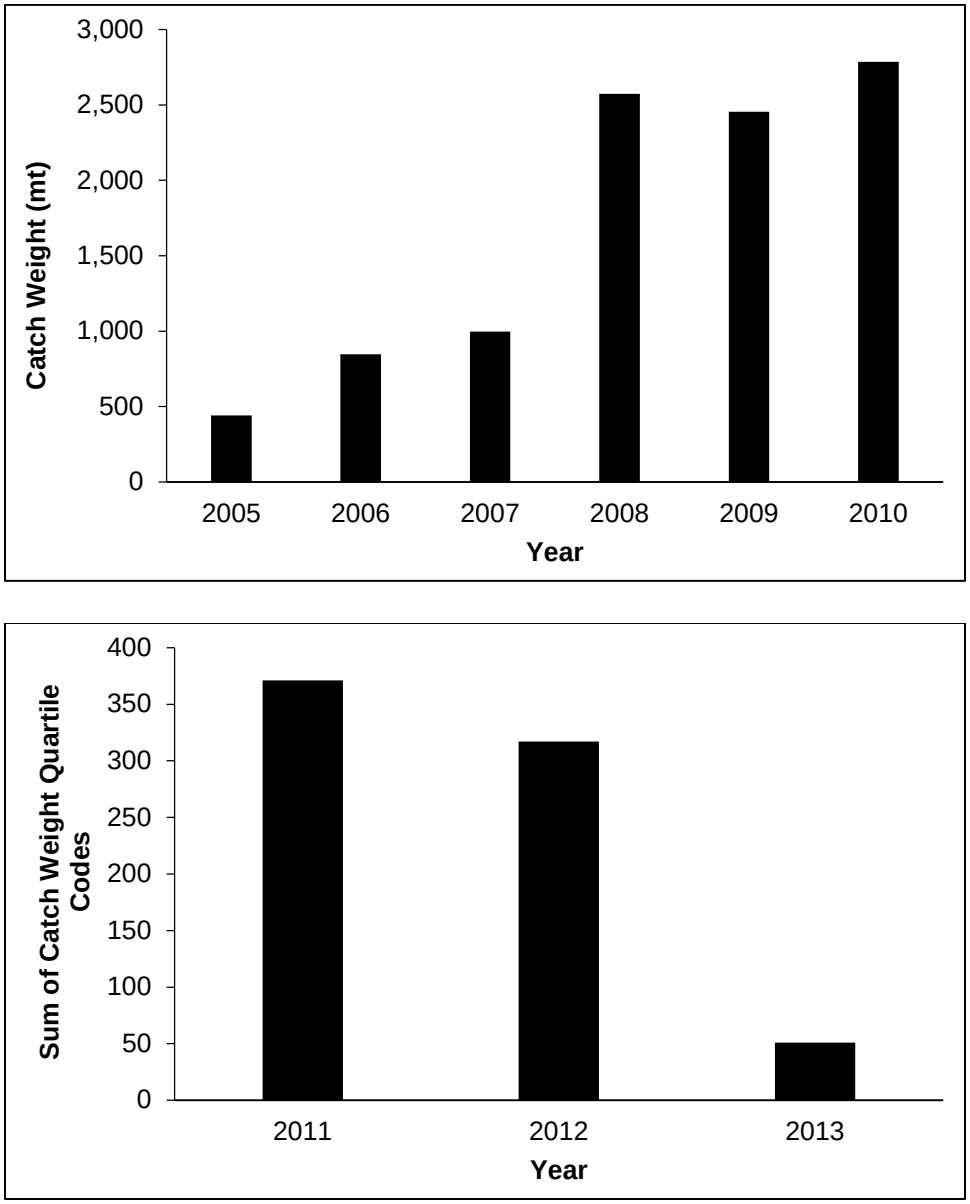
Note: Sum of catch weight quartile codes is the summation of quartile codes (i.e., 1–4) for all catch records for all species; the greater the sum of quartile code counts, the greater the catch weight for a given month.

Figure 4.29 Monthly Average Catch Weights, May–November, 2005–2010 (top), and Monthly Sum of Catch Weight Quartile Codes, May–November, 2011 (bottom), for Cockles in the Study Area.

Whelks

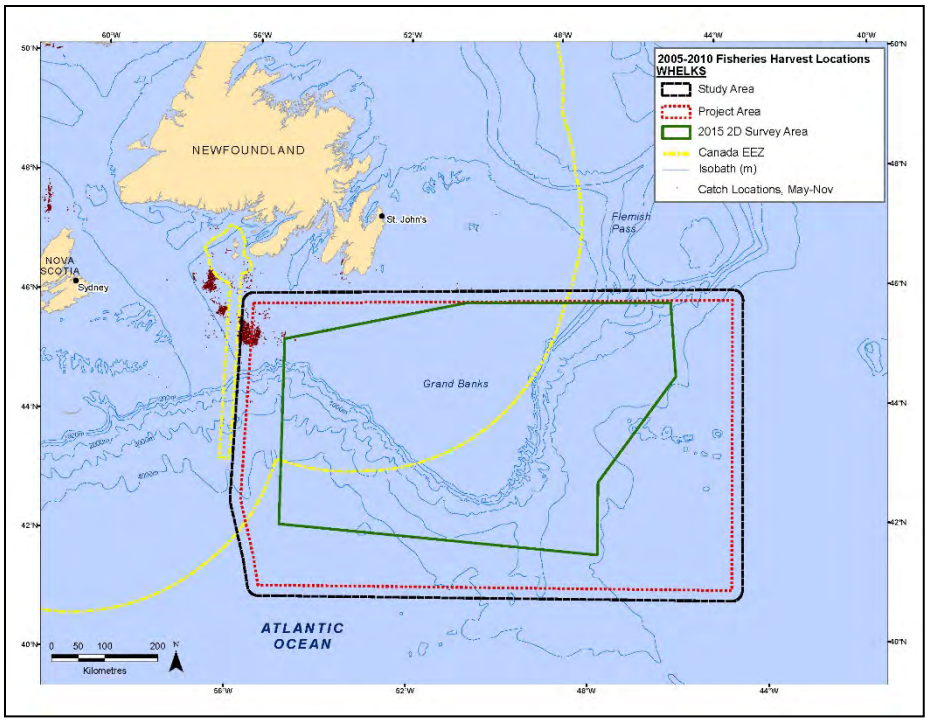
In terms of catch weight, whelks were the most important commercial gastropod species in the Study Area during 2005–2010, and accounted for 4–5% of the total catch weight in 2011–2013, based on coarse analysis using the catch weight quartile codes. Annual total catch weights (2005–2010) and sum of catch weight quartile codes (2011–2013) for whelks in the Study Area between May–November are indicated in Figure 4.30. Figure 4.31 shows the whelk harvest locations for 2005–2010 combined.

Figures 4.32–4.34 show whelk harvesting patterns for 2011, 2012 and 2013, respectively. Whelks were only caught in the northwest portions of the Study, Project, and 2015 2D Survey Areas in water depths <200 m. The monthly average and total whelk harvests in the Study Area during the May–November in 2005–2010 and 2011–2013 periods are shown in Figure 4.35. Whelks were primarily caught during the summer months in the Study Area.



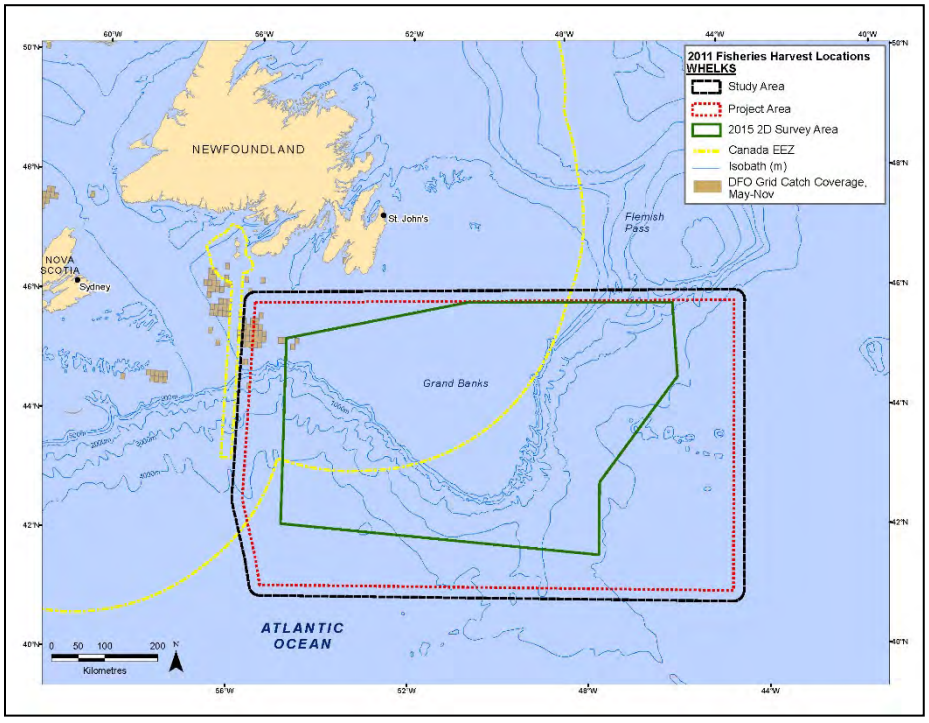
Source: DFO commercial landings database, 2005–2013.
Note: Sum of catch weight quartile codes is the summation of quartile codes (i.e., 1–4) for all catch records for all species; the greater the sum of quartile codes, the greater the catch weight for a given year.

Figure 4.30 Annual Total Catch Weights, May–November, 2005–2010 (top), and Annual Sum of Catch Weight Quartile Codes, May–November, 2011–2013 (bottom), for Whelks in the Study Area.



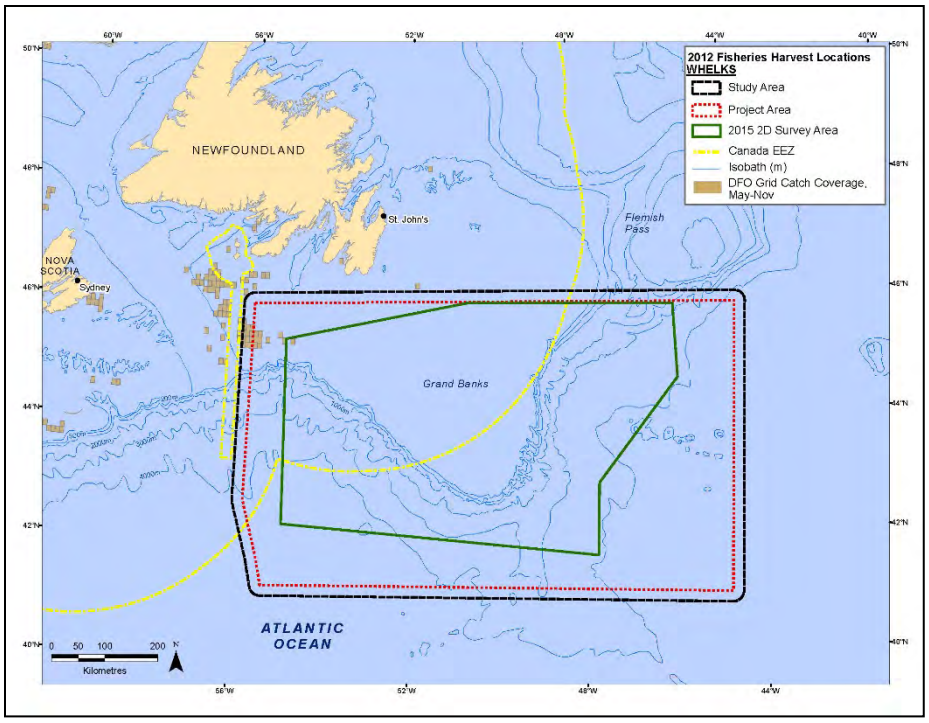
Source: DFO commercial landings database, 2005–2010.

Figure 4.31 Distribution of Commercial Harvest Locations for Whelks, May–November, 2005-2010.



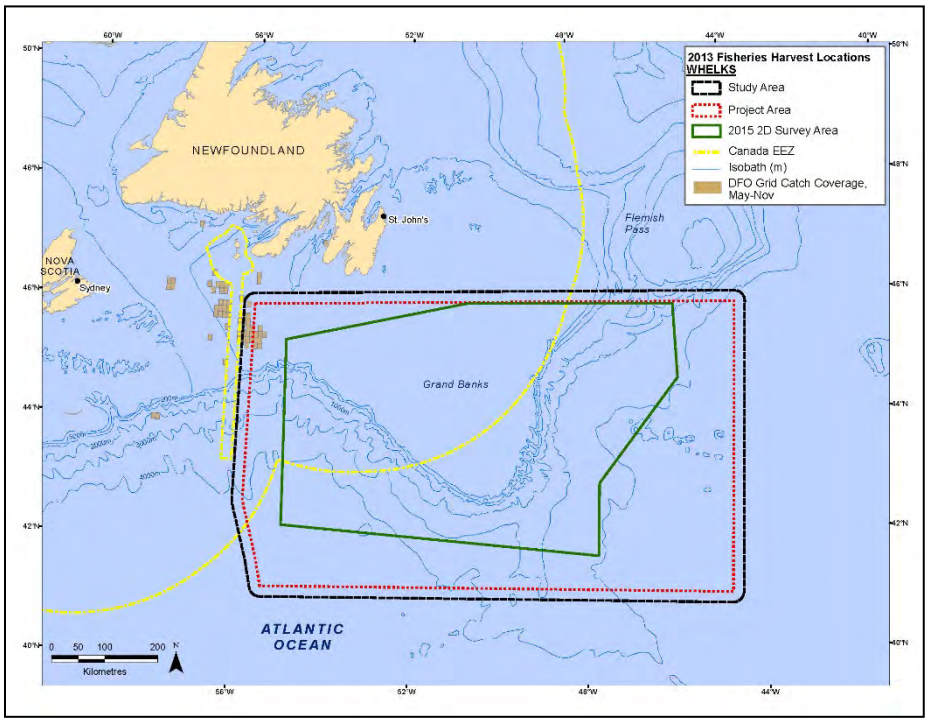
Source: DFO commercial landings database, 2011.

Figure 4.32 Distribution of Commercial Harvest Locations for Whelks, May–November, 2011.



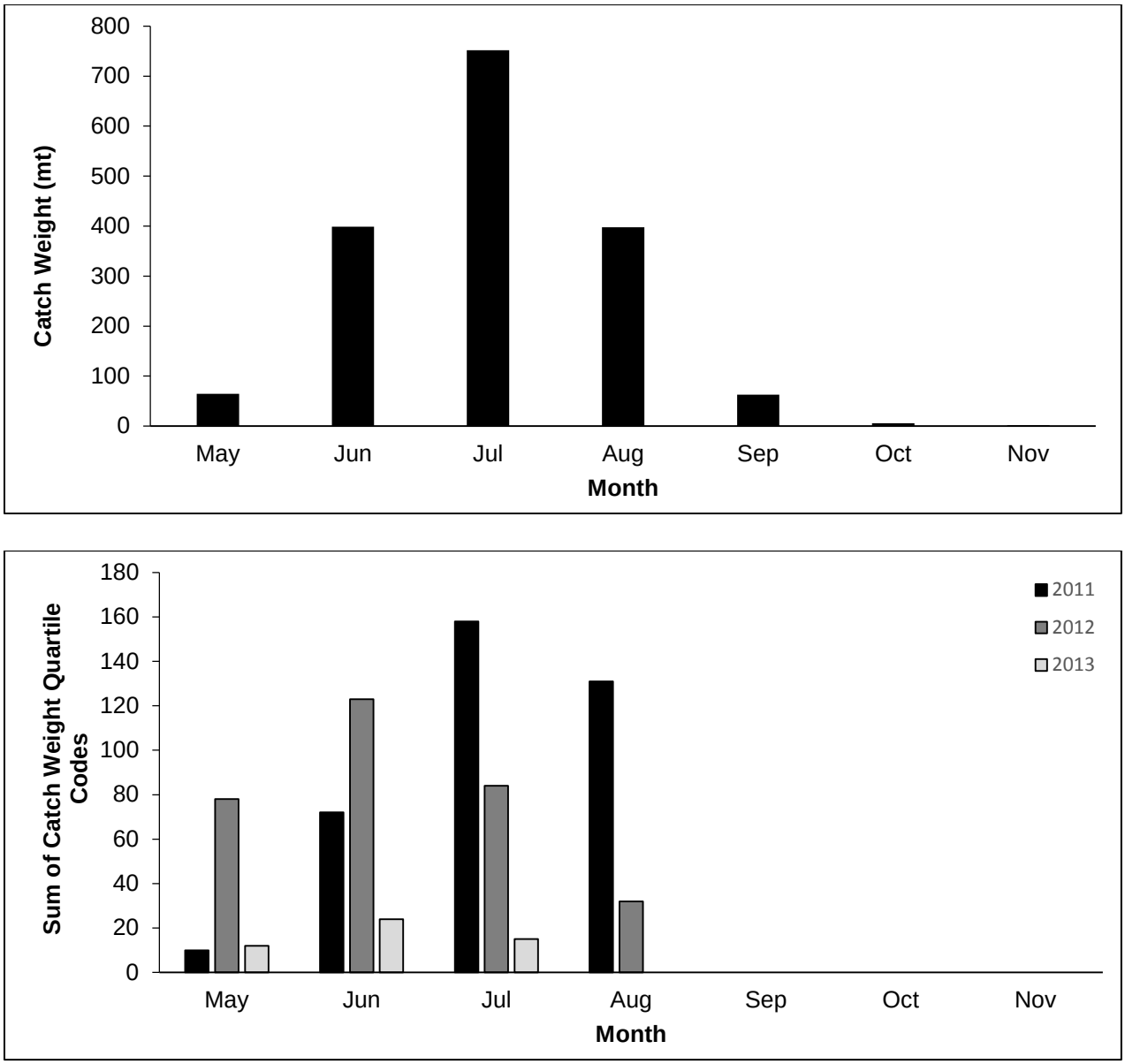
Source: DFO commercial landings database, 2012.

Figure 4.33 Distribution of Commercial Harvest Locations for Whelks, May–November, 2012.



Source: DFO commercial landings database, 2013.

Figure 4.34 Distribution of Commercial Harvest Locations for Whelks, May–November, 2013.



Source: DFO commercial landings database, 2005–2013.

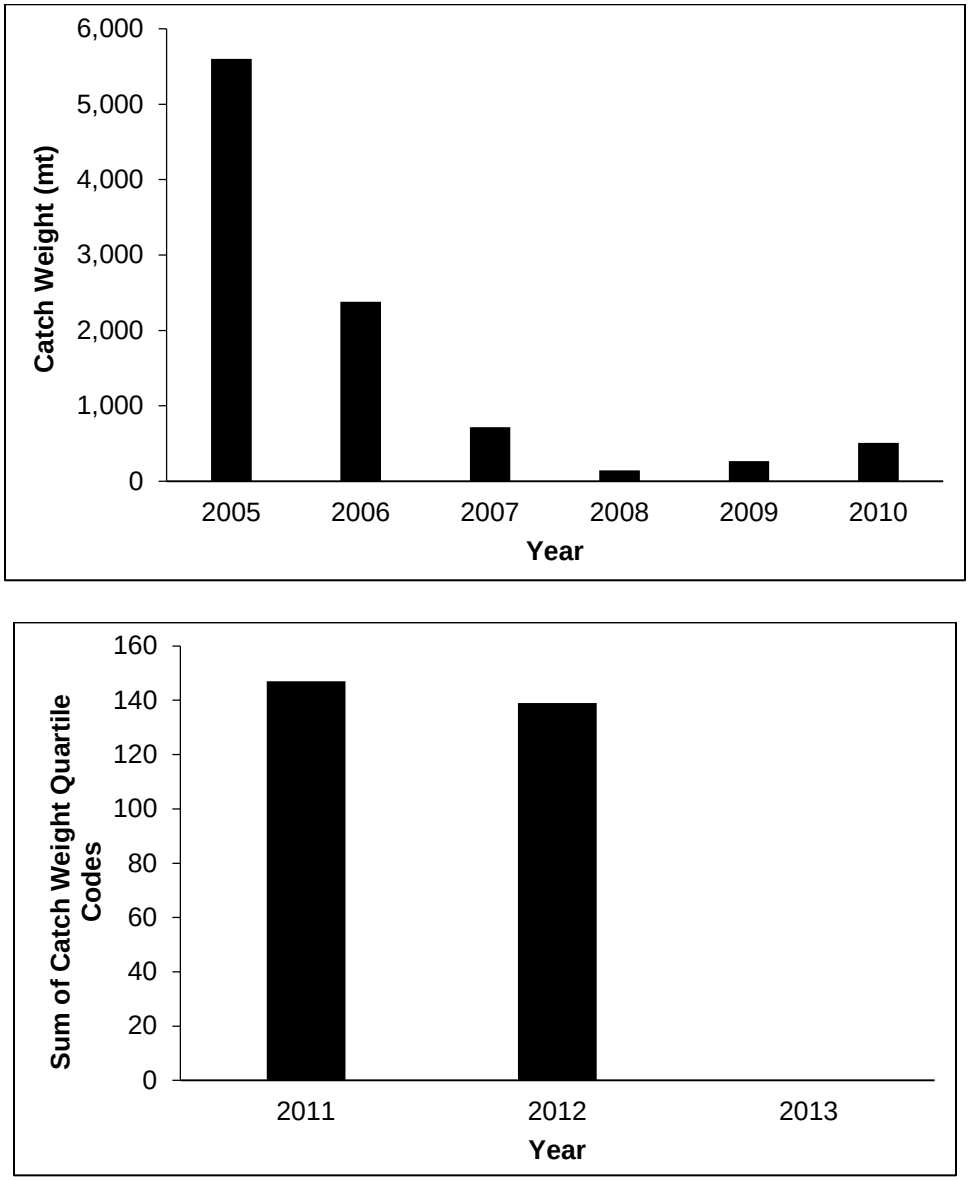
Note: Sum of catch weight quartile codes is the summation of quartile codes (i.e., 1–4) for all catch records for all species; the greater the sum of quartile code counts, the greater the catch weight for a given month.

Figure 4.35 Monthly Average Catch Weights, May–November, 2005–2010 (top), and Monthly Sum of Catch Weight Quartile Codes, May–November, 2011–2013 (bottom) for Whelks in the Study Area.

Redfish

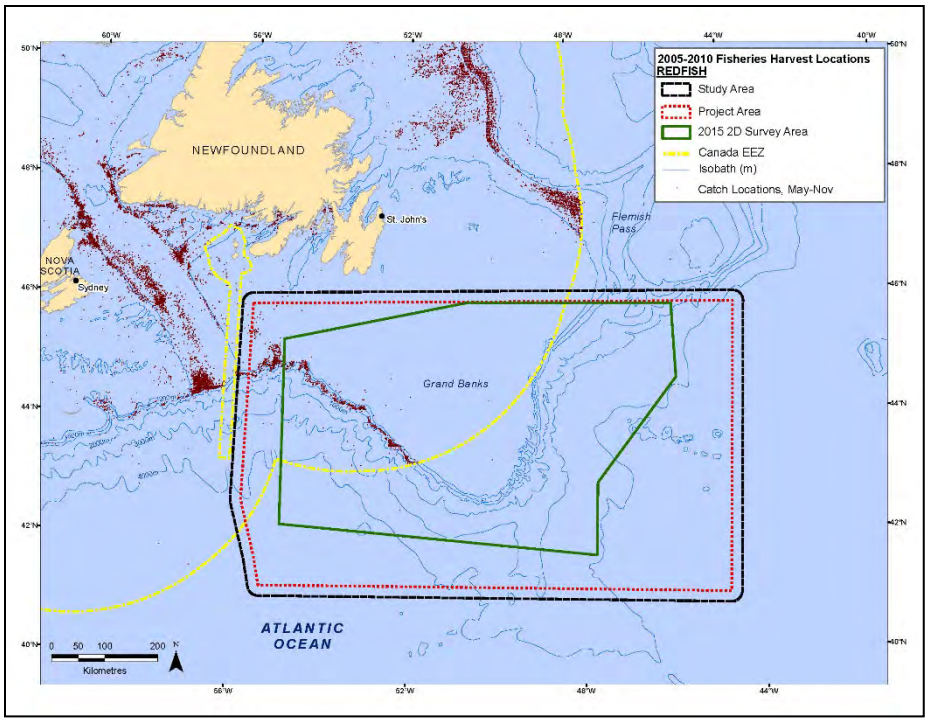
In terms of catch weight, redfish was the second most important commercial groundfish species in the Study Area during 2005–2010, and accounted for about 2–3% of the total catch weight during 2011-2012, based on coarse analysis using the catch weight quartile codes. There were not any redfish harvests recorded within the Study Area in 2013. Annual total catch weights (2005–2010) and annual sum of catch weight quartile codes (2011–2012) for redfish in the Study Area between May–November

are indicated in Figure 4.36. Figure 4.37 shows the redfish harvest locations for 2005–2010 combined. Figures 4.38–4.39 show redfish harvest locations in 2011 and 2012, respectively. Most of the redfish were caught in the northwest portion of the Study, Project and 2015 2D Survey Areas, and along the western portion of the slope of the Grand Banks during 2005–2011 in water depths to 1,000 m. Harvest locations for redfish also extended along the southern and eastern slope of the Grand Banks in 2012. The monthly average and total redfish harvests in the Study Area during May–November in 2005–2010 and 2011–2012 periods are shown in Figure 4.40. Redfish were mainly caught between mid-summer and early-fall.



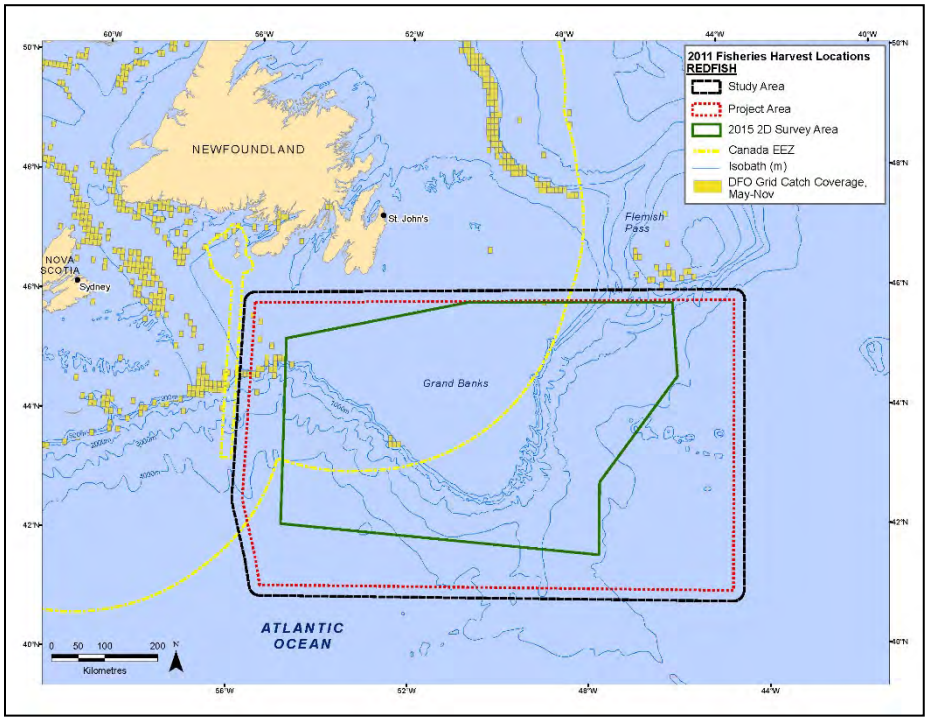
Source: DFO commercial landings database, 2005–2013.
Note: Sum of catch weight quartile codes is the summation of quartile codes (i.e., 1–4) for all catch records for all species; the greater the sum of quartile codes, the greater the catch weight for a given year.

Figure 4.36 Annual Total Catch Weights, May–November, 2005–2010 (top), and Annual Sum of Catch Weight Quartile Codes, May–November, 2011–2013 (bottom), for Redfish in the Study Area.



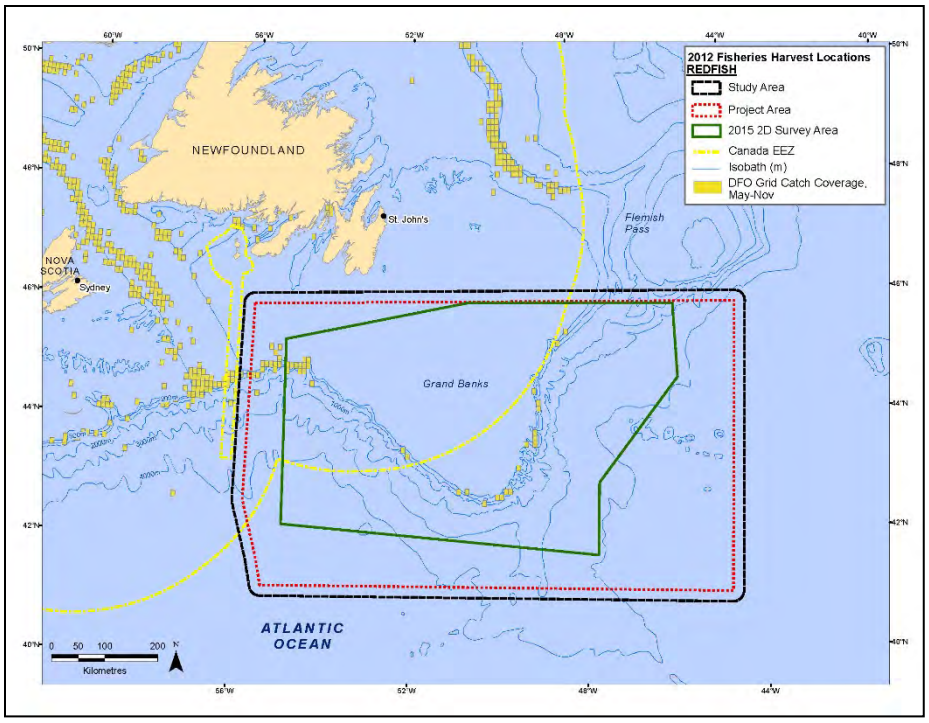
Source: DFO commercial landings database, 2005–2010.

Figure 4.37 Distribution of Commercial Harvest Locations for Redfish, May–November, 2005-2010.



Source: DFO commercial landings database, 2011.

Figure 4.38 Distribution of Commercial Harvest Locations for Redfish, May–November, 2011.

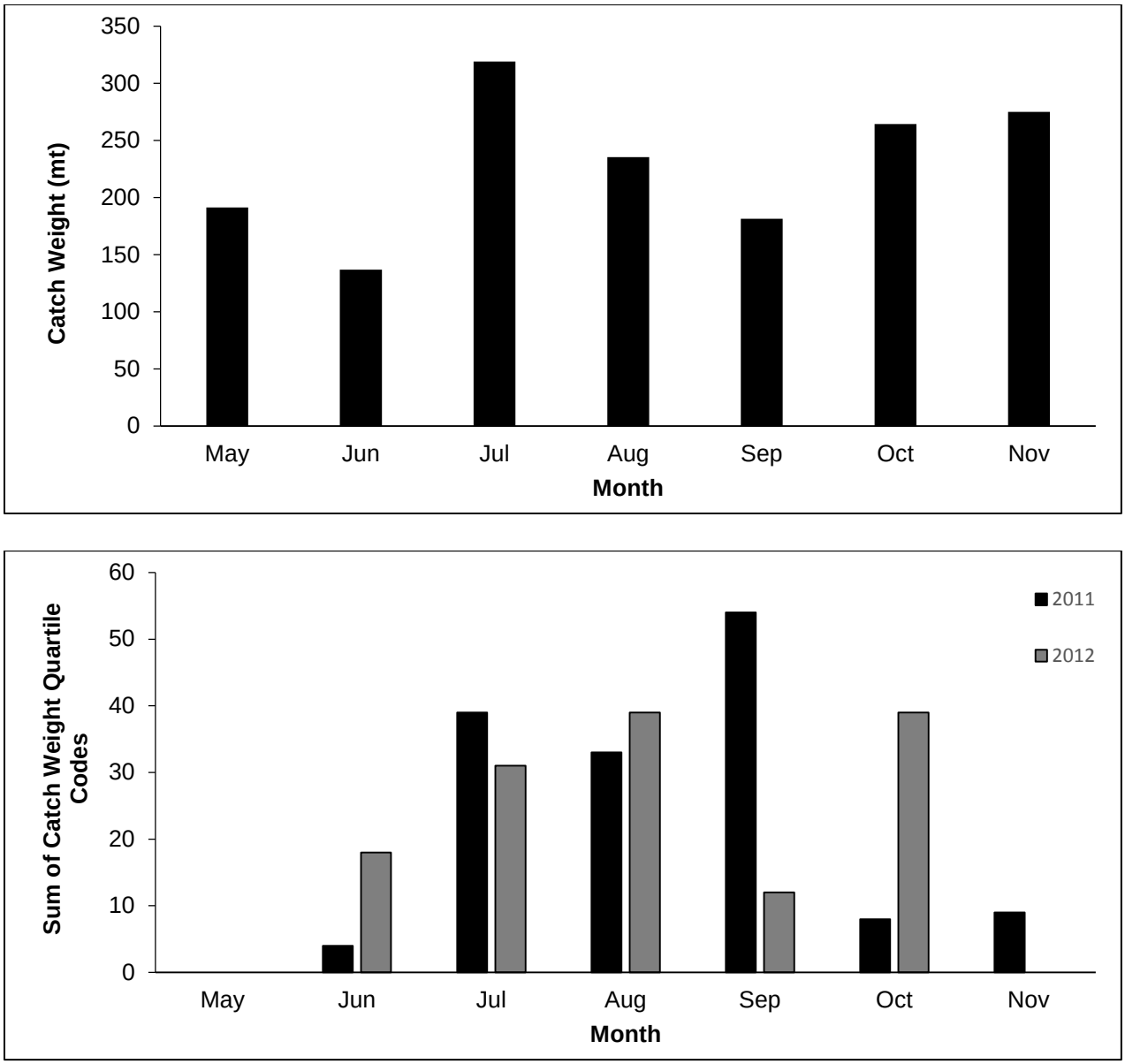


Source: DFO commercial landings database, 2012.

Figure 4.39 Distribution of Commercial Harvest Locations for Redfish, May–November, 2012.

Atlantic Cod

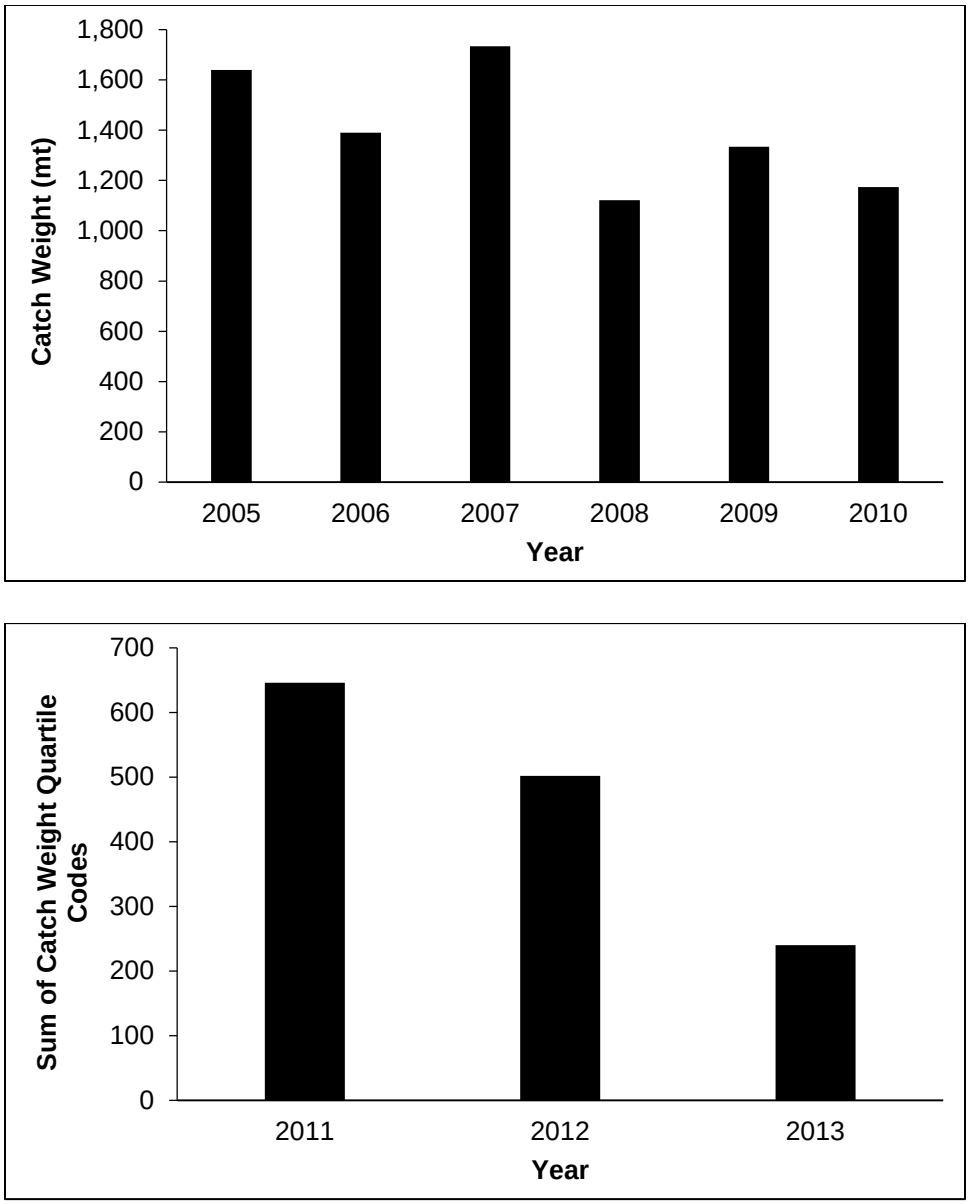
Atlantic cod was the third most important groundfish commercial species in the Study Area during 2005–2010 in terms of catch weight, and the second most in terms of catch value. Cod accounted for about 8–9% of the total catch in 2011–2012, and about 30% in 2013, based on coarse analysis using the catch weight quartile codes. Annual total catch weights (2005–2010) and sum of catch weight quartile codes (2011–2013) for Atlantic cod in the Study Area between May–November are indicated in Figure 4.41. Figure 4.42 shows the Atlantic cod harvest locations for 2005–2010 combined. Figures 4.43–4.45 show Atlantic cod harvest locations for 2011, 2012 and 2013, respectively. The majority of Atlantic cod were caught in the northwest and north-central portions of the Study, Project and 2015 2D Survey Areas, as well as along with the slope of the Grand Banks in water depths up to 1,000 m. The monthly average and total Atlantic cod harvests in the Study Area during May–November in 2005–2010 and 2011–2013 periods are shown in Figure 4.46. Atlantic cod were mainly caught in the Study Area between September–November in 2005–2010, and May–July and September–November in 2011–2013.



Source: DFO commercial landings database, 2005–2013.

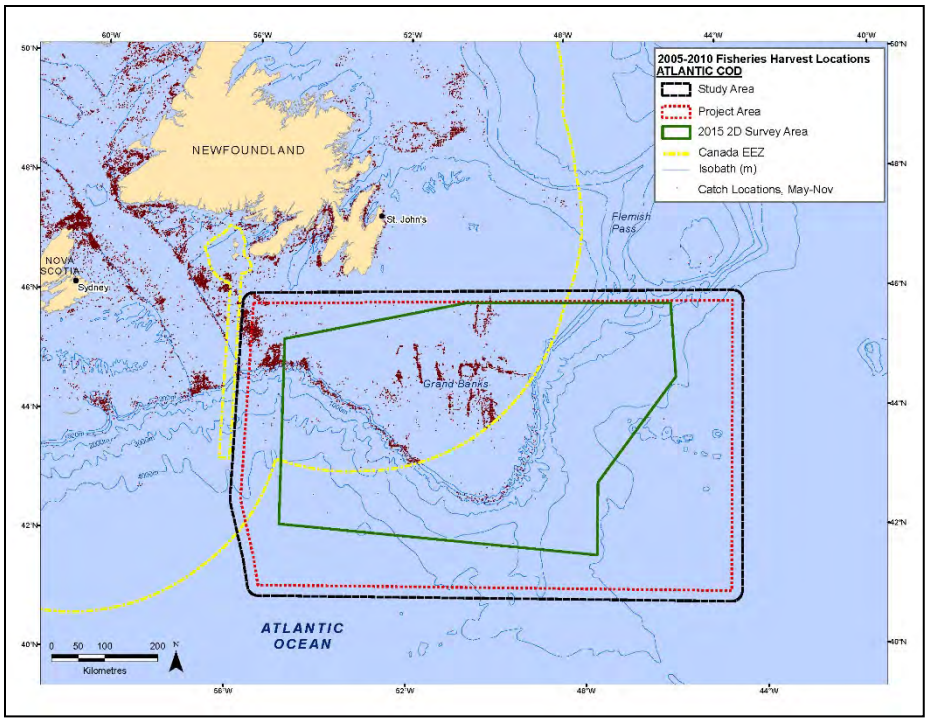
Note: Sum of catch weight quartile codes is the summation of quartile codes (i.e., 1–4) for all catch records for all species; the greater the sum of quartile code counts, the greater the catch weight for a given month.

Figure 4.40 Monthly Average Catch Weights, May–November, 2005–2010 (top), and Monthly Sum of Catch Weight Quartile Codes, May–November, 2011–2012 (bottom), for Redfish in the Study Area.



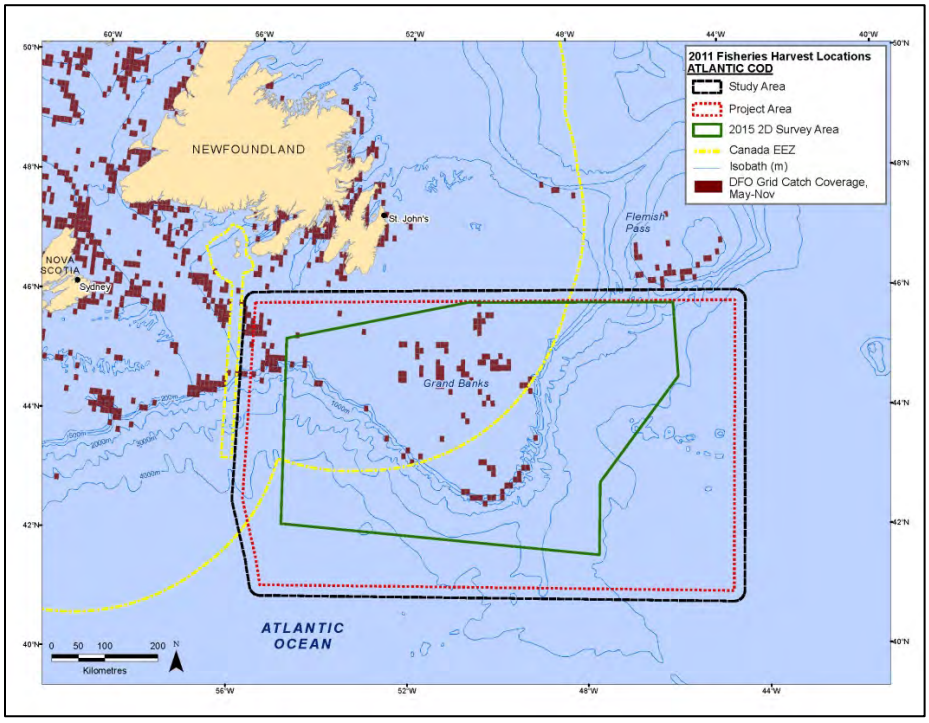
Source: DFO commercial landings database, 2005–2013.
Note: Sum of catch weight quartile codes is the summation of quartile codes (i.e., 1–4) for all catch records for all species; the greater the sum of quartile codes, the greater the catch weight for a given year.

Figure 4.41 Annual Total Catch Weights, May–November, 2005–2010 (top), and Annual Sum of Catch Weight Quartile Codes, May–November, 2011–2013 (bottom), for Atlantic Cod in the Study Area.



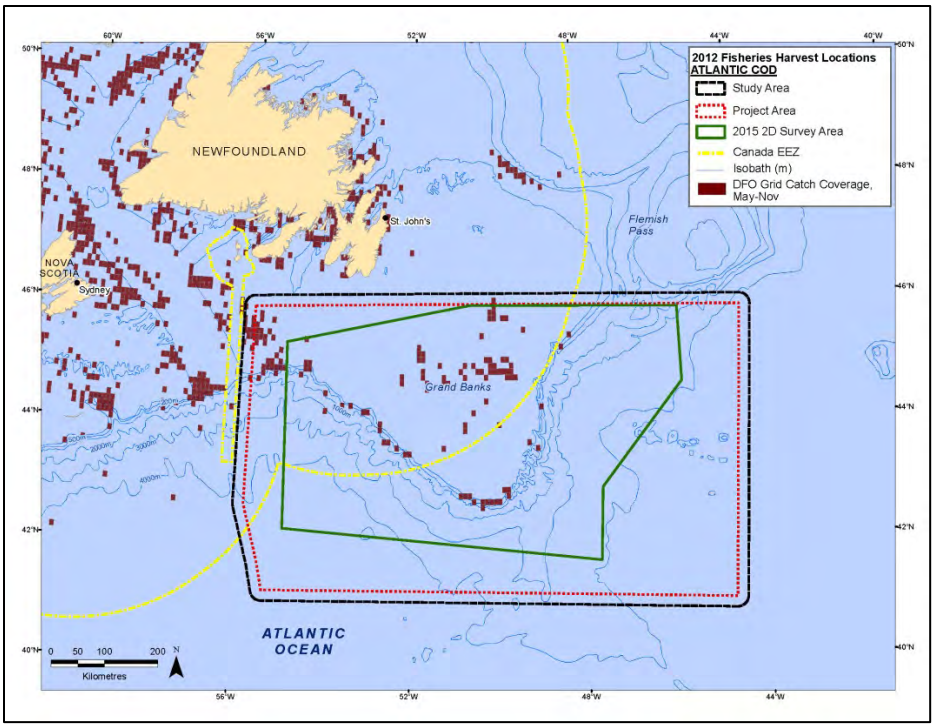
Source: DFO commercial landings database, 2005–2010.

Figure 4.42 Distribution of Commercial Harvest Locations for Atlantic Cod, May–November, 2005–2010.



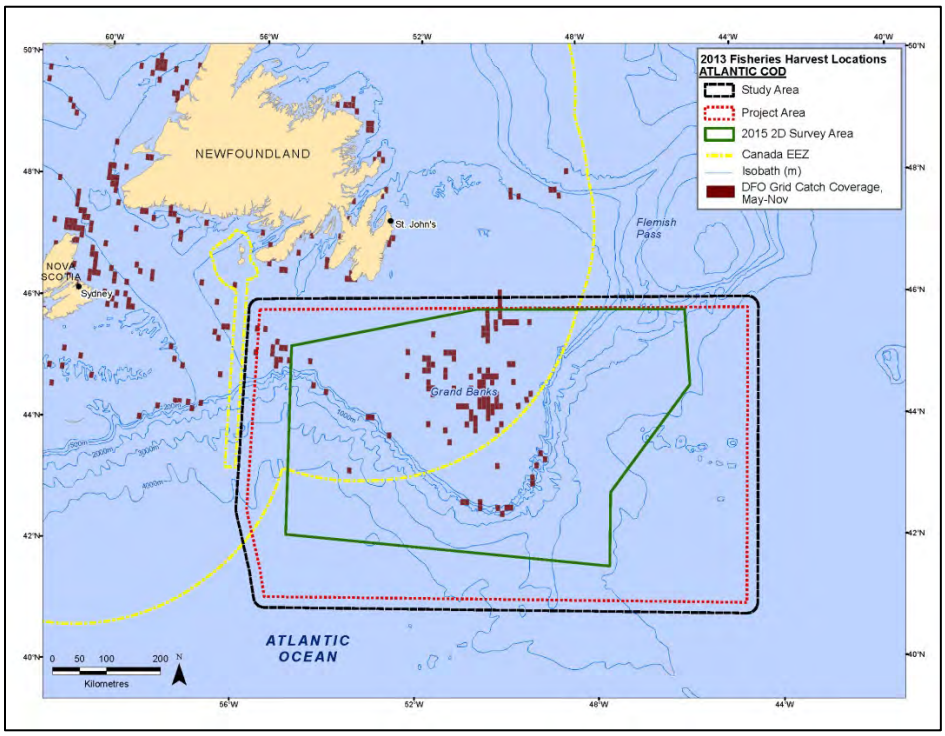
Source: DFO commercial landings database, 2011.

Figure 4.43 Distribution of Commercial Harvest Locations for Atlantic cod, May–November, 2011.



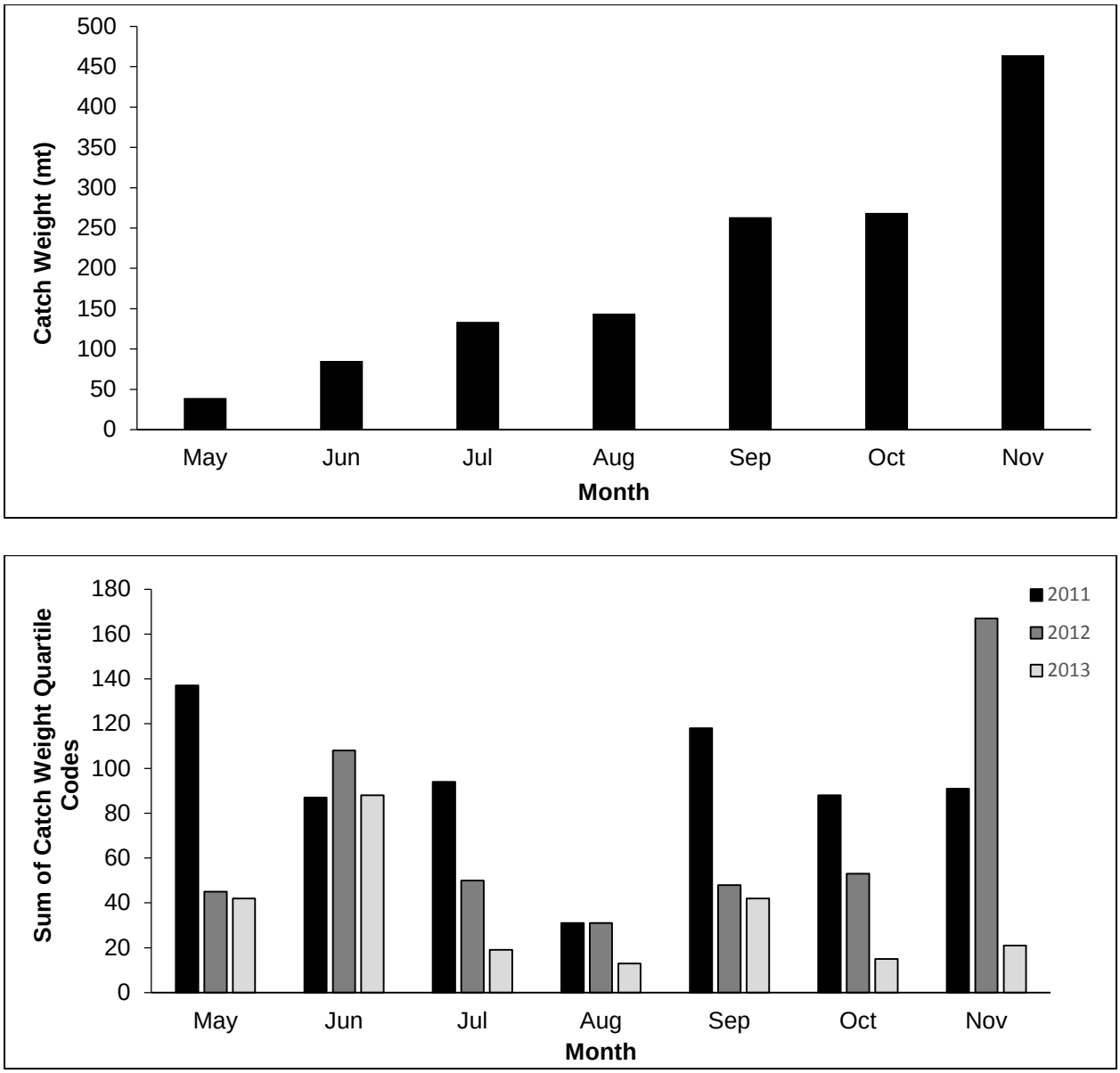
Source: DFO commercial landings database, 2012.

Figure 4.44 Distribution of Commercial Harvest Locations for Atlantic Cod, May–November, 2012.



Source: DFO commercial landings database, 2013.

Figure 4.45 Distribution of Commercial Harvest Locations for Atlantic Cod, May–November, 2013.



Source: DFO commercial landings database, 2005–2013.

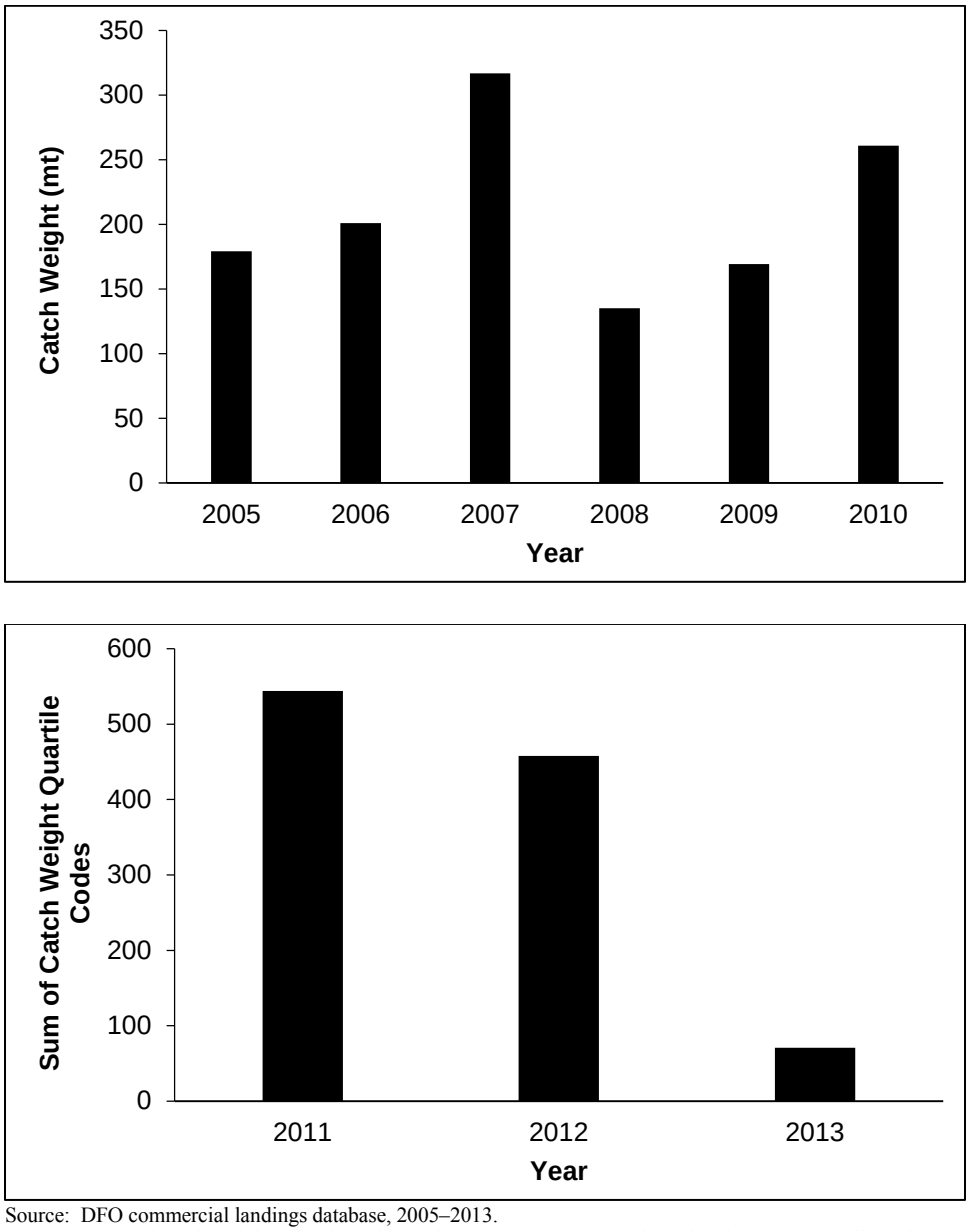
Note: Sum of catch weight quartile codes is the summation of quartile codes (i.e., 1–4) for all catch records for all species; the greater the sum of quartile code counts, the greater the catch weight for a given month.

Figure 4.46 Monthly Average Catch Weights, May–November, 2005–2010 (top), and Monthly Sum of Catch Weight Quartile Codes, May–November, 2011–2013 (bottom), for Atlantic Cod in the Study Area.

Atlantic Halibut

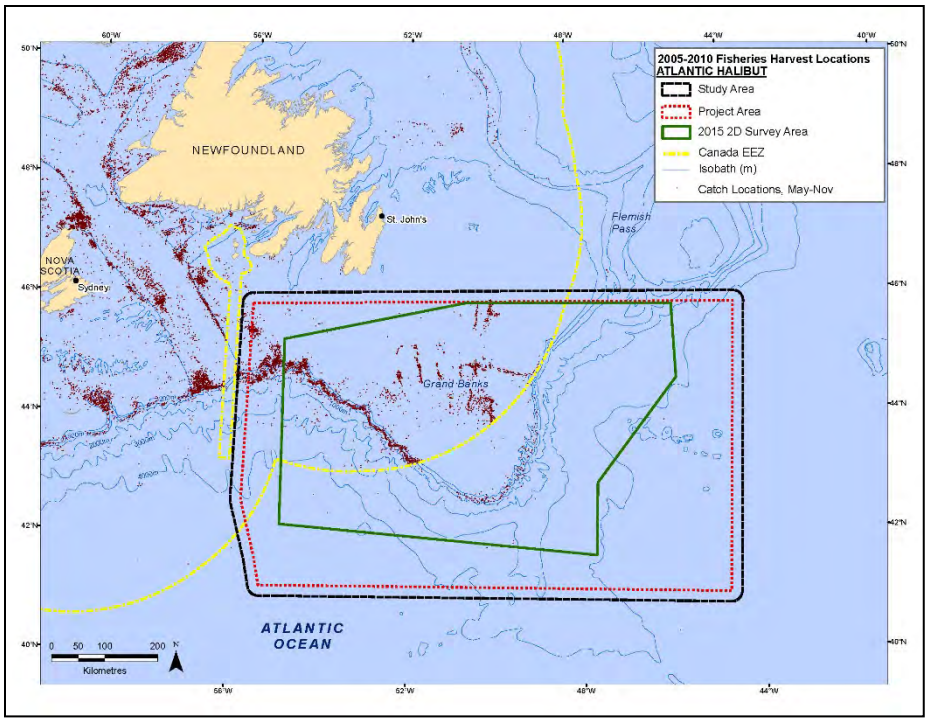
In terms of catch value, Atlantic halibut was the fourth most important commercial species in the Study Area during 2005–2010, and accounted for about 10–13% of the total catch in 2011–2013, based on coarse analysis using the catch weight quartile codes. Annual total catch weights (2005–2010) and sum of catch weight quartile codes (2011–2013) for Atlantic halibut in the Study Area between May-November are indicated in Figure 4.47. Figure 4.48 shows the Atlantic halibut harvest locations

for 2005–2010 combined. Figures 4.49–4.51 show Atlantic halibut harvest locations in 2011, 2012 and 2013, respectively. The majority of Atlantic halibut were captured along the slope of the Grand Banks in the Study, Project and 2015 2D Survey Areas, with a lesser component in the north-central region in water depths up to 1,000 m. Harvest locations were almost exclusively along the slope of the Grand Banks in 2013. The monthly average and total Atlantic halibut harvests in the Study Area during the May–November in 2005–2010 and 2011–2013 periods are shown in Figure 4.52. Atlantic halibut were primarily caught between June–July in the Study Area.



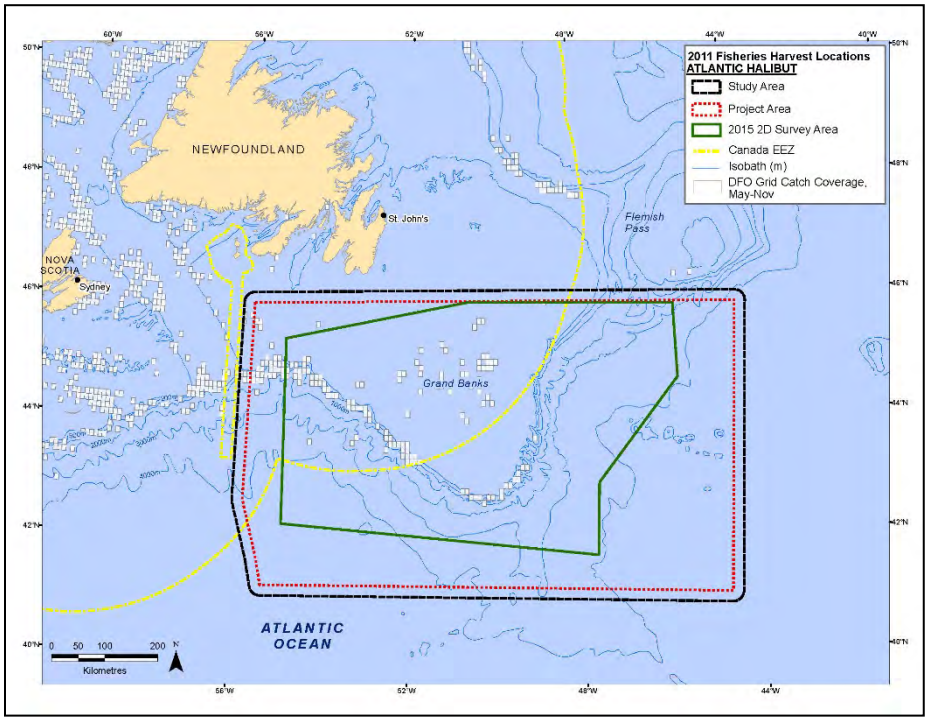
Source: DFO commercial landings database, 2005–2013.
Note: Sum of catch weight quartile codes is the summation of quartile codes (i.e., 1–4) for all catch records for all species; the greater the sum of quartile codes, the greater the catch weight for a given year.

Figure 4.47 Annual Total Catch Weights, May–November, 2005–2010 (top), and Annual Sum of Catch Weight Quartile Codes, May–November, 2011–2013 (bottom), for Atlantic Halibut in the Study Area.



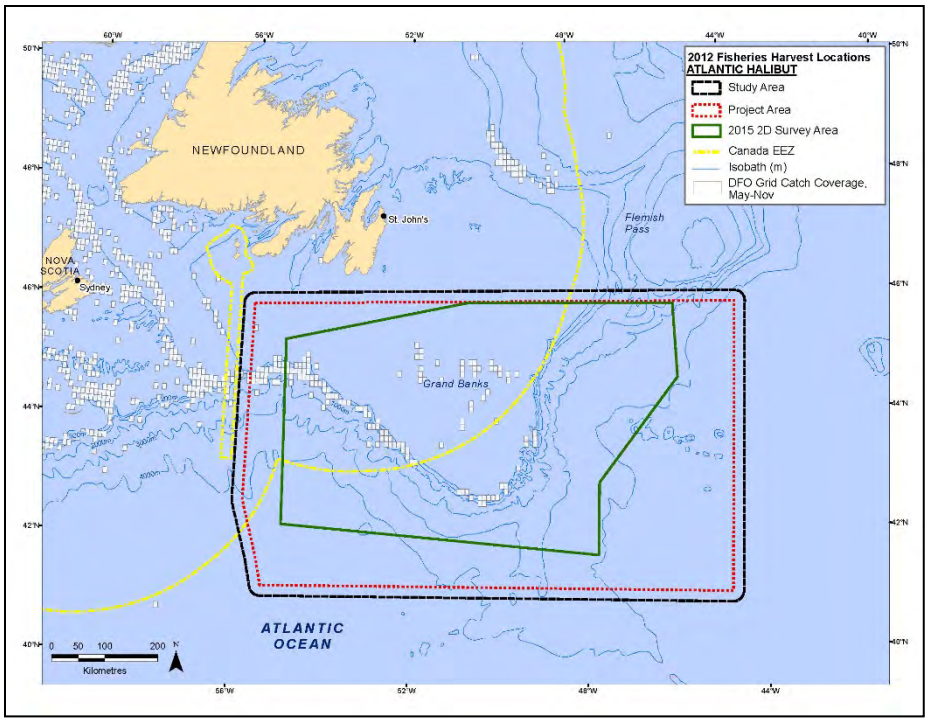
Source: DFO commercial landings database, 2005–2010.

Figure 4.48 Distribution of Commercial Harvest Locations for Atlantic Halibut, May-November, 2005–2010.



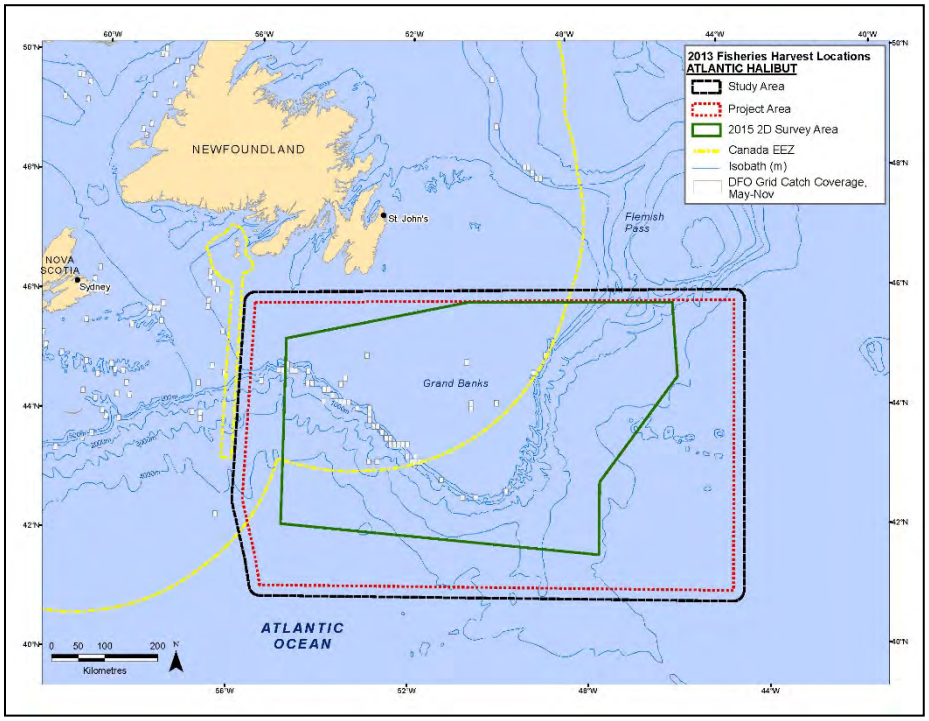
Source: DFO commercial landings database, 2011.

Figure 4.49 Distribution of Commercial Harvest Locations for Atlantic Halibut, May-November, 2011.



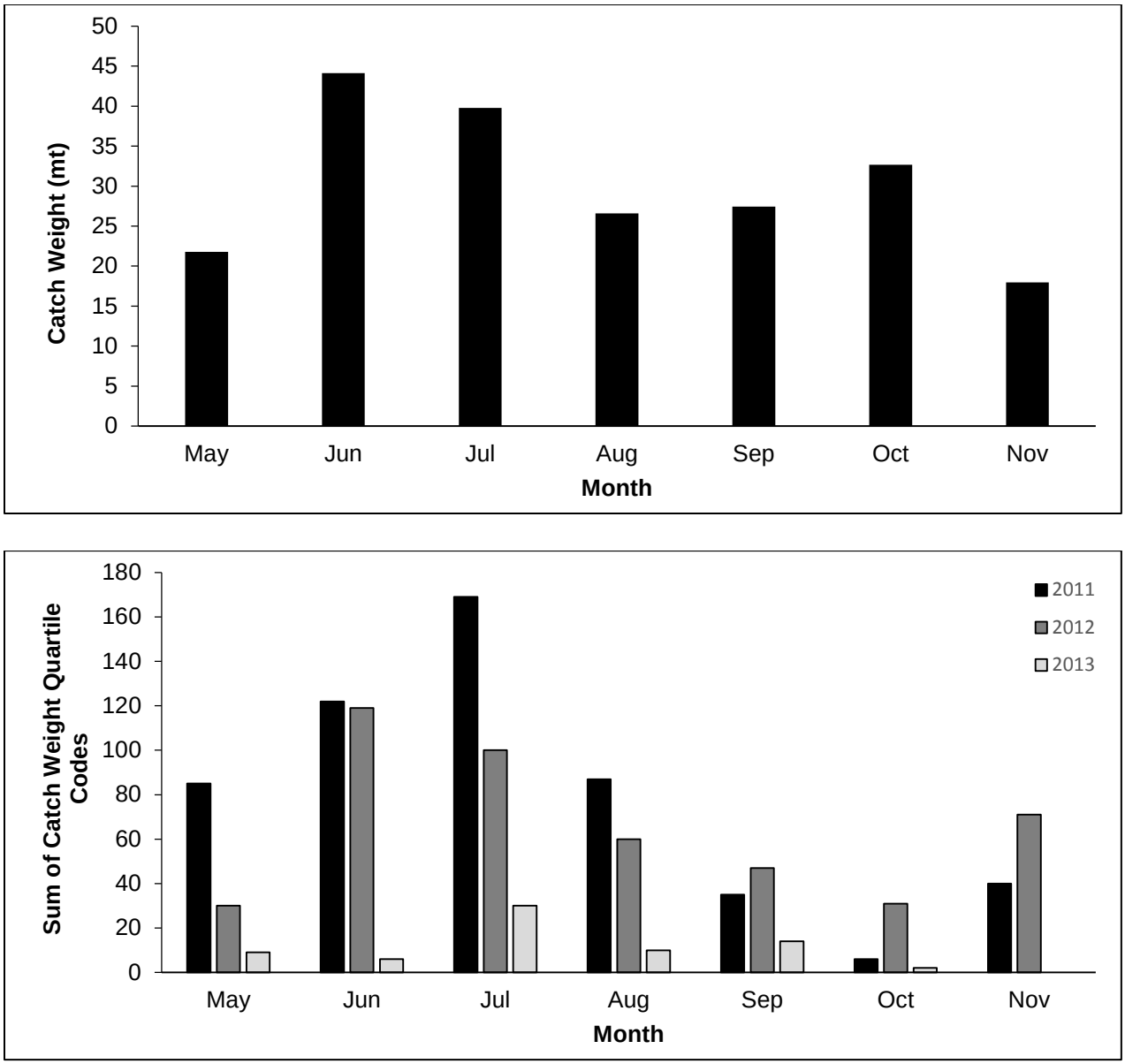
Source: DFO commercial landings database, 2012.

Figure 4.50 Distribution of Commercial Harvest Locations for Atlantic Halibut, May-November, 2012.



Source: DFO commercial landings database, 2013.

Figure 4.51 Distribution of Commercial Harvest Locations for Atlantic Halibut, May-November, 2013.



Source: DFO commercial landings database, 2005–2013.

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

Figure 4.52 Monthly Average Catch Weights, May–November, 2005–2010 (Top), and Monthly Sum of Catch Weight Quartile Codes, May–November, 2011–2013 (Bottom), for Atlantic Halibut in The Study Area.

4.3.4 Traditional and Aboriginal Fisheries

According to the Southern Newfoundland SEA (C-NLOPB 2010), waters in the northwestern portion of the Study Area (within NAFO Division 3Ps) are used by the Conne River Band Council (Miawpukek First Nation Government) for Food, Social and Ceremonial fisheries, along with Communal/Commercial fishing activities. These fishing activities and associated regulations are described in detail in Section 3.3.4 in the Southern Newfoundland SEA (C-NLOPB 2010).

While the Nunatsiavut Government does hold a Communal Snow Crab licence and allocation within NAFO Divisions 2GHJ, the region with the allocation is north of the Study Area (DFO 2010c).

4.3.5 Recreational Fisheries

Recreational fisheries in Newfoundland and Labrador are briefly described in Section 4.3.4.4 of the Eastern Newfoundland SEA (C-NLOPB 2014), and in detail in Section 3.3.3.1 of the Southern Newfoundland SEA (C-NLOPB 2010). In 2015, the recreational groundfish fishery will occur in all NAFO areas around Newfoundland and Labrador, including NAFO Divisions 2GH, 2J3KL, 3Ps, 3Pn and 4R (DFO 2014e). Of these NAFO areas, portions of 3L and 3Ps are within the Study Area. This fishery is largely conducted in coastal and inshore waters (C-NLOPB 2010, 2014), and is open for three weeks in the summer beginning on 18 July 2015 and for nine days in the fall beginning on 19 September 2015 (dates are subject to change) (DFO 2014e). Species that are harvested recreationally typically include brown trout, Atlantic mackerel, squid, capelin, and Atlantic cod (C. Boland, DFO, pers. comm., 2009 *in* C-NLOPB 2010). Management measures in place for 2013–2015 indicate there is no requirement for licences or tags to fish recreationally for these species (DFO 2014e). Scallops may also be harvested with a recreational license (C-NLOPB 2010). Atlantic salmon, trout (brook, brown, rainbow and ouananiche), Arctic char and smelts are fished in freshwater in Newfoundland and Labrador (FWE 2014).

The retention of Atlantic halibut, spotted wolffish, northern wolffish, and any species of shark is prohibited in Newfoundland and Labrador recreational fisheries (DFO 2014e). Sculpins and cunners may be released but all other groundfish caught must be retained (DFO 2014e).

It is highly unlikely that any recreational fisheries will be conducted within the Study Area, with the possible exception of waters in the far northwestern portion of the Study Area.

4.3.6 Aquaculture

Aquaculture operations in Newfoundland and Labrador are described in Section 4.3.6 of the Southern Newfoundland SEA (C-NLOPB 2010) and Section 4.3.4.3 of the Eastern Newfoundland SEA (C-NLOPB 2014). Currently, all aquaculture sites in eastern Newfoundland are coastal and located north of the Study Area (C-NLOPB 2014; DFA 2014).

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 invertebrate and fish species not discussed in Section 4.3.3 as well as additional distributional information for some of the commercial species discussed in Section 4.3.3.

The total catch weight during 2008–2012 spring (April, May, June) and fall (September–December) DFO RV surveys in the Study Area was 679 mt. Data collected during these surveys were analyzed, and catch weights, numbers, and mean catch depths of species/groups contributing ≥0.1% of the total catch weight and species at risk (see Section 4.6) are presented in Table 4.8.

Table 4.8 Catch Weights and Numbers of Macroinvertebrates and Fishes Collected during DFO RV Surveys within the Study Area, 2008–2012.

Species	Catch Weight (mt)	Catch Number	Mean Catch Depth (m)	
			Spring	Fall
Deepwater Redfish (*Sebastes mentella*)	361	2,711,175	294	430
Yellowtail Flounder (*Limanda ferruginea*)	77	266,564	71	54
American Plaice (*Hippoglossoides platessoides*)	47	281,254	116	89
Atlantic Cod (*Gadus morhua*)	38	68,071	126	84
Thorny Skate (*Raja radiata*)	36	19,790	160	121
Orange-footed Sea Cucumber (*Cucumaria frondosa*)	15	48,108	82	72
Sand Lance (*Ammodytes dubius*)	10	890,568	83	63
Capelin (*Mallotus villosus*)	8	567,373	95	77
Silver Hake (*Merluccius bilinearis*)	8	62,860	163	248
Witch Flounder (*Glyptocephalus cynoglossus*)	6	17,289	268	199
Longfin Hake (*Urophycis chesteri*)	5	49,954	412	525
Sponges	4	49	220	464
Roughhead Grenadier (*Macrourus berglax*)	4	7,811	499	641
Greenland Halibut (*Reinhardtius hippoglossoides*)	3	6,593	337	600
White Hake (*Urophycis tenuis*)	3	3,683	290	196
Haddock (*Melanogrammus aeglefinus*)	3	3,503	105	82
Atlantic Wolffish (*Anarhichas lupus*)	3	2,352	142	121
Comb-jelly (Ctenophora)	3	64,865	74	55
Polar Sea Star (*Leptasterias polaris*)	3	22,343	82	64
Snow Crab (*Chionoecetes opilio*)	2	14,004	126	114
Marlin Spike (*Nezumia bairdi*)	2	35,097	402	637
Sea Cucumber (Holothuroidea)	2	10,338	114	467
Monkfish (*Lophius americanus*)	2	372	178	273
Atlantic Halibut (*Hippoglossus hippoglossus*)	2	127	191	315
Shorthorn Sculpin (*Myoxocephalus scorpius*)	1	2,400	86	59
Longhorn Sculpin (*Myoxocephalus octodecemspinosus*)	1	5,352	66	35
Longnose Eel (*Synaphobranchus kaupi*)	1	28,781	455	724
Black Dogfish (*Centroscyllium fabricii*)	1	2,341	524	853
Blue Hake (*Antimora rostrata*)	1	8,858	507	795
Sea Urchin (Echinoidea)	1	44,451	108	403
Striped Shrimp (*Pandalus montagui*)	1	377,115	87	74
Jellyfishes (Scyphozoa)	1	160	421	578
Sea Raven (*Hemitripterus americanus*)	1	602	74	31
Atlantic Argentine (*Argentina silus*)	1	4,433	305	252
Sessile Tunicate (*Boltenia* sp.)	1	7,661	96	74
Toad Crab (*Hyas* sp.)	1	65,247	87	68
Brittle Star (Ophiuroidea)	1	23,702	137	474
Icelandic Scallop (*Chlamys islandica*)	1	9,118	93	77
Pollock (*Pollachius virens*)	1	191	189	59
Northern Wolffish (*Anarhichas denticulatus*)	1	200	322	583

Species	Catch Weight (mt)	Catch Number	Mean Catch Depth (m)	
			Spring	Fall
Roundnose Grenadier (*Coryphaenoides rupestris*)	1	4,410	598	824
Greenland Shark (*Somniosus microcephalus*)	1	1	-	200
Arctic Eelpout (*Lycodes reticulatus*)	1	1,542	107	83
Spinytail Skate (*Bathyraja spinicauda*)	1	53	314	228
Offshore Silver Hake (*Merluccius albidus*)	1	2,516	118	22
Sand Dollar (*Echinarachnius parma*)	1	21,761	114	127
Basket Star (Gorgonocephalidae)	1	89	146	71
Sea Urchin (*Strongylocentrotus* sp.)	1	12,502	82	90
Corals	0.5	10,237	256	492
Green Sea Urchin (*Strongylocentrotus droebachiensis*)	0.5	28,158	94	70
Mailed Sculpin (*Triglops* sp.)	0.5	51,044	89	54
Moustache Sculpin (*Triglops murrayi*)	0.4	37,429	81	71
Spotted Wolffish (*Anarhichas minor*)	0.3	127	233	196
Cusk (*Brosme brosme*)	0.3	1,407	275	172
Northern Shrimp (*Pandalus borealis*)	0.2	33,489	245	179
Total	**671**	**5,939,520**	**203**	**255**

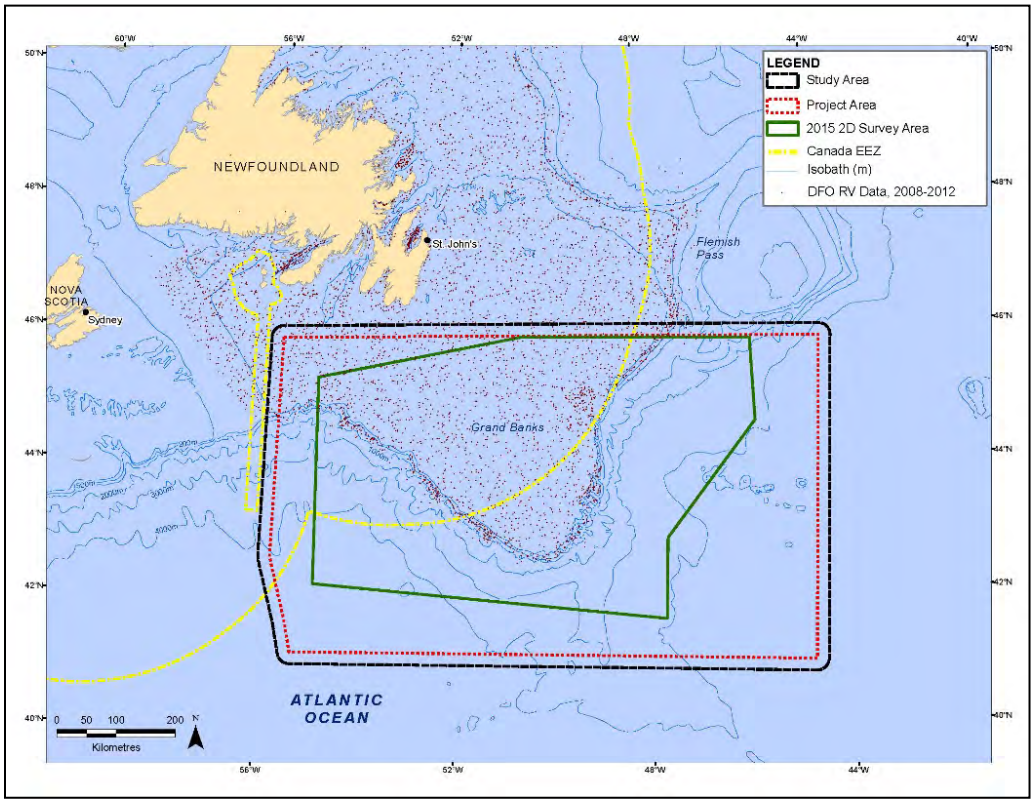
Source: DFO RV Survey Data, 2008–2012.
Note: n/d denotes data unavailable.

Deepwater redfish accounted for 53% of the total 2008–2012 catch weight, followed by yellowtail flounder (11%), American plaice (7%), Atlantic cod (6%), thorny skate (5%), orange-footed sea cucumber (2%), sand lance (2%), and capelin, silver hake, witch flounder, longfin hake, sponges, roughhead grenadier, Greenland halibut, white hake and haddock (1% each). All other species/groups accounted for less than 1% of the total 2008–2012 catch weight in the Study Area. Principal species captured during the 2008–2012 DFO RV surveys were generally representative of predominant species targeted using similar mobile gear (bottom trawls) in the commercial fishery during recent years. The distribution of georeferenced catch locations reported during the 2008–2012 DFO RV surveys within the Study Area are shown in Figure 4.53. Species were caught in the central, north-central and northwestern portions of the Study Area during the 2008–2012 DFO RV surveys in water depths <1,000 m. Across all species caught during the 2008–2012 DFO RV surveys in the Study Area, total catch weight ranged from 115–148 mt per year.

Spring and fall RV surveys each accounted for 50% of the total catch weight. The average mean depths of catch during spring and fall surveys from 2008–2012 were 203 m (min: 37 m; max: 741 m) and 255 m (min: 38 m; max: 1,454 m), respectively.

In descending order, the top five species/groups in terms of catch weight during the 2008–2012 spring surveys were deepwater redfish, yellowtail flounder, Atlantic cod, American plaice and thorny skate. Similarly for the fall surveys, the top five species/groups in terms of catch weight during 2008–2012 were deepwater redfish, yellowtail flounder, American plaice, thorny skate and Atlantic cod. Species/groups that were caught predominantly during the spring RV surveys included offshore silver hake, capelin, sand dollar, pollock, mailed sculpin, shorthorn sculpin, Atlantic argentine, sea raven, sea

urchin (*Strongylocentrotus* sp.), longhorn sculpin, orange-footed sea cucumber, haddock, silver hake, sea cucumber (Holothuroidea), basket star, Atlantic cod and Atlantic wolffish. Species/groups that were caught predominantly during the fall RV surveys included Greenland shark, polar sea star, moustache sculpin, Icelandic scallop, sponges, black dogfish, roundnose grenadier, sessile tunicate, blue hake, roughhead grenadier, snow crab and spinytail skate. The survey depth differences between spring and fall surveys likely account for some of the seasonal differences. Species/groups that were caught in essentially equal amounts during both surveys included monkfish, thorny skate, comb-jelly, Arctic eelpout, striped shrimp, American plaice, marlin spike and deepwater redfish.

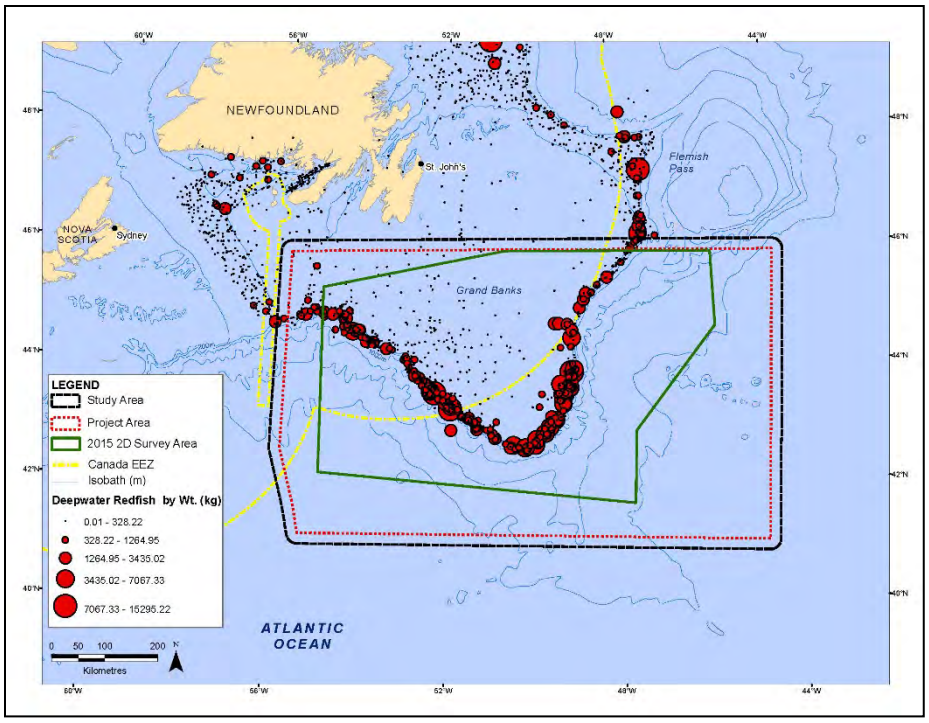


Source: DFO Research Vessel Survey Database, 2008–2012.

Figure 4.53 Distribution of DFO RV Survey Catch Locations within the Study Area, 2008–2012.

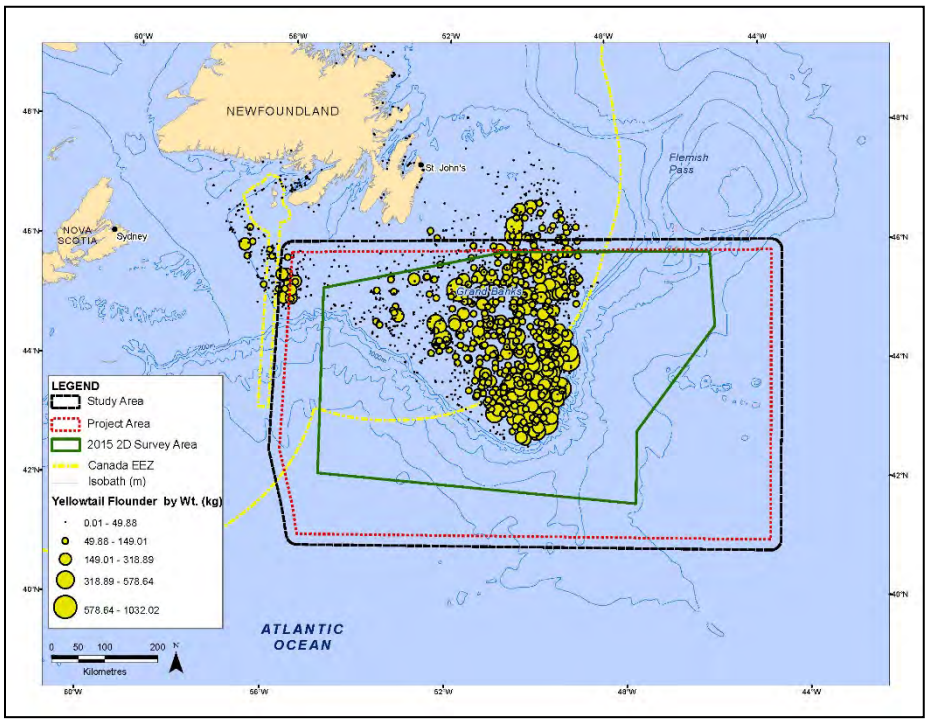
Figures 4.54 to 4.61 indicate DFO RV survey catch locations for deepwater redfish, yellowtail flounder, American plaice, Atlantic cod, thorny skate, sponges, corals, and wolffishes, respectively, during 2008-2012. The differently sized circular symbols used in these figures represent various weight ranges defined in each figure. Note that since there was an insufficient range of catch weights to demonstrate proportional catches for northern and spotted wolffishes, catch numbers were used instead (Figure 4.61).

Catches at various mean depth ranges are also examined in this section. Table 4.9 presents total catch weights and predominant species caught within each mean depth range in the Study Area during the 2008–2012 period. The predominantly commercial species typically targeted with mobile gear and mostly caught during RV surveys in areas where water depths were <500 m include yellowtail flounder, deepwater redfish, Atlantic cod and Atlantic halibut.



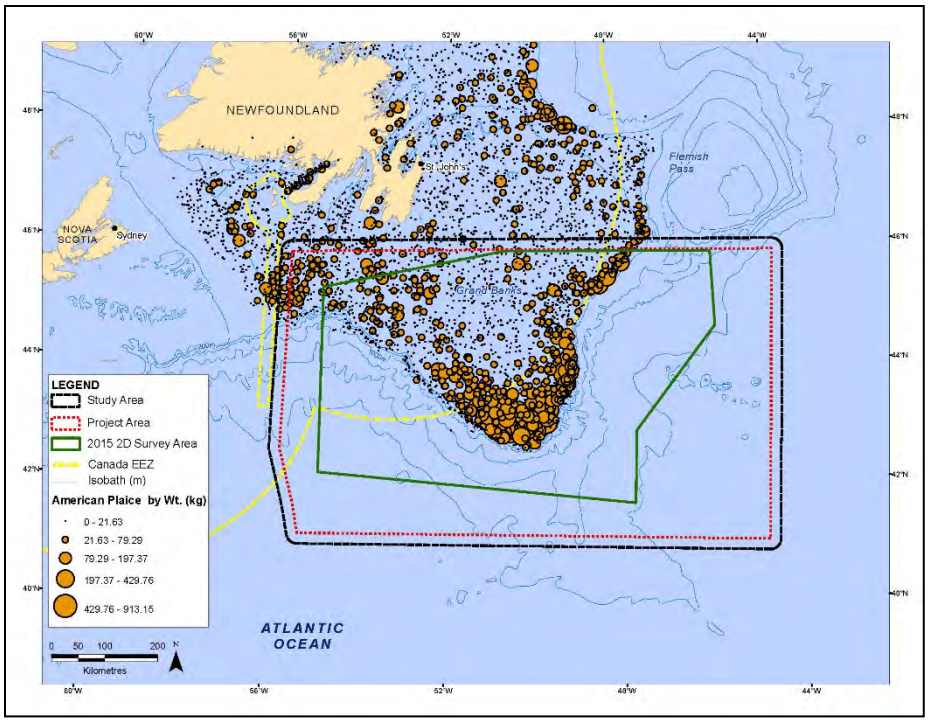
Source: DFO Research Vessel Survey Database, 2008–2012.

Figure 4.54 Distribution of DFO RV Survey Deepwater Redfish Catch Locations in the Study Area, 2008–2012.



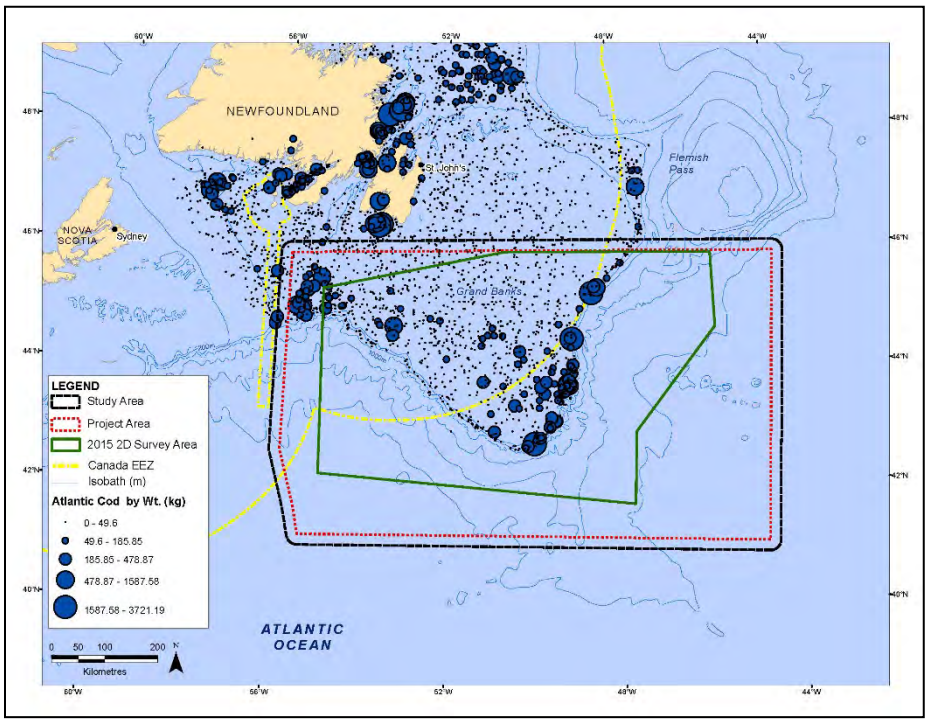
Source: DFO Research Vessel Survey Database, 2008–2012.

Figure 4.55 Distribution of DFO RV Survey Yellowtail Flounder Catch Locations in the Study Area, 2008–2012.



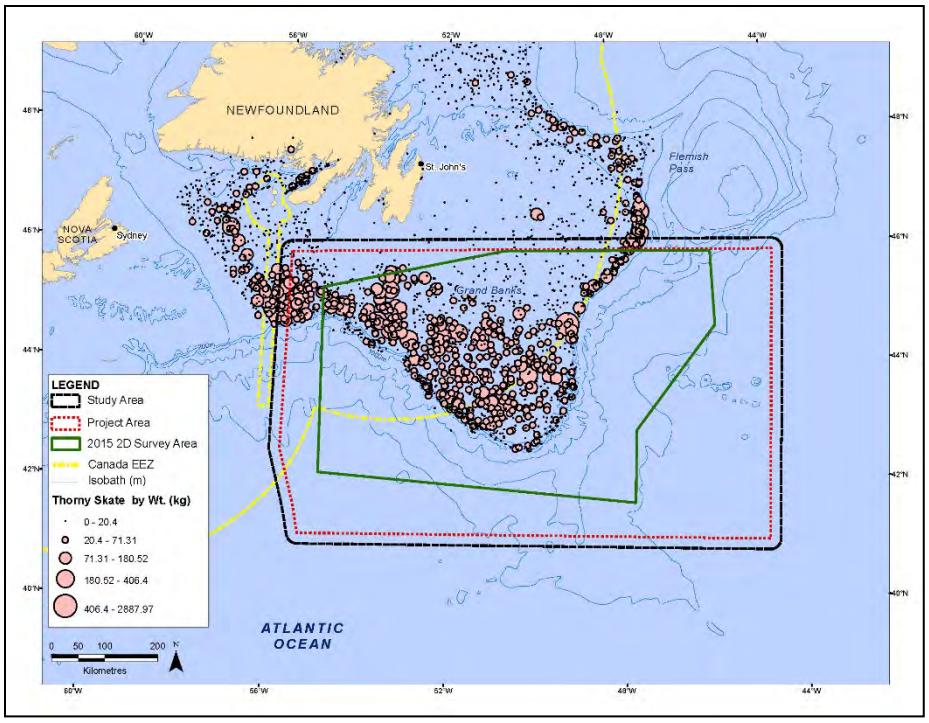
Source: DFO Research Vessel Survey Database, 2008–2012.

Figure 4.56 Distribution of DFO RV Survey American Plaice Catch Locations in the Study Area, 2008–2012.



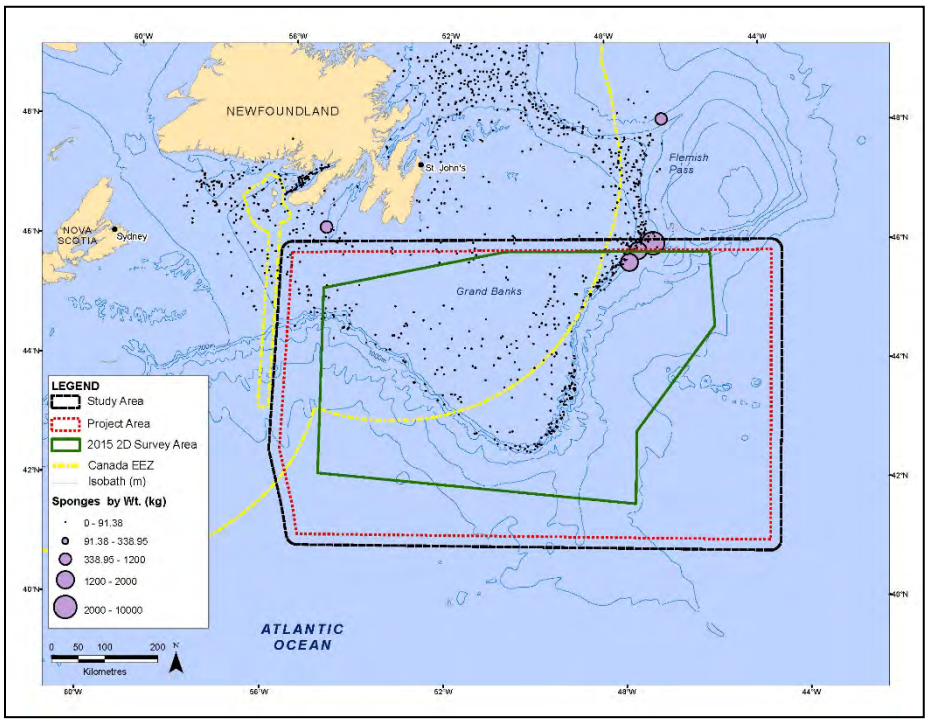
Source: DFO Research Vessel Survey Database, 2008–2012.

Figure 4.57 Distribution of DFO RV Survey Atlantic Cod Catch Locations in the Study Area, 2008–2012.



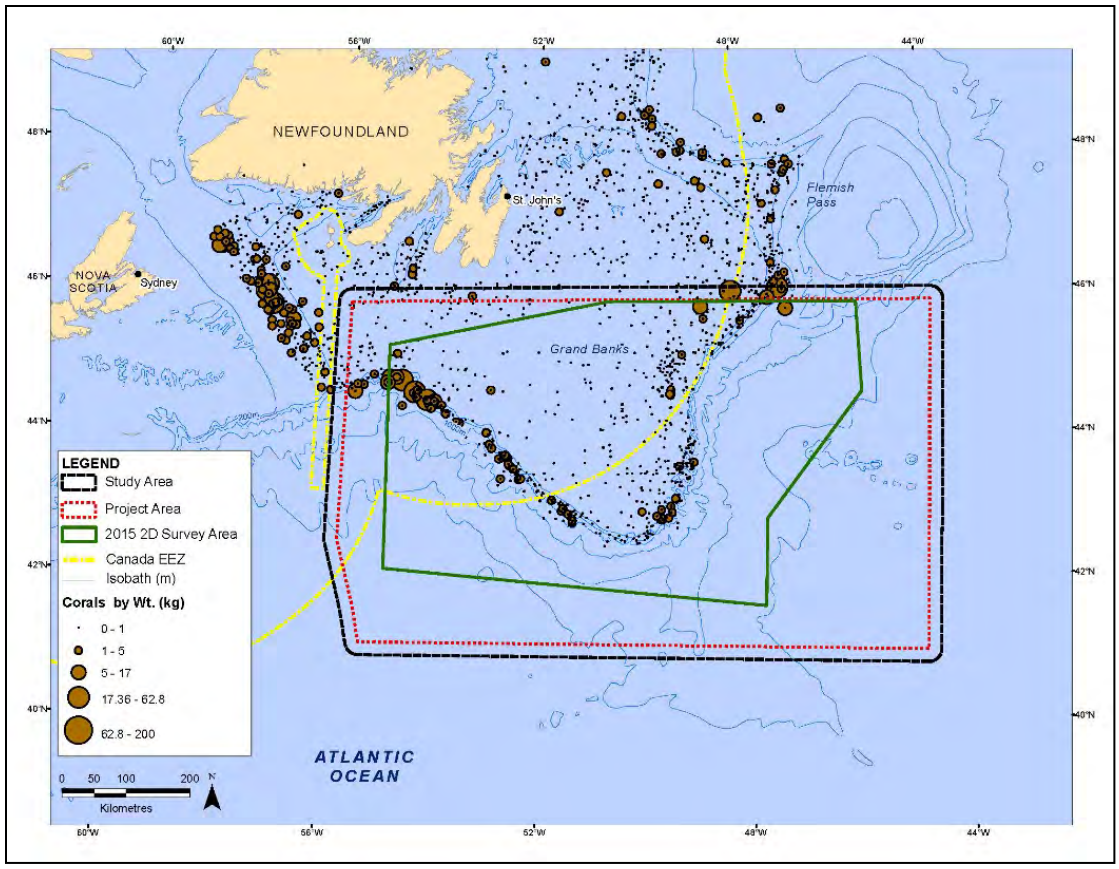
Source: DFO Research Vessel Survey Database, 2008–2012.

Figure 4.58 Distribution of DFO RV Survey Thorny Skate Catch Locations in the Study Area, 2008–2012.



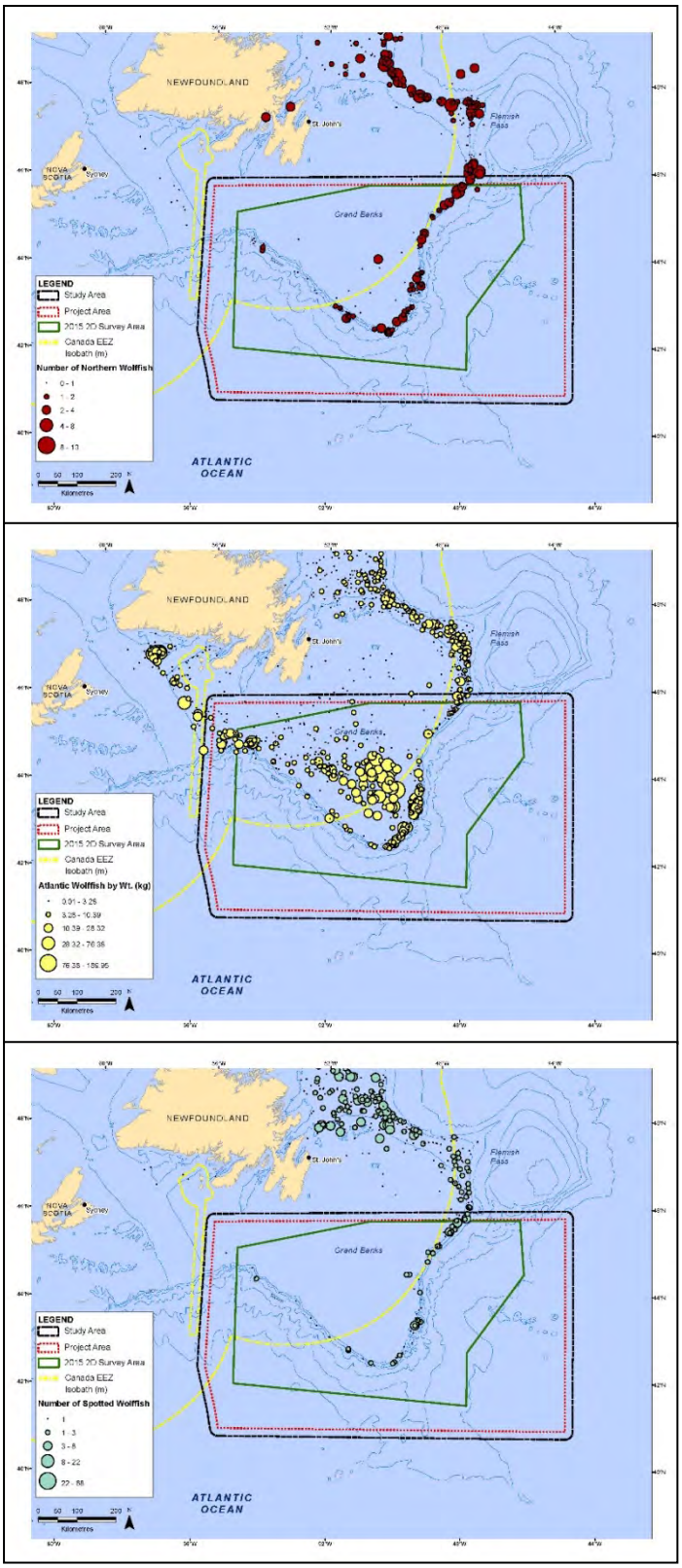
Source: DFO Research Vessel Survey Database, 2008–2012.

Figure 4.59 Distribution of DFO RV Survey Sponge Catch Locations in the Study Area, 2008-2012.



Source: DFO Research Vessel Survey Database, 2008–2012.

Figure 4.60 Distribution of DFO RV Survey Coral Catch Locations in the Study Area, 2008-2012.



Source: DFO Research Vessel Survey Database, 2008–2012.

Figure 4.61 Distribution of DFO RV Survey Northern (top), Atlantic (middle), and Spotted (bottom) Wolffish Catch Locations within the Study Area, 2008–2012.

Table 4.9 Total Catch Weights and Predominant Species Caught at Various Mean Catch Depth Ranges, DFO RV Surveys, 2008–2012.

Mean Catch Depth Range (m)	Total Catch Weight (mt)	Predominant Species (% of Total Catch Weight)
<100	125	Yellowtail Flounder (62%) Orange-footed Sea Cucumber (12%) Sand Lance (8%)
≥100 – <200	148	American Plaice (32%) Atlantic Cod (26%) Thorny Skate (25%)
≥200 – <300	380	Deepwater Redfish (95%) Witch Flounder (1%) Sponges (1%) White Hake (1%)
≥300 – <400	3	Atlantic Argentine (31%) Corals (18%) Spotted Wolffish (11% Cusk (10%)
≥ 400 – <500	12	Longfin Hake (38%) Greenland Halibut (28%) Marlin Spike (15%)
≥500 – <600	6	Roughhead Grenadier (70%) Longnose Eel (24%)
≥600 – <700	2	Blue Hake (72%) Large Scale Tapirfish (*Notacanthus nasus*; 11%)
≥700 – <800	1	Roundnose Grenadier (46%) Greenland Shark (46%)
≥800 – <900	1	Black Dogfish (95%)
≥900 – <1,000	0.05	Agassiz's Smoothhead (*Alepocephalus agassizii*; 38%) Baird's Smoothhead (*Alepocephalus bairdii*; 30%) Pallid Deepsea Sculpin (*Cottunculus thompsoni*; 14%)
≥1,000	0.6	Smoothheads (Alepocephalidae; 26%) Jensen's Skate (*Amblyraja jenseni*; 19%) Longnose Chimaera (*Harriotta raleighana*; 18%)

Source: DFO Research Vessel Survey Database, 2008–2012.

4.3.8 Industry and DFO Science Surveys

Fisheries research surveys conducted by DFO and the fishing industry are important to the commercial fisheries in the determination of stock status. In any year, there will be spatial overlap between the Study Area and research surveys in NAFO Divisions 3LNO and 3Ps.

The tentative schedule of DFO RV surveys in the Study Area in 2015 is indicated in Table 4.10. Spring surveys are currently set to begin at the end of March and continue into mid-June. DFO fall research surveys will begin in mid-September and continue until early-December.

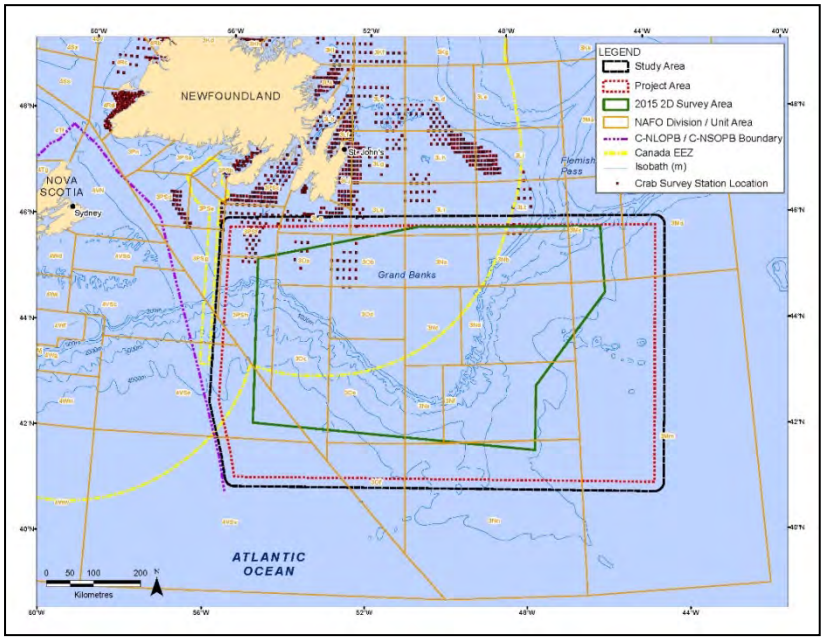
Members of the FFAW have been involved in a DFO-industry collaborative post-season snow crab trap survey for over ten years. This survey is intended to "allow the fishing industry to more accurately assess and ultimately better manage the valuable snow crab resource" (FFAW|Unifor 2014). Data from these surveys are incorporated into the scientific assessment of snow crab and as a result, harvesters and

managers have improved partnership and higher confidence in the accuracy of recent stock status assessments (FFAW|Unifor 2014). This annual survey typically starts in early September and may continue through to November. The station locations, ~1,500 in total, remain constant from year to year. Several stations fall within the northwestern portion of the Study Area. The survey station locations in relation to the Study Area, Project Area, and 2015 2D Survey Area are shown in Figure 4.62.

Table 4.10 Tentative Schedule of DFO RV Surveys in the Study Area, 2015.

NAFO Division	Start Date	End Date	Vessel
3P	31 Mar	14 Apr	*Needler*
3P	14 Apr	28 Apr	*Needler*
3P + 3O	29 Apr	12 May	*Needler*
3O + 3N	12 May	26 May	*Needler*
3L + 3N	27 May	13 Jun	*Needler*
3O	16 Sep	29 Sep	*Needler*
3O + 3N	29 Sep	13 Oct	*Needler*
2H	04 Oct	13 Oct	*Teleost*
2H + 2J	14 Oct	27 Oct	*Teleost*
3N + 3L	14 Oct	27 Oct	*Needler*
2J + 3K	27 Oct	10 Nov	*Teleost*
3L	28 Oct	10 Nov	*Needler*
3K	11 Nov	24 Nov	*Teleost*
3K + 3L	11 Nov	24 Nov	*Needler*
3K + 3L Deep	24 Nov	08 Dec	*Teleost*

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



Source: DFO 2014.

Figure 4.62 Locations of DFO-Industry Collaborative Post-Season Snow Crab Trap Survey Stations in Relation to the Study, Project, and 2015 2D Survey Areas.