5.0 Biological Environment

The descriptions of the biological environment in the White Rose Comprehensive Study (Husky 2000), the Husky Jeanne d'Arc Basin exploration drilling EAs and update (LGL 2002, 2005a, 2006a), and the Husky Jeanne d'Arc Basin 3-D seismic EA and update (LGL 2005c; Moulton et al. 2006a) are directly relevant to the vicinity of the proposed development of new drill centres. Summaries of relevant information from these documents are presented in the following sections for plankton, benthos, invertebrates/fish and related habitats, marine birds, marine mammals, and sea turtles.

5.1 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 complicated with shelves, slopes, and 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 economically and socially, with potential to interact with the Project. This is the valued ecosystem component (VEC) approach to EA which is detailed in Section 6.0. The VECs and/or their respective groups are discussed in the following sections.

5.2 Sensitive/Special Areas

Although there are likely important feeding areas for fish, marine birds, marine mammals, and sea turtles, particularly in localized upwelling areas that may be associated with the channels and slopes, there are no designated Marine Protected Areas (MPAs) in the Study Area. Figure 5.1 shows the spatial relationships between proximate sensitive/special areas (i.e., the Bonavista Cod Box and eastern Newfoundland significant seabird breeding colonies) and the Project and Study areas. Further discussions of the indicated special/sensitive areas are in the relevant sections that follow.

5.3 *SARA*-listed Species

The *Species at Risk Act* (*SARA*) was assented to in December 2002 with certain provisions coming into force in June 2003 (e.g., independent assessments of species by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC)) and June 2004 (e.g., prohibitions against harming or harassing listed endangered or threatened species or damaging or destroying their critical habitat). The information provided below is current as of 2 August 2006 on the websites for *SARA* (http://www.sararegistry.gc.ca/default_e.cfm) and COSEWIC (http://www.cosepac.gc.ca/index.htm).

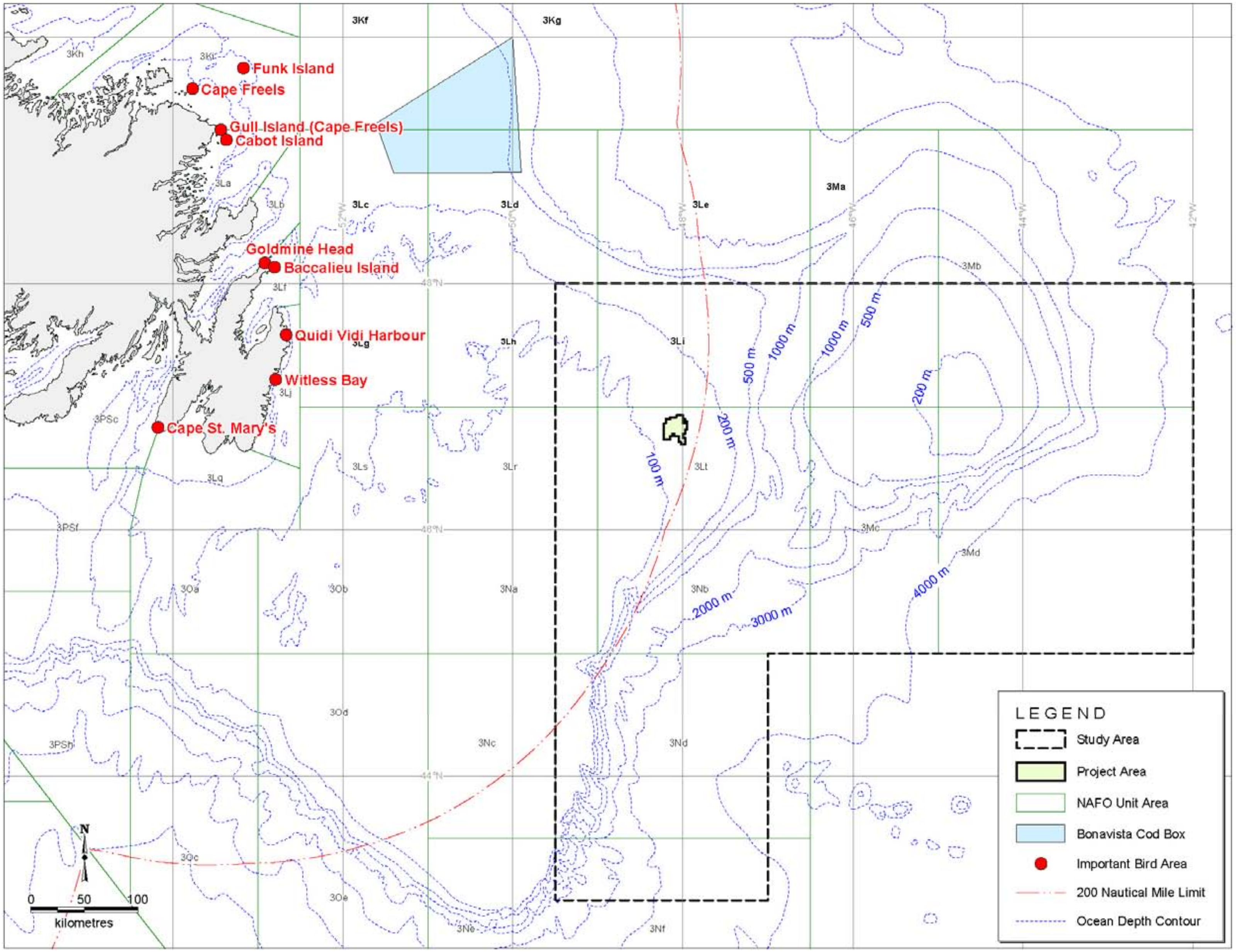

Figure 5.1. Locations of Bonavista Cod Box and Significant Seabird Breeding Colonies Relative to Project Area and Study Area.

Species are listed under *SARA* on Schedules 1 to 3 with only those listed as endangered or threatened on Schedule I having immediate legal implications. Nonetheless, attention must be paid to all of the *SARA*-listed species because of their sensitivities to perturbation and the potential for status upgrades. Schedule 1 is the official list of wildlife species at risk in Canada. Once a species/population is listed, the measures to protect and recover it are implemented. The two cetacean species/populations, one sea turtle species, and two fish species/populations that are legally protected under *SARA* and have potential to occur in the Study Area are listed in Table 5.1. Atlantic wolffish (*Anarhichas lupus*) and Ivory Gull (*Pagophila eburnea*) are listed as "special concern" on Schedule 1 (Table 5.1). Schedules 2 and 3 of *SARA* identify species that were designated "at risk" by COSEWIC prior to October 1999 and must be reassessed using revised criteria before they can be considered for addition to Schedule 1. Species that potentially occur in the Study Area and are considered at risk but which have not received specific legal protection (i.e., proscribed penalties and legal requirement for recovery strategies and plans) under *SARA* are also listed in Table 5.1. Other non-*SARA* listed marine species which potentially occur in the Study Area and are listed by COSEWIC as either endangered, threatened or species of special concern, are also included in Table 5.1.

Under *SARA*, a 'recovery strategy' and corresponding 'action plan' must be prepared for endangered, threatened, and extirpated species. A management plan must be prepared for species listed as special concern. Currently, there are no recovery strategies, action plans, or management plans in place for species listed as endangered or threatened under Schedule 1 and which are known to occur in the Study Area. Husky will monitor *SARA* issues through the Canadian Association of Petroleum Producers (CAPP), the law gazettes, the Internet and communication with DFO and Environment Canada, and will adaptively manage any issues that may arise in the future. The company will comply with relevant regulations pertaining to *SARA* Recovery Strategies and Action Plans.

Species profiles and any special or sensitive habitat, and any effects or mitigations that relate to *SARA* species are discussed in the following sections.

5.4 Plankton

Plankton is composed of free-floating organisms that form the basis of the pelagic ecosystem. Members include bacteria, fungi, phytoplankton, and zooplankton (mostly invertebrates, but may also include fish eggs and larvae, termed ichthyoplankton). In simplest terms, phytoplankton (e.g., diatoms) produce carbon through the utilization of sunlight and nutrients (e.g., nitrogen, phosphorus, silicon); this process is called primary production. Herbaceous zooplankton (e.g., calanoid copepods, the dominant component of northwest Atlantic zooplankton) feed on phytoplankton; this growth process is secondary production. The herbivores in turn are fed upon

Table 5.1. *SARA*-listed and COSEWIC-listed Marine Species Potentially Occurring in the Study Area.

SPECIES		*SARA*[a]			COSEWIC[b]		
Common Name	**Scientific Name**	**Endangered**	**Threatened**	**Special Concern**	**Endangered**	**Threatened**	**Special Concern**
Blue whale	*Balaenoptera musculus*	Schedule 1			X		
North Atlantic right whale	*Eubalaena glacialis*	Schedule 1			X		
Leatherback sea turtle	*Dermochelys coriacea*	Schedule 1			X		
Northern wolffish	*Anarhichas denticulatus*		Schedule 1			X	
Spotted wolffish	*Anarhichas minor*		Schedule 1			X	
Atlantic wolffish	*Anarhichas lupus*			Schedule 1			X
Ivory Gull	*Pagophila eburnean*			Schedule 1	X		
Harbour porpoise	*Phocoena phocoena*			Schedule 2			X
Sowerby's beaked whale	*Mesoplodon bidens*			Schedule 3			X
Atlantic cod (NL[d] population)	*Gadus morhua*			Schedule 3	X		
Porbeagle	*Lamna nasus*				X		
White shark	*Carcharodon carcharias*				X		
Cusk	*Brosme brosme*					X	
Shortfin mako	*Isurus oxyrinchus*					X	
Blue shark	*Prionace glauca*						X

Sources: [a] *SARA* website (http://www.sararegistry.gc.ca/default_e.cfm)
[b] COSEWIC website (http://www.cosepac.gc.ca/index.htm)
[c] Scotian Shelf
[d] Newfoundland and Labrador

by predators (i.e., tertiary production) such as predacious zooplankton (e.g., chaetognaths, jellyfish, etc.), all of which may be grazed by higher predators such as fish, seabirds, 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 fish, seabirds, and marine mammals congregate to feed. Production is enhanced in areas of bottom upwelling where a combination of bottom topography, wind and currents bring nutrient-rich bottom water to the surface. An example of a well-known area of bottom upwelling is the anchovy fishery off the west coast of South America. Frontal areas are where two dissimilar water masses meet to create lines of convergence which 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. The two physical processes (upwelling and fronts) may be found together in varying degrees, particularly in coastal areas.

In the northwest Atlantic, there is generally a spring plankton bloom which is often followed by a smaller bloom in the fall. This general pattern likely applies to the Study Area. There may be areas of enhanced production in the Study Area, similar to other slope areas that have been studied.

Since the proposed development of new drill centres has no potential to significantly affect phytoplankton or zooplankton at the ecosystem level, they are not discussed further in this EA other than references to their relationship with VECs such as commercial fish or marine mammals.

5.5 Invertebrates and Fish

5.5.1 Marine Habitats

While the Project Area occurs entirely on the shelf in a relatively homogenous gravel/sand habitat with water depths ranging between 100 and 200 m, the Study Area is much more diverse. It includes shelf, slope and byssal habitat, and is characterized by water depths ranging from <100 to >4,000 m and every conceivable bottom substrate type. Therefore, marine invertebrates and fish that occur in the Study Area occupy a variety of marine habitats. Gross classification of these habitats include benthic, demersal and pelagic, each of which can be divided into finer classifications. While some of the invertebrate and fish fauna in each of these habitats are important in the commercially fisheries prosecuted within the Study Area, all are ecologically important.

5.5.1.1 Benthic

Benthos includes plants (flora) and animals that live in (infauna) or on (epifauna) the sea bottom. The marine benthos is quite diverse, including micro- and macroalgae, invertebrates such as polychaete worms, molluscs and crustaceans, and certain fish species (e.g., flatfish). The composition of the benthic community is highly related to substrate type and water depth. The benthos is obviously a very important component of the benthic habitat and represents important food sources for both lower and higher trophic animal species.

Epibenthic invertebrate species caught during the White Rose baseline characterization program in 2000 included snow crab, Iceland scallop, toad crab, various echinoderms and sponges (Husky 2000). Benthic infauna collected during the same program was dominated by polychaetes which accounted for about 80% of the organisms in the samples. Other infauna included molluscs, crustaceans and echinoderms.

Results of 2001 site surveys at Gros Morne and Trepassey indicated abundant benthos including echinoderms (sand dollars, sea urchins, sea stars, and brittle stars), molluscs (bivalves and gastropods), and crustaceans (crabs). These are the animals expected to be associated with primarily sandy substrate with occasional gravel, cobble and shell detritus (Fugro Jacques GeoSurveys Inc. 2002a,b).

Based on sediment sampling during the Husky EEM program in 2004 and 2005, polychaetes continue to dominate the benthic infauna (~ 75% of all invertebrates) proximate to the White Rose development area (Husky 2005, 2006). Bivalves also accounted for a large proportion of the total number of invertebrates in the 2004 and 2005 sediment samples.

The infauna determined from 200 grab samples collected during a three-year trawling impact study (1993 to 1995) near White Rose has been described by Kenchington et al. (2001). The sediment samples contained 246 taxa (species or species groups), primarily polychaetes, crustaceans, echinoderms and molluscs. The biomass was dominated by propeller clams (*Cyrtodaria siliqua*) and sand dollars (*Echinarachnius parma*). The brittlestar *Ophiura sarsi*, the bivalve *Macoma calcarea*, and the sea urchin *Strongylocentrotus pallidus* also contributed substantially to the biomass collected. Abundance was dominated by the polychaetes *Prionospio steenstrupi* and the mollusc *Macoma calcarea*. Other species that were relatively abundant included the polychaetes *Chaetozone setosa*, *Spio filicornis*, and *Nothria conchylega*, the amphipod *Priscillina armata*, and the sand dollar.

5.5.1.1.1 Deep-water Corals

Deep-water corals are common in certain areas in Atlantic Canada. They are found primarily below the 200 m depth along the edge of the continental slope, in canyons or in channels between banks. Some soft corals are common in shallower areas on the continental shelf (Mortensen et al. 2006).

The distribution of deep-water corals is patchy and influenced by several environmental factors including substrate, temperature, salinity and currents. The substrate largely determines which species can occur. For example, gorgonians (horny corals) are most common on cobble and boulder but some also have anchorage apparatus for attachment in soft sediments (Mortensen et al. 2006).

Deep-water corals are known to provide habitat for a variety of invertebrate and fish species. For example, redfish have been observed in close association with deep-water corals. Fisheries and Oceans Canada have recently created three conservation areas to protect deep-water corals from damage due to fishing activity; the Northeast Channel between Georges Bank and the southwest Scotian Shelf, the Gully on the southern Scotian Shelf, and the Stone Fence at the southern end of the Laurentian Channel. None of these areas occur within the new drill centre Study Area (Mortensen et al. 2006).

Mortensen et al. (2006) present distribution maps of deep-water corals based on bycatch in DFO groundfish trawl surveys (1999-2001), fishery observer reports (2000-2001), and local ecological knowledge of Newfoundland fishermen. Mapped distributions within the Study Area include *Paragorgia arborea* (Bubble Gum Coral) on the upper slope region of the southern Flemish pass, *Primnoa resedaeformis* (Sea Corn) on the slope region of the northern part of the Study Area, and *Paramuricea* spp. (Black Coral) along the eastern slope region of the Tail of the Bank in the southern Study Area.

It is noted that the comprehensive ESRF summary report on deep-water corals and their habitats off Atlantic Canada (Mortensen et al. 2006) was made possible through the financial support of the oil and gas industry.

5.5.1.2 Demersal and Pelagic

Other invertebrate and fish species occur principally in the water column above the bottom substrate. Those that occur primarily in the lower water column and remain in association with the bottom are referred to as demersal species. Others that occur higher in the water column and have little or no association with the benthic habitat are referred to as pelagic species.

Demersal and pelagic invertebrates include certain crustacean (e.g., shrimp) and cephalopod (e.g., squid) species. Recent Spanish trawl surveys in the Flemish Cap region, reported 17 crustacean and eight cephalopod species over a depth range of 126 to 720 m (Torres and Loureiro 2001). The northern shrimp (*Pandalus borealis*) was the most abundant invertebrate species caught during the survey, occurring primarily between 182 and 253 m. The most abundant cephalopod in the catches was the northern shortfin squid (*Illex illecebrosus*), occurring primarily in the 344 to 618 m depth range.

Examples of demersal and pelagic fish species in the Study Area are numerous. Many of them will be discussed in the following sections.

5.5.2 Profiles of Commercially-Important Species

Based on commercial fishery landings data related to harvesting in the proposed Project and Study areas, specific fish and invertebrate species have been selected and described in the following sections.

5.5.2.1 Invertebrates

Based on commercial fishery landings data 2003-2005, invertebrate landings have accounted for almost all of the reported commercial landings weight in the drill centre Study Area during that period. Crustaceans and molluscs account for the invertebrate landings within the Study Area, including snow crab, northern shrimp, various clam species (e.g., Stimpsons surf clam, cockles, quahaugs and propeller clams) and Iceland scallops in 2005. More details concerning these commercial fisheries are discussed in Section 5.6.

5.5.2.1.1 Snow Crab

Snow crabs (*Chionoecetes opilio*) are decapod crustaceans that occur over a broad depth range (20 to >400 m) in the Northwest Atlantic. This species' distribution in waters off Newfoundland and southern Labrador is known to be widespread but the stock structure remains unclear. Snow crabs have a tendency to prefer water temperatures ranging between –1 and 4ºC. Large snow crabs (≥95-mm carapace width) occur primarily on soft bottoms (mud or mud-sand) (DFO 2006), particularly in water depths of 70 to 280 m, and small snow crabs appear to occur primarily on relatively hard substrates (DFO 2006c). Mating generally occurs during the early spring and the females subsequently carry the fertilized eggs for about two years. The larvae hatch in late spring or early summer, and then remain in the water column for 12 to 15 weeks before settling on the bottom (DFO 2006). Snow crab feed on fish, clams, polychaete worms, brittle stars, shrimp and crustaceans, including smaller snow crab.

Based on DFO fall multi-species bottom trawl surveys in Divisions 2J3KLNO together with offshore commercial catch per unit effort (CPUE), evaluations are made of trends in exploitable biomass. There have been indications of decline in exploitable biomass since 1998 (DFO 2006). Domestic snow crab harvesting occurs primarily in the central and northern parts of the eastern Study Area (I.e., Unit Areas 3Li, 3Lt and 3Nb). More details relating to commercial snow crab harvesting are discussed in Section 5.6. Snow crab is presently used as an indicator species in the Husky EEM program (Husky 2005).

5.5.2.1.2 Northern Shrimp

Northern shrimp (*Pandalus borealis*) occur in the northwest Atlantic from Davis Strait to the Gulf of Maine, primarily in areas where the substrate is soft mud and bottom water temperatures range from 2 to 6ºC (DFO 2004a). These environmental conditions typically occur in waters offshore of Newfoundland and Labrador where depths range between 150 and 600 m.

Colbourne and Orr (2004) showed that most of the large spring survey catches between 1995 and 2003 occurred in the warm water along the slopes of Divisions 3LN while in the fall, the largest catches occurred in most areas of 3L, including the inshore areas of the bays along the east coast of Newfoundland. It is not clear whether the changes in shrimp distribution observed in 2004 are environmentally driven or due to other factors (e.g., change in trawl catchability due to vertical migration and feeding behaviour).

Casas et al. (2005) indicated that northern shrimp abundance on the Flemish Cap generally showed an increasing trend between 1988 and 2005. Casas and del Rio (2005) reported data relating to the Spanish commercial northern shrimp fishery in NAFO Divisions 3M and 3L in 2004. Catches were greatest along either side of the Flemish Pass in 3Li, 3Lt, 3Ma and 3Mc, as well as along the northern slope region of the Flemish Cap in 3Ma and 3Mb.

Northern shrimp typically exhibit diel vertical migration, remaining relatively deep in the water column during the day, followed by upward movement in the water column during the night in order to feed on zooplankton. Common predators of northern shrimp include Atlantic cod, Greenland halibut, Atlantic halibut, skates, wolffishes and harp seals (DFO 2003).

Northern shrimp spawn once a year, typically in late-June or early-July. In eastern Canadian waters, shrimp eggs are extruded during late summer and fall and they remain attached to the female until larval hatch the following spring/summer. Females may move into shallower areas to maximize the rate of embryonic development. The larvae remain planktonic in the upper water column for a few months after which time they move downward through the water column and metamorphose to adulthood (DFO 1993).

Since fall of 2002, fall and spring research surveys in NAFO Divisions 3LNO have indicated the greatest concentrations of northern shrimp along the 3L slope region between 185 m and 550 m in the northwestern part of the Study Area, north-northeast of the Project Area. Results from fall 2002, spring 2003 and fall 2003 were quite similar but the distribution map for the spring 2004 research survey indicated slightly smaller catches in this region. During recent years, 90.5 to 99.9% of the total Divisions 3LNO northern shrimp biomass has been found within 3L. Between 2000 and 2003, 21% of the fall biomass and 26% of the spring biomass was found outside the 200 nautical miles limit (Orr et al. 2004a). Analyses from the fall 2003 survey indicated that the Divisions 3LNO trawlable biomass remained stable at 224,000 tons (47 billion animals) (Orr et al. 2004b).

5.5.2.1.3 Bivalves

Stimpsons surf clams, cockles, quahaugs, propeller clams have all been harvested commercially within the Study Area during recent years. In 2005, Iceland scallops were also harvested. Most of the bivalve harvesting has occurred in Unit Areas 3Na, 3Nb and 3Nd in the southwestern Study Area, more than 100 km south and southwest of the Project Area.

Stimpson's Surf Clam

Stimpson's surf clams (*Mactromeris polynyma*) are sedentary, benthic bivalve molluscs found along the western Atlantic coast. External fertilization by this clam results in pelagic larvae that remain in the upper water column for a few weeks prior to settling in suitable habitat. Spawning typically occurs during the late summer/fall months (DFO 2002).

This surf clam appears to prefer substrate comprised on medium to coarse sand (DFO 1999) although Davis and Shumway (1996) reported that the growth rate of this bivalve was greatest in silt/sand substrate. Stimpson's surf clams have been found in benthic communities that also include Greenland cockles and northern propeller clams (Lambert and Goudreau 1996), two bivalve species also known to occur in the drill centre Study Area.

Stimpson's surf clams are filter feeders with a microalgal diet. Predators of this clam include sea stars, waved whelks, crabs, and various groundfish (Roddick and Lemon 1992; Morissette and Himmelman 2000).

Greenland Cockle

The Greenland cockle (*Serripes groenlandicus*) in the northwestern Atlantic is distributed from Greenland to Cape Cod in subtidal depths exceeding nine metres. Barrie (1979) observed this cockle species on sandy substrate at various Labrador locations ranging in depth from six to 18 metres. It has also been observed on substrates consisting primarily of mud. Generally, the life history of this bivalve is poorly understood. The ranges of optimum temperatures of inhabitancy and spawning for Greenland cockles have been presented as -0.4 to 8 °C and 0 to 10 °C, respectively. Primary predators of the Greenland cockle include sea stars, groundfish and marine mammals (Dolgov and yaragina 1990; Legault and Himmelman 1993; Fisher and Stewart 1997; Born et al. 2003).

Ocean Quahaug

Ocean quahaugs (*Arctica islandica*) are subtidal bivalves that appear to be most abundant in muddy to sandy substrates compared to clays and gravels. This clam species is typically found as deep 250 m but has been dredged from as deep as 480 m. The peak spawning time of ocean quahaugs appears to be anytime from spring to early fall, depending on local water temperatures

(DFO 1998). Eggs and larvae of the ocean quahaug are planktonic. Golikov and Scarlato (1973) reported that the optimum temperature range for inhabitancy by juvenile and adult quahaugs is six to 16°C, and that this bivalve is able to survive well in areas where water currents are low. Juvenile and adult quahaugs are suspension feeders on phytoplankton (Witbaard et al. 2003). Predators of this bivalve include crabs, lobsters, sea stars, moon snails, whelks, and various groundfish (Cargnelli et al. 1999). Catto et al. (1999) identified the ocean quahaug as a key animal species in the biota assemblage associated with 'clam bed' habitat in Newfoundland and Labrador. General physical characteristics of this habitat type include fine to coarse sand/fine gravel substrate and full salinity.

Northern Propeller Clam

The northern propeller clam (*Cyrtodaria siliqua*) is a deepwater bivalve species that has so far been found in areas with water temperatures ranging from -1.0 to 5.7°C. Little is known about the life history of this shallow burrower. Propeller clams are known to be prey of cod, haddock and yellowtail flounder (DFO 1996).

Iceland Scallop

The Iceland scallop (*Chlamys islandica*) off Newfoundland is typically found in water depths ranging between 50 and 185 m, usually on hard substrate consisting primarily of gravel, sand, shell fragments and stones (DFO 2001). The timing of spawning by Iceland scallop is driven by water temperature and can happen as early in the year as April or May or as late in the year as September (Giguere et al. 1993, 1994). Iceland scallop larvae are planktonic for up to 10 weeks before settling to the ocean bottom. Iceland scallops occurring on the western Grand Banks are very susceptible to sea star predation (Naidu et al. 1999). In the Study Area, commercial quantities occur on the shelf in southern 3Lt, 3Nb (Carson Canyon), and 3Nd (Lilly Canyon), south of the Project Area in Unit Area 3Li.

5.5.2.2 Fish

Commercial fish species that occur in the drill centre Study Area include Atlantic halibut, Greenland halibut (turbot), yellowtail flounder, large pelagic species such as swordfish and various tunas, and sharks.

5.5.2.2.1 Atlantic Halibut

Atlantic halibut (*Hippoglossus hippoglossus*), the largest of the flatfishes, is typically found along the slopes of the continental shelf. Atlantic halibut move seasonally between deep and shallow waters, apparently avoiding temperatures below 2.5ºC (Scott and Scott 1988). The spawning grounds of the Atlantic halibut are not clearly defined. The fertilized eggs are slightly positively buoyant so that they naturally disperse and only gradually float toward the ocean's surface. Once hatched, the developing larvae live off their yolk for the next six to eight weeks while their digestive system develops so they can begin feeding on natural zooplankton. After a few weeks of feeding, they metamorphose from a bilaterally symmetrical larva to an asymmetrical flatfish, and are ready to assume a bottom-living habit. At this point they are approximately 20-mm long. As juveniles, Atlantic halibut feed mainly on invertebrates, including annelid worms, crabs, shrimps, and euphausiids. Young adults (between 30 to 80-cm in length) consume both invertebrates and fish, while mature adults (greater than 80-cm) feed entirely on fishes (Scott and Scott 1988).

According to 2003-2005 domestic harvest catch statistics, landed weight of Atlantic halibut in the Study Area is very low.

5.5.2.2.2 Greenland Halibut

The Greenland halibut (turbot) (*Reinhardtius hippoglossoides*) is a deepwater flatfish species that occurs in water temperatures ranging between –0.5 to 6.0ºC but appears to have a preference for temperatures of 0.0 to 4.5ºC. In the northwest Atlantic off northeastern Newfoundland and southern Labrador, these fish are normally caught at depths exceeding 450 m. Reported depths of capture range from 90 to 1,600 m. The larger individuals tend to occur in the deeper parts of its vertical distribution. Unlike many flatfishes, the Greenland halibut spends considerable time in the pelagic zone (Scott and Scott 1988).

These halibut are believed to spawn in Davis Strait during the winter and early spring at depths ranging from 650 to 1,000 m. They are also thought to spawn in the Laurentian Channel and the Gulf of St. Lawrence during the winter. The large fertilized eggs of this species (4 to 5-mm diameter) are benthic but the hatched young move upwards in the water column and remain at about 30 m below surface until they attain an approximate length of 70 mm. As they grow, the young fish move downward in the water column and are transported by the currents in the Davis Strait southward to the continental shelf and slopes of Labrador and Newfoundland (Scott and Scott 1988).

Greenland halibut are voracious bathypelagic predators that feed on a wide variety of prey. Summer and fall appear to be the seasons of most intense feeding. Prey items include capelin, Atlantic cod, polar cod, young Greenland halibut, grenadier, redfishes, sand lance, barracudinas, crustaceans (e.g., northern shrimp), cephalopods and various benthic invertebrates. Major predators of Greenland halibut include the Greenland shark, various whales, hooded seals, cod, salmon and Greenland halibut (Scott and Scott 1988).

Greenland halibut are widely distributed throughout the Labrador-eastern Newfoundland area (Bowering 2002; Kulka et al. 2003). During the late 1970s and most of the 1980s, they were plentiful along the deep slopes of the continental shelf and in the deep channels running between fishing banks, particularly in NAFO Divisions 2G, 2H, 2J and 3K. By 1991, the Greenland halibut distribution in the northern areas was greatly reduced and most of these fish were located in Division 3K and along the northern slope of Division 3L. By 1996-2001, its distribution to some of the more northern areas of historical high abundance began to reoccur (Bowering 2002).

Between 1996 and 2001, the DFO stratified random fall surveys in Division 3L extended to at least 730 m in the spring and to 1,500 m in the fall using the Campelen 1800 shrimp trawl (Bowering 2002). The surveys in 1999 showed larger catches in 3K and along the northern slope of 3L. Catches have remained relatively low along the eastern slope of 3L and in 3M. In 2000, survey results showed improved catches along the northeast slope of 3L while results in 3K were similar to 1999 (Bowering 2002). European Union (EU) trawl surveys conducted during July at the Flemish Cap since 1988 showed increasing Greenland halibut biomass up to 1998 after which the biomass has decreased. These surveys have been conducted over a depth range of 200 to 730 m (Vázquez 2002).

According to 2003-2005 domestic harvest catch statistics, landed weight of Greenland halibut in the Study Area is very low.

5.5.2.2.3 Yellowtail Flounder

Yellowtail flounder (*Limanda ferruginea*) inhabit the continental shelf of the Northwestern Atlantic Ocean from Labrador to Chesapeake Bay at depths ranging from 10 to 100 m. It has reached its northern limit of commercial concentrations on the Grand Bank off the east coast of Newfoundland. Yellowtail spawning on the Grand Bank generally occurs between May and September with peaks during the latter part of June. It tends to occur at depths less than 100 m and at water temperatures exceeding 2ºC (LGL 2001). The eggs, larvae and early juvenile stages of yellowtail are pelagic. Because of its small gape, this flounder is restricted in its choice of prey. The most common prey of yellowtail flounder include polychaetes, amphipods, shrimp cumaceans, isopods and small fish (LGL 2001).

Juvenile and adult yellowtail are generally concentrated on the southern Grand Bank, on or near the Southeast Shoal where the substrate consists primarily of sand (Unit Area 3Nc, primarily) (Walsh et al. 2001).

Walsh et al. (2006) discussed the distribution and abundance of yellowtail flounder on the Grand Bank based on spring and fall trawl surveys. They indicated yellowtail occurrences on the slope region of the southern drill centre Study Area (i.e., Unit Areas 3Nd and 3Nf) but the greatest concentrations of this flatfish occurred west of the Study Area in the vicinity of the Southeast Shoal.

5.5.2.2.4 Large Pelagics

Large pelagic species including swordfish and various tuna species (bigeye, bluefin, albacore) occur in the deeper water areas of the Study Area (3Mb, 3Mc, 3Md, 3Nd and 3Nf). Of the large pelagics, swordfish are most heavily harvested in the Study Area (Section 5.6).

5.5.3 Profiles of *SARA*- and COSEWIC-Listed Fish

5.5.3.1 Wolffishes

Two species, the northern wolffish and the spotted wolffish, are presently listed as 'threatened' on both Schedule 1 of the *SARA*, and by COSEWIC (Table 5.1). A third species, the Atlantic or striped wolffish, is listed as a species of 'special concern' on both Schedule 1 of the *SARA* and by COSEWIC (Table 5.1).

The three wolffish species show highest density and widest distribution on the northeast Newfoundland and Labrador Shelf. There they distribute over a wide range of depths, from 25 to 1,400 m. The northern wolffish occupies the widest range while the Atlantic wolffish occupies the narrowest. Kulka et al. (2004) demonstrated the importance of water temperature as a component of wolfish habitat. All three species are associated with a narrow thermal range (1.5 to 4.5 °C) and absent where water temperatures are < 0 °C. Kulka et al. (2004) also demonstrated the relationship between substrate type and the distributions of the three species. Spotted wolfish and Atlantic wolfish appear to distribute over a wide variety of sediment types while northern wolffish appear to occupy areas with sand/shell hash, gravely sand and rock sediments most frequently.

While the decline in abundance and biomass estimates of all three species has occurred throughout Newfoundland waters, it appears that the decline has been greatest in the more northern areas (Divisions 2J, 3K and northern 3L) than in the southern areas (southern 3L, 3N, 3O) (Simpson and Kulka 2002, 2003). Interestingly, the rate of decline at unfished locations was observed to be similar or higher than in the most intensely fished areas (Kulka et al. 2004). Changes in ambient water temperature appear to have resulted in a greater proportion of wolffish being concentrated on the outer shelf where fishing intensity, making them more vulnerable to capture.

DFO is presently preparing a 'Wolffish Recovery Plan' but this document has not yet been published (J. Simms, DFO biologist, pers. comm.).

5.5.3.1.1 Northern Wolffish

Northern wolffish typically occur at intermediate depths of 90 to 200 m but have been found at depths as great as 600 m. Tagging studies have suggested that northern wolffish do not migrate long distances nor do they form large schools. This benthic/bathypelagic predator, preying upon jellyfish, comb jellies, crabs, brittle stars, seastars, and sea urchins. Predators of the northern wolffish include redfish and Atlantic cod.

It is not known with certainty if northern wolffish spawn in the Study Area, although it is probable given the limited migration of the species. If spawning does occur in the Study Area, it would most likely take place along the slope. During the late fall fertilized eggs are deposited on either a hard bottom or underwater ledge (Scott and Scott 1988), producing larvae which are large (2-cm long upon hatching) and semipelagic (DFO 2004b).

The northern wolffish is not regarded as a commercial species in Newfoundland waters (Simpson and Kulka 2002, 2003).

5.5.3.1.2 Spotted Wolffish

Spotted wolffish typically occur at depths exceeding 475 m. Tagging studies have suggested that spotted wolffish only migrate locally and do not form schools. Spatial analysis of DFO research vessel catch data indicated that spotted wolffish abundance declined from the late 1980s to the mid-1990s, followed by an increase in abundance during both survey seasons since the mid-1990s (Kulka et al. 2003). This analysis indicated that spotted wolffish are most abundant along the Study Area slope in the fall compared to the spring. Its prey includes hard-shelled invertebrates such as crustaceans, molluscs, and echinoderms, and fish, primarily those discarded by trawlers. The species has few predators, although remains have been found in the stomachs of Atlantic cod, pollock and Greenland sharks (Scott and Scott 1988).

It is not known with certainty if spotted wolffish spawn in the Study Area, although it is probable given the limited migration of the species. If spawning does occur in the Study Area, it would most likely take place along the slope. During the late fall fertilized eggs are deposited on either a hard bottom or underwater ledge (Scott and Scott 1988), producing larvae which are large (2-cm long upon hatching) and semipelagic (DFO 2004b).

The spotted wolffish is regarded as a commercial species in Newfoundland waters (Simpson and Kulka 2002, 2003).

5.5.3.1.3 Atlantic (aka striped) Wolffish

Atlantic or striped wolfish are typically distributed further south than both northern and spotted wolffish. It is known to occur at depths up to 350 m (Scott and Scott 1988). As with spotted wolffish, Atlantic wolffish are more abundant along the Study Area slope in the fall than in the spring (Kulka et al. 2003). There is no evidence to suggest that Atlantic wolffish migrate long distances or form schools in Newfoundland waters (DFO 2004b). In the Northwest Atlantic, Atlantic wolffish feed primarily on benthic invertebrates including echinoderms, molluscs and crustaceans, supplemented by a limited diet of fish. Little is known about predators of adult Atlantic wolffish although juveniles have been found in the stomachs of Atlantic cod (Scott and Scott 1988).

It is not known with certainty if Atlantic wolffish spawn in the Study Area, although it is probable given the limited migration of the species. If spawning does occur in the Study Area, it would most likely take place along the slope. During the late fall fertilized eggs are deposited on either a hard bottom or underwater ledge (Scott and Scott 1988), producing larvae which are large (2-cm long upon hatching) and semipelagic (DFO 2004b).

Distributions of young-of-the-year Atlantic wolffish based on sampling with IYGPT trawl gear in August and September, 1996-1999, were most concentrated in Division 3K compared to Divisions 2J and northern 3L (Simpson and Kulka 2002, 2003). The Atlantic wolffish is regarded as a commercial species in Newfoundland waters (Simpson and Kulka 2002, 2003).

5.5.3.2 Atlantic Cod

The Newfoundland and Labrador population of Atlantic cod id currently listed on Schedule 3 of the *SARA* as a species of ‘special concern’ and as ‘endangered’ by COSEWIC (Table 5.1).

Atlantic cod has historically been distributed throughout Newfoundland and Labrador waters. The cod spawns both inshore and offshore in the Newfoundland-Labrador region and its eggs and larvae are both planktonic. Atlantic cod fertilized eggs, larvae and early juvenile stages remain in the plankton for 10 to 12 weeks. Juvenile Atlantic cod gradually shift from a pelagic to a benthic diet over a standard length range of about 4 to 10 cm, seemingly related to change in fish gape size (Lomond et al. 1998). Cod larvae and pelagic juveniles are primarily zooplankton feeders but once the switch is made to the demersal lifestyle, benthic and epibenthic invertebrates become the main diet. As the fish grow, the array of prey also widens. Prey often includes various crustaceans (crab, shrimp, euphausiids) and fish (capelin, sand lance, redfish, other cod, herring). Adult cod are commonly prey for seals and toothed whales, while juvenile cod are commonly preyed upon by squid, Pollock and adult cod (Scott and Scott 1988).

The stock of Atlantic cod that occurs off northeast Newfoundland and Labrador is known as the ‘northern’ cod. The northern cod ecosystem historically encompassed a vast area from the northern Labrador Shelf to the Grand Bank. Declines in this stock occurred first in the northern part of its distributional area (NAFO Divisions 2GH) in the late 1950s, 1960s and 1970s, and then southward (NAFO Division 2J) in the late 1980s and early 1990s. By the mid-1990s, most of the remaining biomass was located in the southern part of the historical distributional area of this cod stock (NAFO Divisions 3KL) (Rose et al. 2000). There is one belief that adult cod shifted their distribution southward in the late 1980s and early 1990s (deYoung and Rose 1993) while others claim that this apparent distributional shift was due to local overfishing, first in the north and then proceeding southward (Hutchings 1996; Hutchings and Myers 1994).

Historically, many of the northern cod migrated between overwintering areas in deep water near the shelf break and feeding areas in the shallower waters, both on the plateau of Grand Bank and along the coasts of Labrador and eastern Newfoundland. Some cod remained in the inshore deep water during the winter. The deep waters, both inshore and offshore, remained refugia for cod until the 1950s when longliners and bottom trawlers joined the fishery. European bottom trawlers initially exploited the outerbanks cod in summer and autumn but eventually extended the fishing to winter and early spring when the cod were highly aggregated. At the same time as offshore cod landings increased dramatically, the longliners fishing deep inshore waters introduced synthetic gillnets to the fishery.

The number and individual size of the fish declined through the 1960s and 1970s. The total allowable catch doubled between 1978 and 1984 due to an overestimation of stock size during this period. The stock was finally closed to Canadian fishing in July 1992 due to its decline (Lilly et al. 2001).

The northern cod has been called one of the least productive of the major cod stocks (Brander 1994). Historically, Atlantic cod spawned on the northeast Newfoundland shelf in late winter and spring, and then migrated shoreward across the shelf to the inshore feeding grounds, annually traversing distances of 500 km and more. Cross-shelf migration routes in spring followed thermal highways along deeper basins and trenches wherein warmer, deeper northwest Atlantic waters undercut the colder surface waters of the Labrador Current (e.g., an area on the northeast shelf known as the 'Bonavista Corridor') (Rose 1993). Ollerhead et al. (2004) indicated that between 1998 and 2002, the largest number of spawning cod along the northeast shelf edge of the Grand Banks occurred in June. Data from 1972 to 1997 indicated the highest number of spawning fish on the northeast shelf edge in April to June, peaking in May (Ollerhead et al. 2004).

After spawning, cod on the northeast Newfoundland shelf initially move southward with the dominant currents. Once they turn shoreward, as they do within the Bonavista Corridor, the dominant currents may flow offshore, against and across the direction of migration. However, flows in the deeper, warmer waters of the Bonavista Corridor do at times reverse and flow shoreward.

The offshore biomass index values from the fall research bottom trawl surveys in 2J3KL have been very low for the past 10 years. The average trawlable biomass of 28,000 mt during 1999-2002 is about 2% of the average in the 1980s (DFO 2003a). The same trend has been evident on the Flemish Cap during recent years (Vázquez 2002).

The most recent assessment of the status of the northern (2J3KL) cod stock was conducted in February 2003. The 2003 research bottom-trawl surveys during both spring and fall indicated that the biomass of cod in the offshore remains extremely low (1% of the average during the 1980s) (DFO 2004c).

The last substantial offshore concentrations of cod were seen at approximately 49-50ºN on the outer shelf and upper slope as the stock collapsed. This is also one of few offshore areas where a very modest increase in cod density has been seen in recent years. In addition, a substantial portion of the cod stock used to overwinter on the northeastern slope of Grand Bank and the Nose of the Bank prior to the collapse of the stock. There have not been any recent winter surveys in these areas so recent cod concentrations are unknown. Nonetheless, these could be critical areas in the recovery of the offshore northern cod. Most cod are found shallower than the 900-m depth (G. Lilly, DFO, pers. comm.). Kulka et al. (2003) mapped the distributions of Atlantic cod on the Grand Banks based on spring and fall DFO research survey data collected between 1972 and 2002.

In March 2003, the FRCC released some recommendations for the Northern Cod. For the bank sub-stocks, the Council recommended a higher level of protection than has been in place since commencement of the moratorium. In order to reduce by-catch mortality and disturbance to spawning and juvenile cod, the FRCC recommended the establishment of experimental 'cod boxes' in both the Hawke Channel and the Bonavista Corridor. The FRCC recommended that these areas be protected from all forms of commercial fishery (except snow crab trapping) and other activity such as seismic exploration (www.frcc-ccrh.ca).

According to DFO's 2006 assessment of 2J3KL northern cod, mortality of cod in the offshore is exceedingly high. Spring and fall research bottom-trawl surveys in 2005 indicated that biomass of cod remains low. The average biomass index from fall surveys between 2003 and 2005 was approximately 2% of the average during the 1980s. Fall survey data indicate that recruitment in the offshore is low and that total mortality has been extremely high since at least the mid-1990s (DFO 2006).

5.5.3.3 Porbeagle Shark

Although not an official species at risk under *SARA*, the porbeagle shark is currently designated as 'endangered' by COSEWIC (Table 5.1). It is now under consideration for addition to Schedule 1 of *SARA*.

Porbeagle sharks are predators of various fish species and cephalopods (Campana et al. 2001). Pelagic species are the primary prey of this shark during the spring and summer, followed by a shift to groundfish species in the winter. This prey shift reflects the seasonal change of distribution of porbeagle (i.e., migration to deeper areas in fall and winter) (Campana et al. 2001).

Porbeagle sharks are migratory, pelagic fish that are known to occur at surface to as deep as 715 m. The porbeagle tends to be most abundant on continental offshore fishing banks but is also found far from land in ocean basins and occasionally inshore (Scott and Scott 1988; SAUP 2006).

5.5.3.4 White Shark

Although not an official species at risk under *SARA*, the great white shark is designated as 'endangered' by COSEWIC (Table 5.1).

The great white shark is a highly migratory fish whose occurrence has been recorded over a broad depth range of surface to 1,280 m. This shark is primarily a coastal and offshore inhabitant of continental and insular shelves but it also occurs off oceanic islands far from any mainland. In Canadian waters, great white sharks occur primarily between April and November, mostly during August (Scott and Scott 1988; SAUP 2006).

5.5.3.5 Shortfin Mako Shark

Although not an official species at risk under *SARA*, the shortfin mako shark is designated as 'threatened' by COSEWIC (Table 5.1).

The known depth range of this migratory shark is 0 to 740 m., although it is usually found in surface waters and down to about 150 m. While typically oceanic, the shortfin mako is sometimes found close inshore.

5.5.3.6 Blue Shark

Although not an official species at risk under *SARA*, the blue shark is designated as a species of 'special concern' by COSEWIC (Table 5.1).

The highly migratory blue shark is pelagic and has a known vertical distribution ranging from surface to 350 m. While primarily oceanic, this shark may be found close to shore where there is a narrowing of the continental shelf (Scott and Scott 1988; SAUP 2006).

5.5.3.7 Cusk

In May 2003, cusk were designated a threatened species by COSEWIC but this species is not on the official *SARA* list (Schedule I) of wildlife at risk. An allowable harm assessment for cusk in Atlantic Canada was recently prepared by DFO (DFO 2004c). Cusk are solitary, slow-swimming groundfish that occur on both sides of the North Atlantic. In Canadian waters, this species is most common in the Gulf of Maine, Gulf of St. Lawrence and the southwestern Scotian Shelf (Scott and Scott 1988). Although most common within a depth range of 128 to 144 m, some have been caught as deep as 600 m. Spawning occurs from May to August, peaking in June. The diet of cusk is not well documented because their stomachs usually evert when they are brought to the surface. Studies have shown that in European waters, cusk feed on crab, molluscs, krill, cod, and halibut. Their diet is presumed to be the same in Canadian waters (Scott and Scott 1988).

5.5.4 Invertebrate and Fish Spawning

Ollerhead et al. (2004) mapped the spawning times and locations for ten commercially important fish and invertebrate species found on the Grand Banks. Mapping was based on data collected on DFO research surveys between 1965 and 2003. Of the species profiles above, Ollerhead et al. (2004) identified spawning within the Study Area by Atlantic cod (April to June with peak in May) and northern shrimp which mate and extrude during summer/early fall. Other species identified as spawners in the Study Area include American plaice (May and June), redfish (June) and witch flounder (May and August). Redfish spawning indicated within the Study Area was very minimal and located in the extreme northeast. Given the high occurrence of snow crab within portions of the Study Area, it is logical to speculate that this crab species also spawns there, likely in spring/early summer.

The distributions of snow crab larvae have been determined at numerous Grand Banks stations sampled during late summer pelagic surveys between 1991 and 1999 (Dalley et el. 2001). An increase in snow crab larvae abundance was observed from 1991 to 1994, followed by lower densities in 1995 and 1996. A dramatic increase was seen in 1997, followed by a dramatic drop in 1998, and then another substantial increase in 1999. Dalley et al. (2001) pointed out that the discontinuous nature of snow crab larvae distribution and their low abundance compared to the dominant invertebrate zooplankton species probably resulted in considerable underestimation. Highest densities were indicated immediately east and northeast of the Avalon Peninsula, outside Husky's proposed Study Area.

5.6 Commercial Fisheries

Past, current and expected commercial fisheries in the Study Area and Project Area are described in this section. Section 5.5 of this study describes the biological characteristics and status of the main commercial and other marine species.

In this discussion of commercial fishing activities, a number of assessment and fisheries management areas are referenced. The Drill Centre Areas (the North, West and South White Rose Extensions) are the areas of proposed development, the Project Area is the White Rose Operational Area which contains the three Drill Centre Areas (Figure 1.2), and the Study Area contains all of the Northwest Atlantic Fisheries Organization (NAFO) Unit Areas (UAs) 3Li, 3Lt (Project Area within this UA), 3Mc, 3Md, 3Nb, 3Nf and portions of UAs 3Lh, 3Lr, 3Ma, 3Mb, 3Na and 3Nf (Figure 1.1). The Study Area is used to characterize regional historical fisheries for both foreign and domestic harvesters.

The principal focus for the fisheries description is the domestic Canadian harvest, for which good geographically-focused datasets (described below) are available. For these fisheries, the period 1985-2005 is used for a historical retrospective, while more detailed analysis of the Study Area and Project Area is based on recent harvesting, 2003 to 2005, since fishing activities in the region have changed so significantly in recent years.

Though the majority of the Study Area is east of (outside) Canada's 200-mile Exclusive Economic Zone (EEZ), all of the Project Area is within the EEZ. Fisheries within the EEZ is expected to be primarily domestic while there is harvesting by several nations outside the zone.

5.6.1 Information Sources

The analysis of commercial fisheries data in this report is based on DFO catch data and NAFO datasets. Catch data derived from DFO Newfoundland and Labrador and Maritimes Regions (Nova Scotia) for the period 1986-2005[1] are used to characterize the historical domestic fisheries in the Project and Study Area, and adjacent waters. Foreign catches not landed in Canadian ports are not captured in the DFO data, so NAFO datasets (1982 – 2001) are used to quantify harvesting by foreign (as well as domestic) fishers for certain fisheries. Foreign fishing for northern shrimp is a factor particularly in areas beyond 200 NMi in the eastern portion of the Study Area.

Maritimes Region DFO data are included because a significant portion of the harvest (mainly shrimp) within the Study Area is typically landed in Nova Scotia.

Past domestic harvesting locations in relation to the Project Area and the Study Area are shown in the fisheries maps in this section. These are based on the DFO datasets, which are georeferenced. These maps capture the great majority of the domestic harvest in the relevant areas. For example, within Unit Areas 3Lt, 97.5% of the harvest in 2005, by quantity, was georeferenced (99% in 2004). The location given in the datasets is that recorded in the vessel's fishing log, and is reported in the database by degree and minute of latitude and longitude; thus, the position is accurate within roughly 0.5 nautical mile of the reported co-ordinates. It should be noted that for some gear, such as mobile gear towed over an extensive area, or for extended gear, such as longlines, the reference point does not represent the full distribution of the gear or activity on the water. However, over many data entries, the reported locations create a fairly accurate indication of where such fishing activities occur and these kinds of database locations have been groundtruthed by Canning & Pitt Inc. with fishers in Nova Scotia, Newfoundland and Labrador and elsewhere over many years.

The maps in the following sections show harvesting locations as dark points. The points are not "weighted" by quantity of harvest, but show where at least some fishing effort was reported. Where the harvests are quantified, the weight of the harvest (in tonnes) is given rather than its value, since these quantities are directly comparable from year to year. Values (for the same quantity of harvest) may vary annually with species, negotiated prices, changes in exchange rates

[1] The DFO data used in the report represent all catch landed within DFO Maritimes Region and for all Newfoundland and Labrador landed catch. Foreign catches landed outside these areas are not included in the DFO data sets, but most are captured in the NAFO data. Data for 2003-2005 are still classified by DFO as preliminary, though the species data used in this report are not likely to change to any significant extent when the data are finalized. The most recent Maritimes Region and Newfoundland Region data were accessed in February 2006.

and fluctuating market conditions. Value, however, would be very important, and carefully evaluated according to the current prices, if there were a compensation incident, as described in the mitigations sections of this assessment.

Other sources consulted for this section include fisheries management plans, quota reports and other DFO documents. Representatives of fisheries organizations and DFO were also consulted. These consultations were undertaken to inform stakeholders about the project, to gather information about expected future fishing activities, and to determine any issues or concerns.

Fisheries-related information provided during the consultations is reported under the discussions of the commercial fisheries below, and any issues raised during the consultations are discussed in Section 6.0. The following fisheries agencies and industry stakeholders were consulted:

- Fisheries and Oceans
- Environment Canada
- Natural History Society
- One Ocean/FFAWU
- Association of Seafood Producers
- Fishery Products International
- Clearwater Seafoods Limited Partnership
- Icewater Harvesting
- Groundfish Enterprise Allocation Council

5.6.2 Historical Overview

Commercial fish harvesting within the Study Area and on the Newfoundland Grand Banks generally has changed significantly over the last two decades, shifting from a groundfish-based industry to primarily invertebrate harvesting. Until the early 1990s, the eastern Grand Banks fisheries were dominated by stern otter trawlers harvesting groundfish, primarily Atlantic cod, as well as redfish, American plaice and several other species. In 1992, with the acknowledgement of the collapse of several groundfish stocks, a harvesting moratorium was declared and directed fisheries for cod is no longer permitted in these areas. Since the collapse of the groundfish fisheries, formerly underutilized species – mainly shrimp and snow crab – have come to replace them as the principal harvest in the general region, as they have in many other areas offshore Newfoundland and Labrador.

Figures 5.2 and 5.3 illustrate these changes in harvesting on the eastern Grand Banks since 1982. These graphs show catches for NAFO-regulated species by foreign and domestic harvesters, based on NAFO-supplied data. Figure 5.2 shows groundfish harvests (largely Atlantic cod, American plaice, capelin and redfish) over this 20-year period, and Figure 5.3 indicates shrimp catches. (Snow crab, presently another principal species harvested on the eastern Grand Banks and its slopes, is not managed by NAFO.)

Other than Canadian ships, those fishing in these areas during this timeframe were from the Faroe Islands, Iceland, Japan, Russia and other former Soviet states, and various European nations.

Within Unit Area 3Lt, which contains the Project Area, the domestic fisheries over the past 20 years (1986-2005) followed a similar pattern, shifting from a groundfish fishery to snow crab, as indicated in Figure 5.4. In the mid-1980s (and earlier) the 3Lt groundfish harvest was primarily Atlantic cod and American plaice; since the mid-1990s, the catch has been virtually all snow crab.

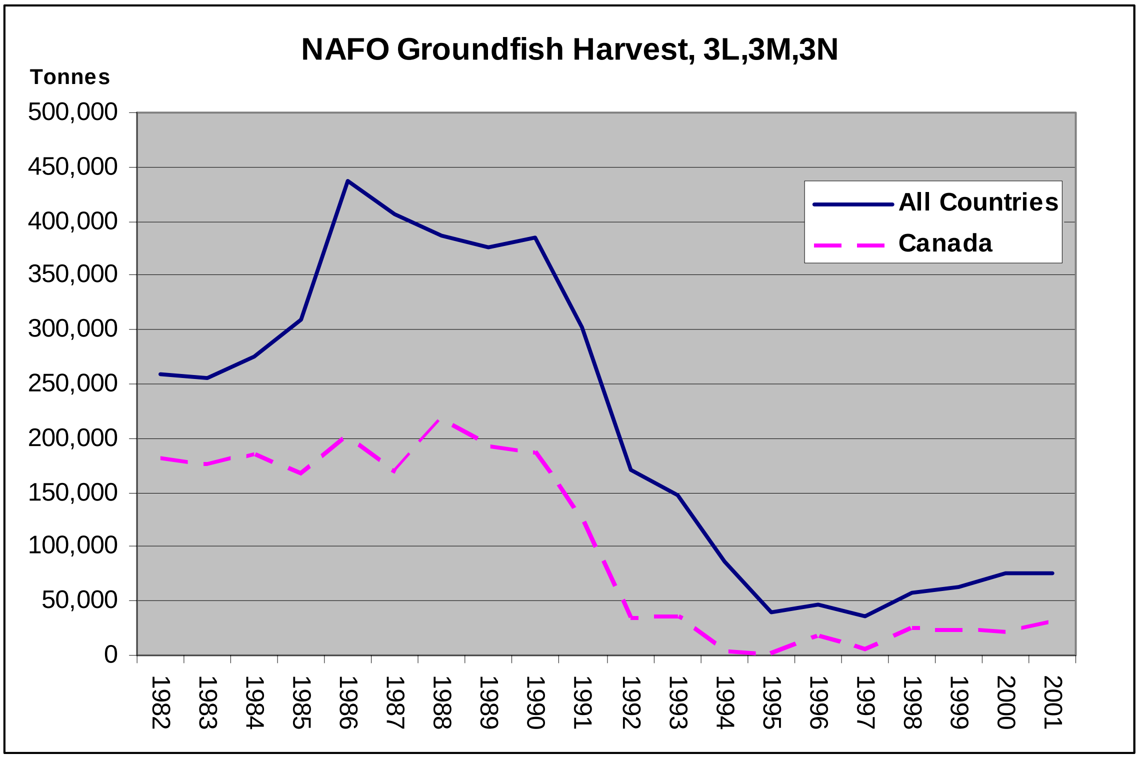

Figure 5.2. DFO Groundfish Species, 1982-2001, Foreign and Domestic.

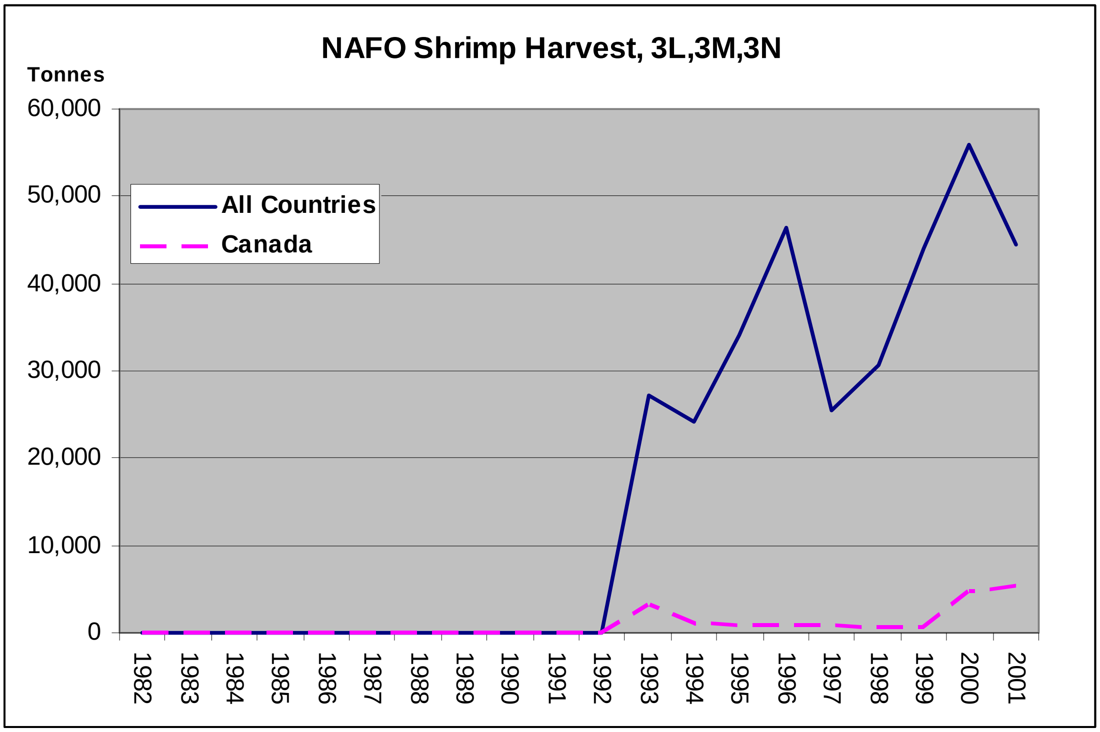

Figure 5.3. NAFO Shrimp Species, 1982-2001, Foreign and Domestic.

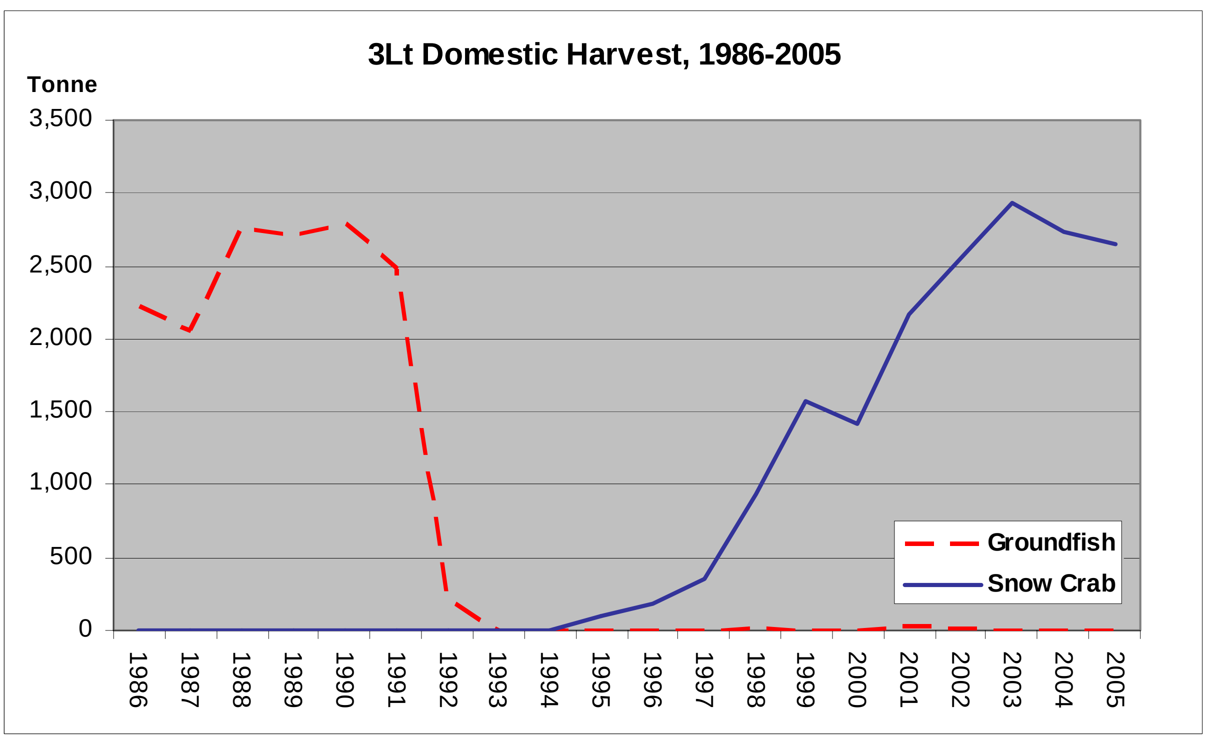

Figure 5.4. 3Lt Harvest, 1986-2005, Groundfish and Snow Crab.

5.6.3 Study Area and Project Area Domestic Fisheries

The Study Area encompasses the easternmost Grand Banks, including its “nose”, which is historically a very productive fishing area. The Flemish Cap area includes other productive fishing grounds within the Study Area, though largely for foreign fishing interests. For example, in 1999-2001, less than 1% of the substantial shrimp harvest in 3M was taken by Canadian vessels. (Most of these foreign fishing activities do not show in the Canadian datasets and the mapping presented in this report.) Farther to the east, beyond the Flemish Cap, and in the southern part of the Study Area east of the shelf, there is relatively little fishing.

The composition of the harvest recorded within the Study Area during 2003 to 2005 is presented in Table 5.2 (this includes the Project Area harvest). As the data indicate, domestic commercial fisheries in the Study Area are almost exclusively for snow crab (38%), mollusks (34%) and northern shrimp (28%). These species made up more than 99% of the domestic harvest in the area over the past three years.

Within the Project Area, in 2003 - 2005, the only substantial harvest recorded was a small quantity of snow crab in 2004. In 2003, less than 1 tonne, of American plaice, was recorded in total, and nothing in 2005 as Table 5.3 indicates.

Table 5.2. Domestic Harvest (Tonnes) by Species, Study Area, 2003-2005.

Species	2003	2004	2005	% of 3-Year Total
Atlantic Cod	0.0	3.1	0.0	0.0%
Redfish	2.6	0.0	0.0	0.0%
Halibut	1.9	1.3	0.0	0.0%
Flounder, American Plaice	1.6	0.0	0.0	0.0%
Flounder, Yellowtail	2.2	4.0	0.0	0.0%
Turbot (Greenland Halibut)	0.4	1.9	0.0	0.0%
Hake, White	0.0	0.5	0.0	0.0%
Swordfish	17.4	15.7	26.9	0.1%
Tuna, Albacore	1.4	0.4	0.0	0.0%
Tuna, Bigeye	14.7	4.9	7.3	0.0%
Tuna, Bluefin	0.7	0.6	0.0	0.0%
Shark, Mako	0.5	2.8	1.6	0.0%
Clams, Quahaugs	2,937.0	0.0	0.0	3.9%
Clams, Propeller	1,258.7	283.2	149.9	2.3%
Clams, Stimpson Surf*	10,457.1	2,170.2	1,519.2	19.0%
Cockles	0.0	2,258.3	2,029.3	5.8%
Unspec. Molluscs	1,984.2	0.0	0.0	2.7%
Scallops, Icelandic	0.0	0.0	95.9	0.1%
Shrimp, Northern	5,221.5	7,228.3	8,396.3	28.0%
Crab, Snow	9,511.0	9,609.9	9,314.0	38.1%
Total	31,412.8	21,585.2	21,540.4	100.0%

Table 5.3. Domestic Harvest (Tonnes) by Species, Project Area, 2003-2005.

Year	Species	Quantity (Tonnes)
2002	American plaice	0.2
2003	Snow crab	6.1
2004	All Species	0

Further information on the snow crab, shrimp and clam fisheries is provided in the sections following.

5.6.3.1 Domestic Harvesting Locations

The fish harvesting location maps below (Figures 5.5 to 5.7) show domestic fishing locations (all species) in relation to the Project Area and Study Area for January to December (aggregated) for 2003, 2004 and 2005. As these maps indicate, most of the domestic fish harvesting in the Study Area is concentrated between the 100 m and 1,000 m contours of the eastern Bank and slope. The maps also illustrate that the main harvesting locations tend to be quite consistent from year to year.

Figures 5.8 to 5.10 show a more detailed view of the Project Area and Drilling Centres for the same timeframe. These maps also indicate that there is virtually no fishing within the Project Area throughout the year.

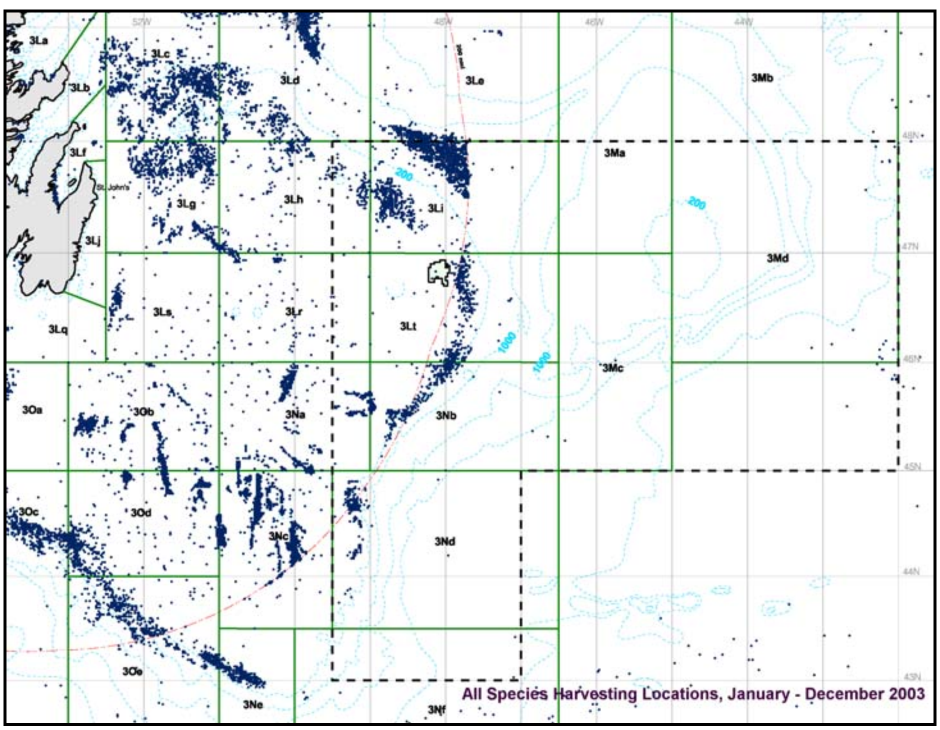

Figure 5.5. All Species Harvesting Locations 2003.

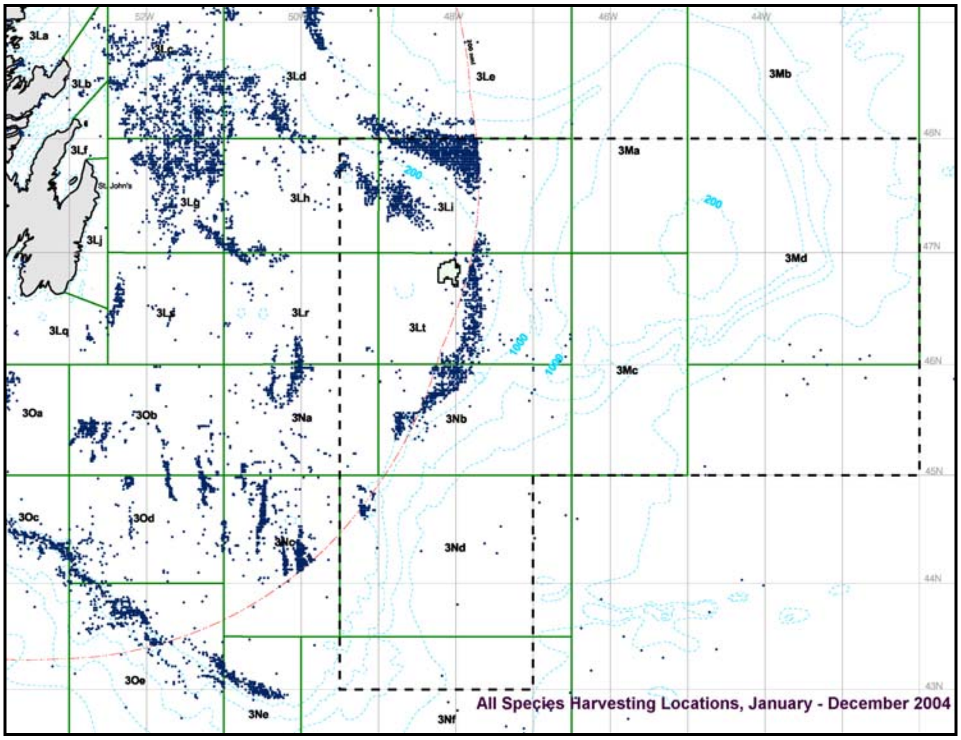

Figure 5.6. All Species Harvesting Locations 2004.

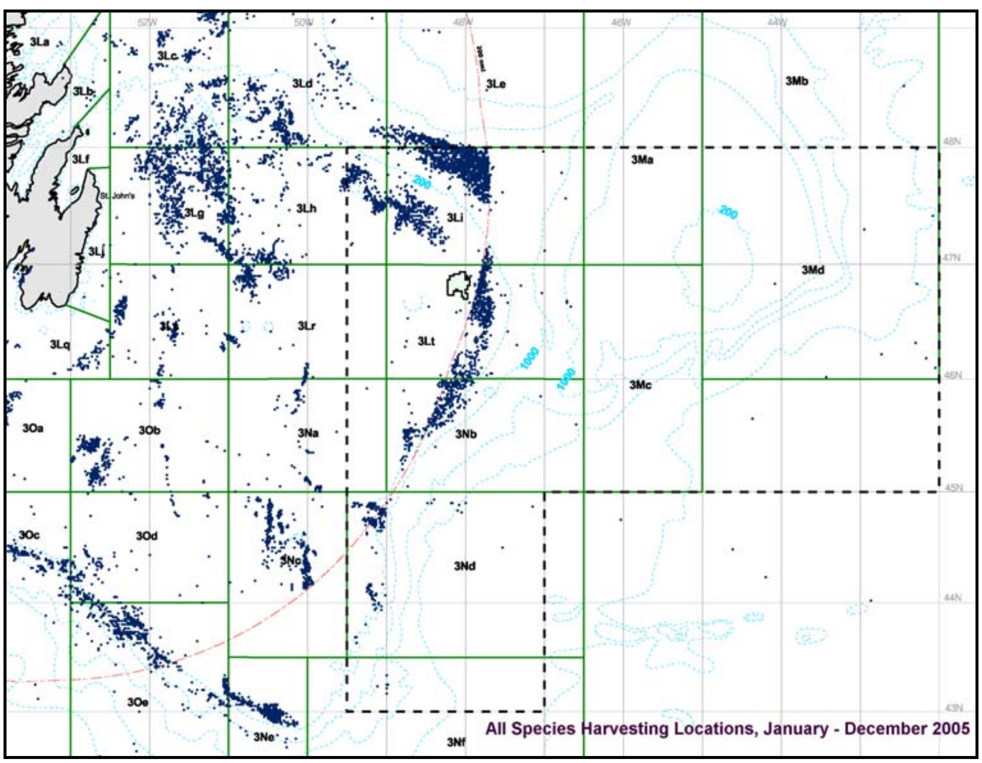

Figure 5.7. All Species Harvesting Locations 2005.

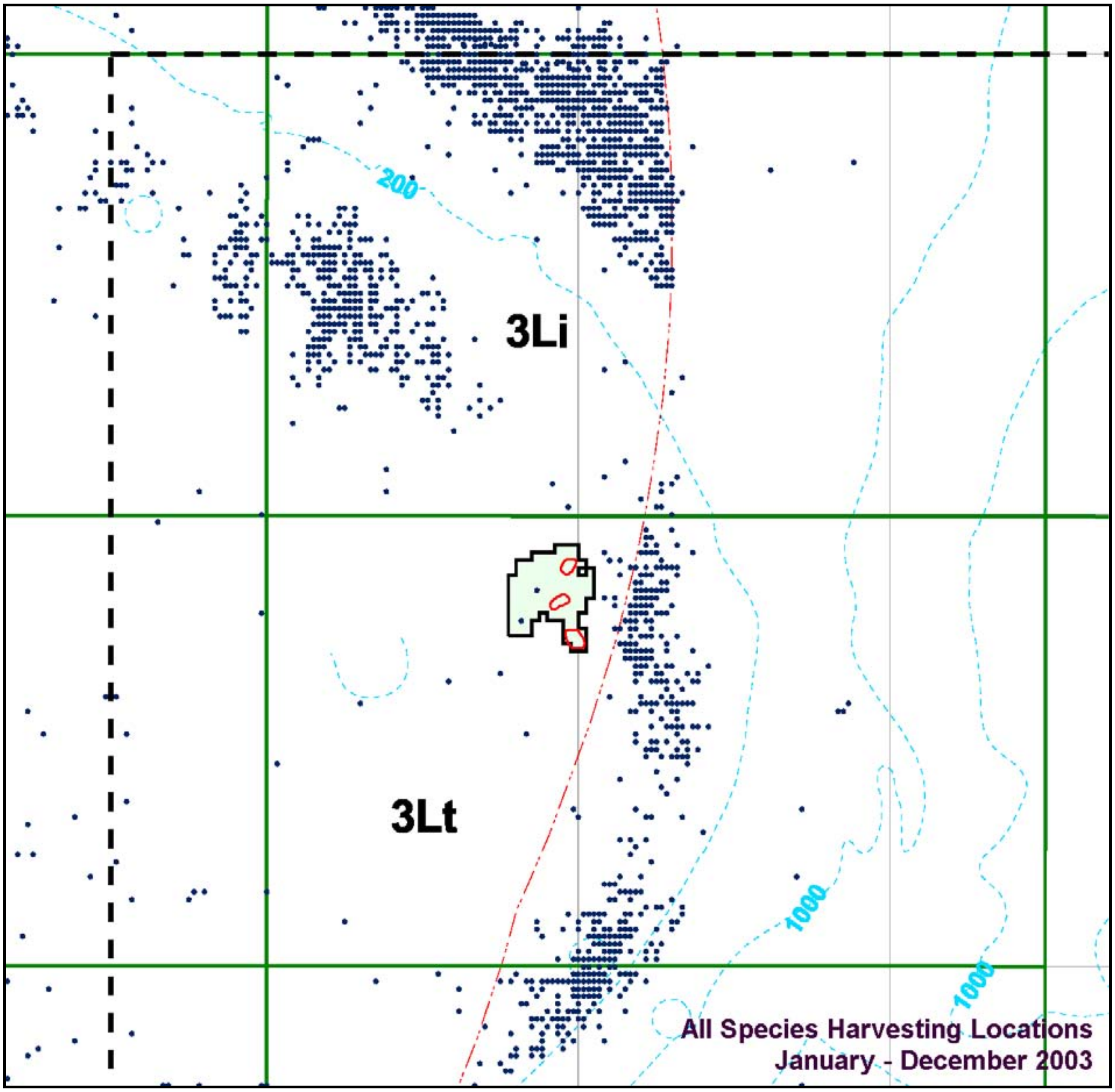

Figure 5.8. All Species Harvesting Locations (Project Area and Drill Centres) 2003.

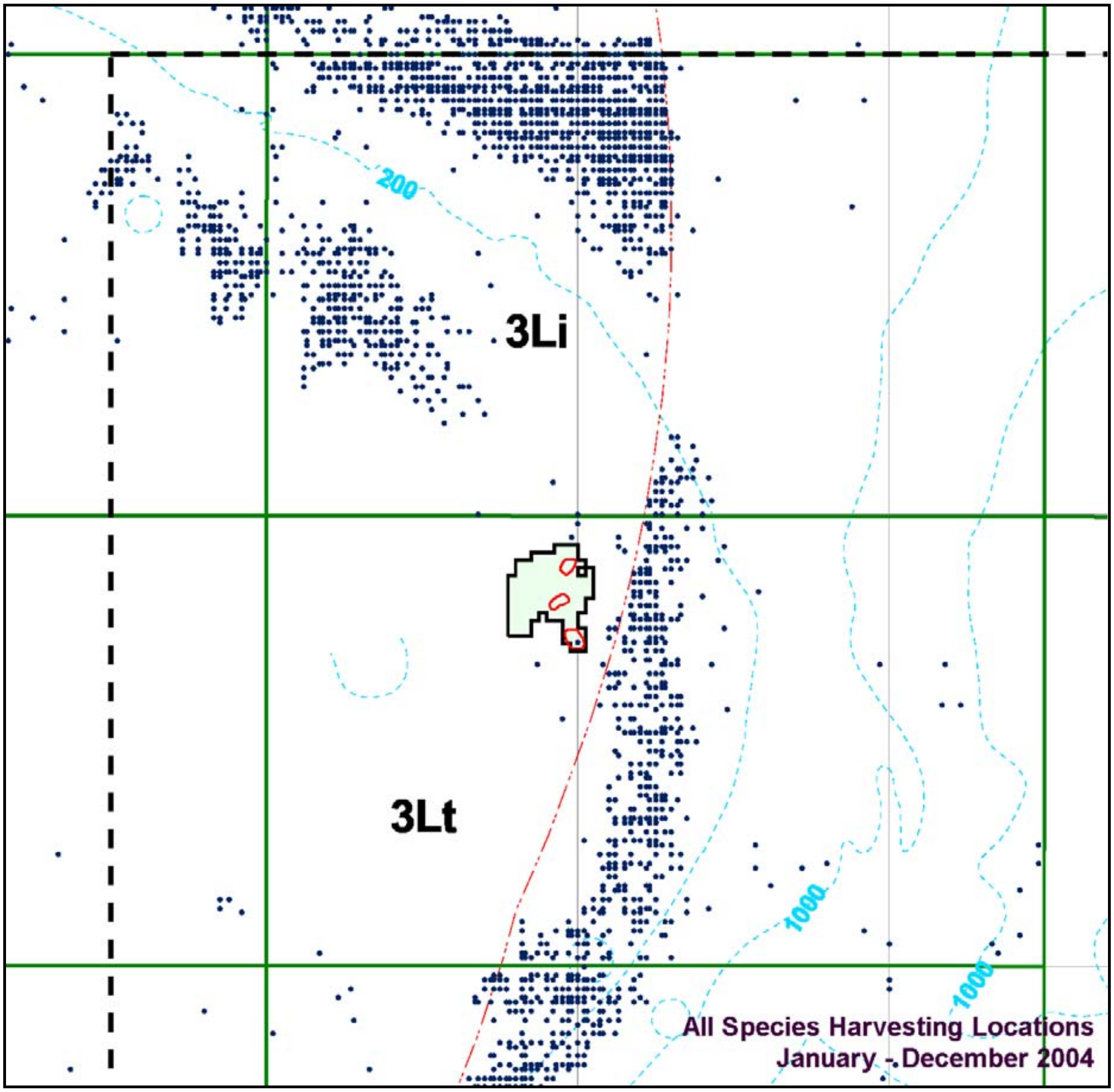

Figure 5.9. All Species Harvesting Locations (Project Area and Drill Centres) 2004.

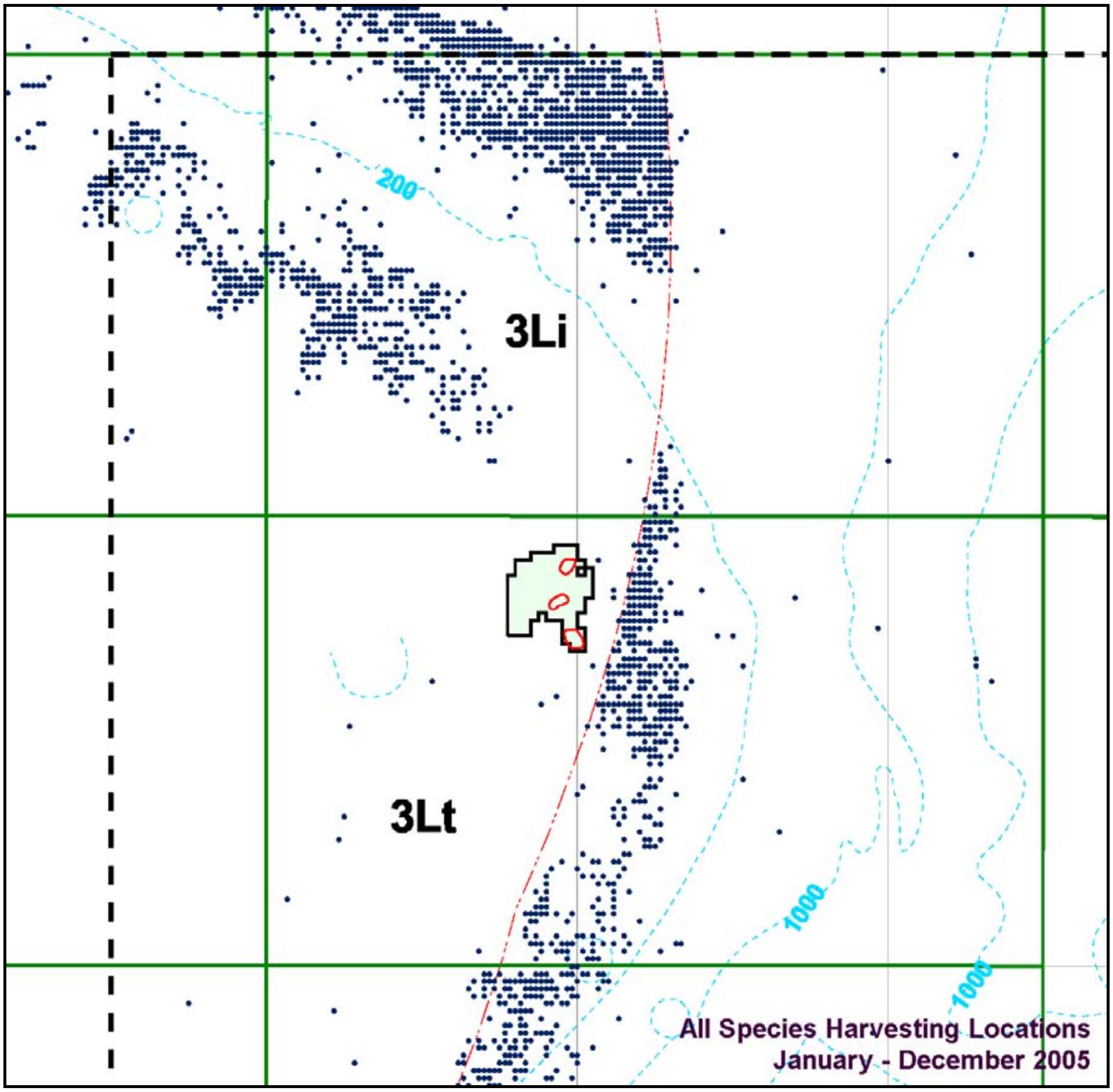

Figure 5.10. All Species Harvesting Locations (Project Area and Drill Centres) 2005.

5.6.3.2 Timing and Seasonality

Harvesting times may change from year to year, depending on seasons and regulations set by DFO, the harvesting strategies of fishing enterprises, or on the availability of the resource itself. The following graphs show the 2003, 2004 and 2005 catch by month (all species) from the Study Area and from Unit Area 3Lt, which contains the Project Area. Within the Project Area itself, the only significant harvest recorded in the last three years (snow crab in 2004) was harvested in May.

As Figure 5.11 illustrates, the Study Area harvest has been highest during May - July over the past three years, though some harvesting may occur year round (based on the DFO georeferenced datasets). Within Unit Area 3Lt (Figure 5.12), harvesting (snow crab) has been confined to the April – August period, with most occurring between May and July in these years.

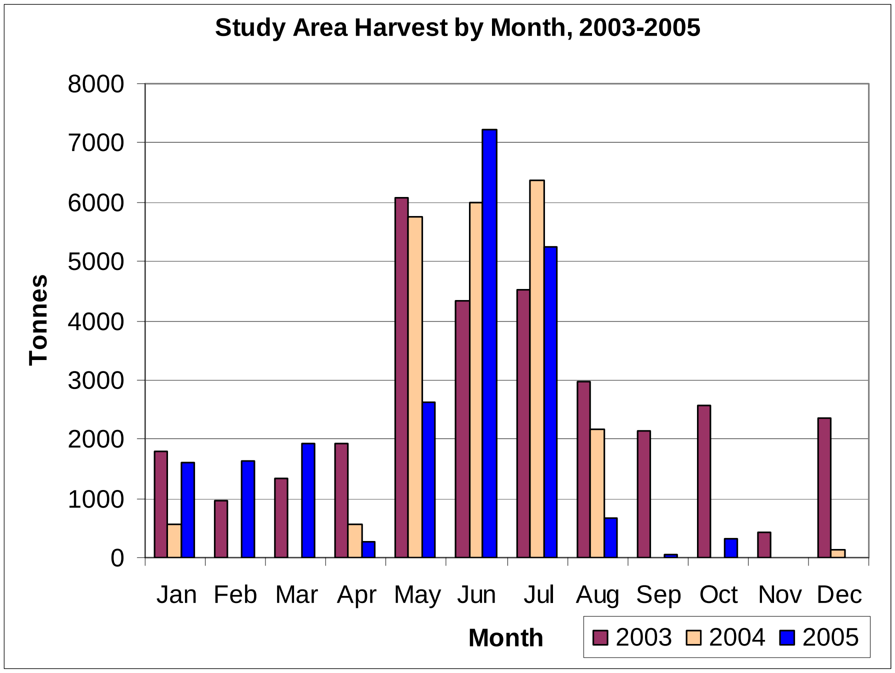

Figure 5.11 Study Area Domestic Harvest by Month, All Species, 2003-2005.

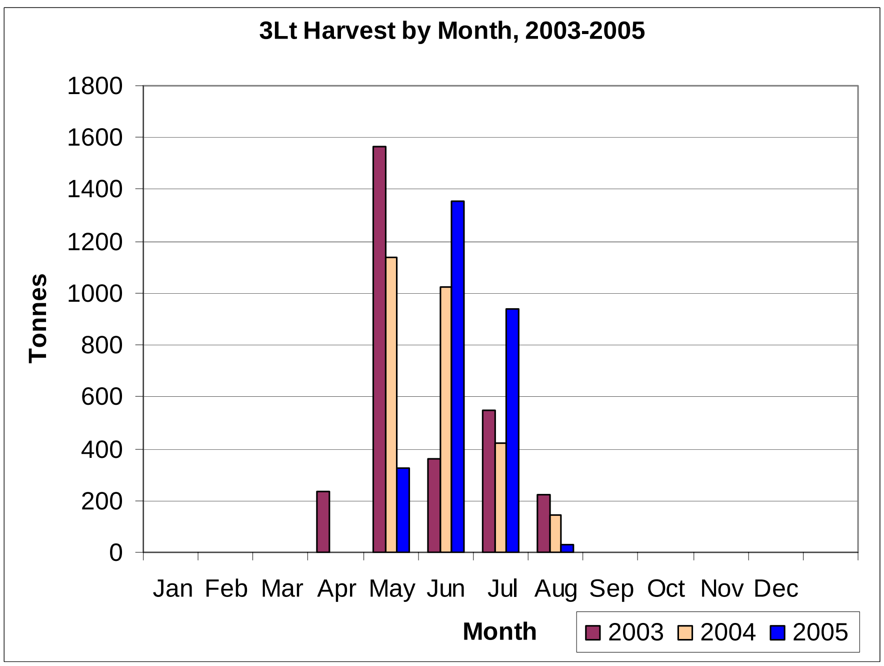

Figure 5.12. Unit Area 3Lt Domestic Harvest by Month, All Species, 2003-2005.

The following maps (Figures 5.13 to 5.18) show the Study Area and the Project Area in relation to the reported domestic harvesting locations (all species) by month for 2005.

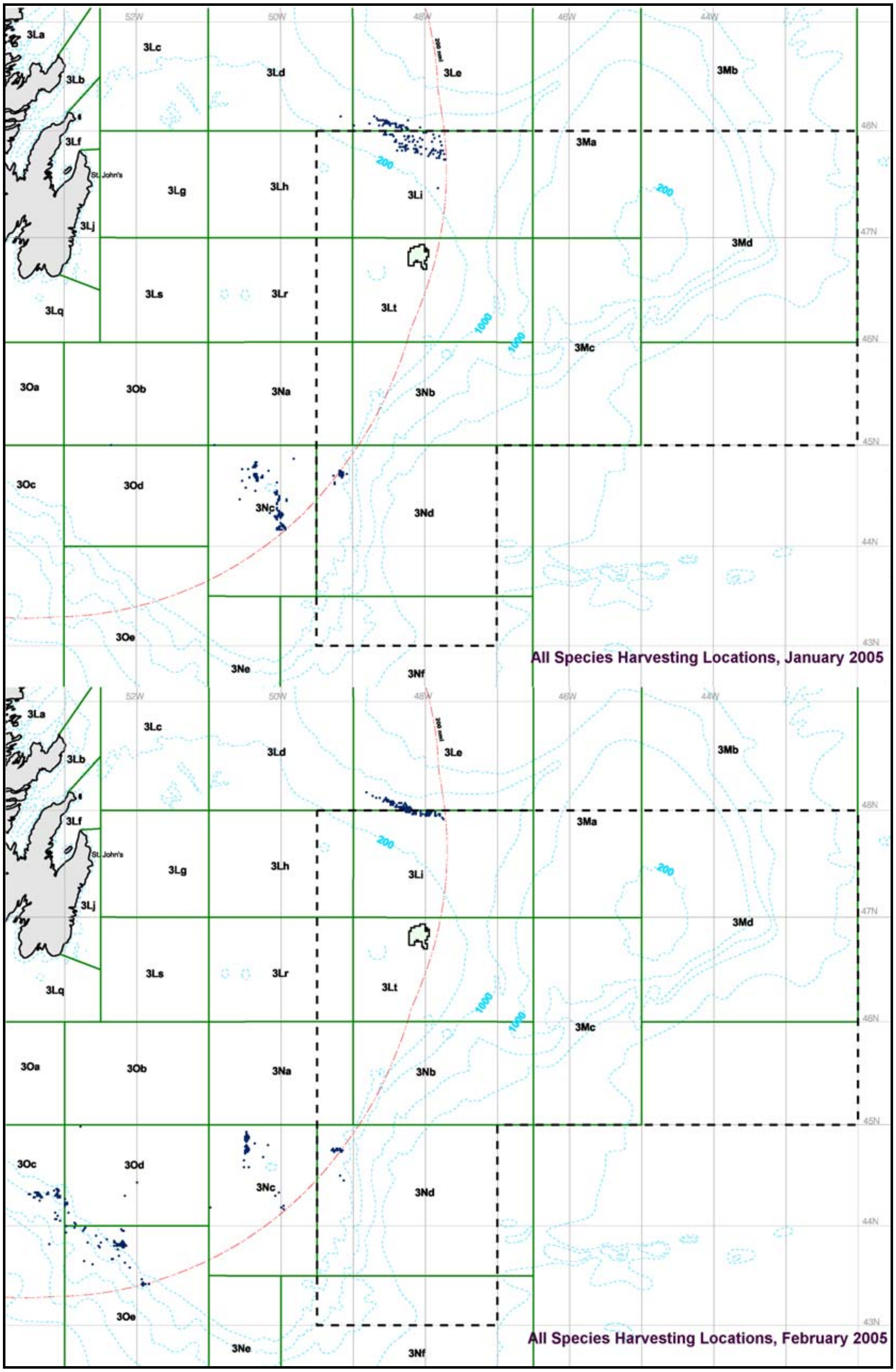

Figure 5.13. Domestic Harvesting Locations, All Species, January – February 2005.

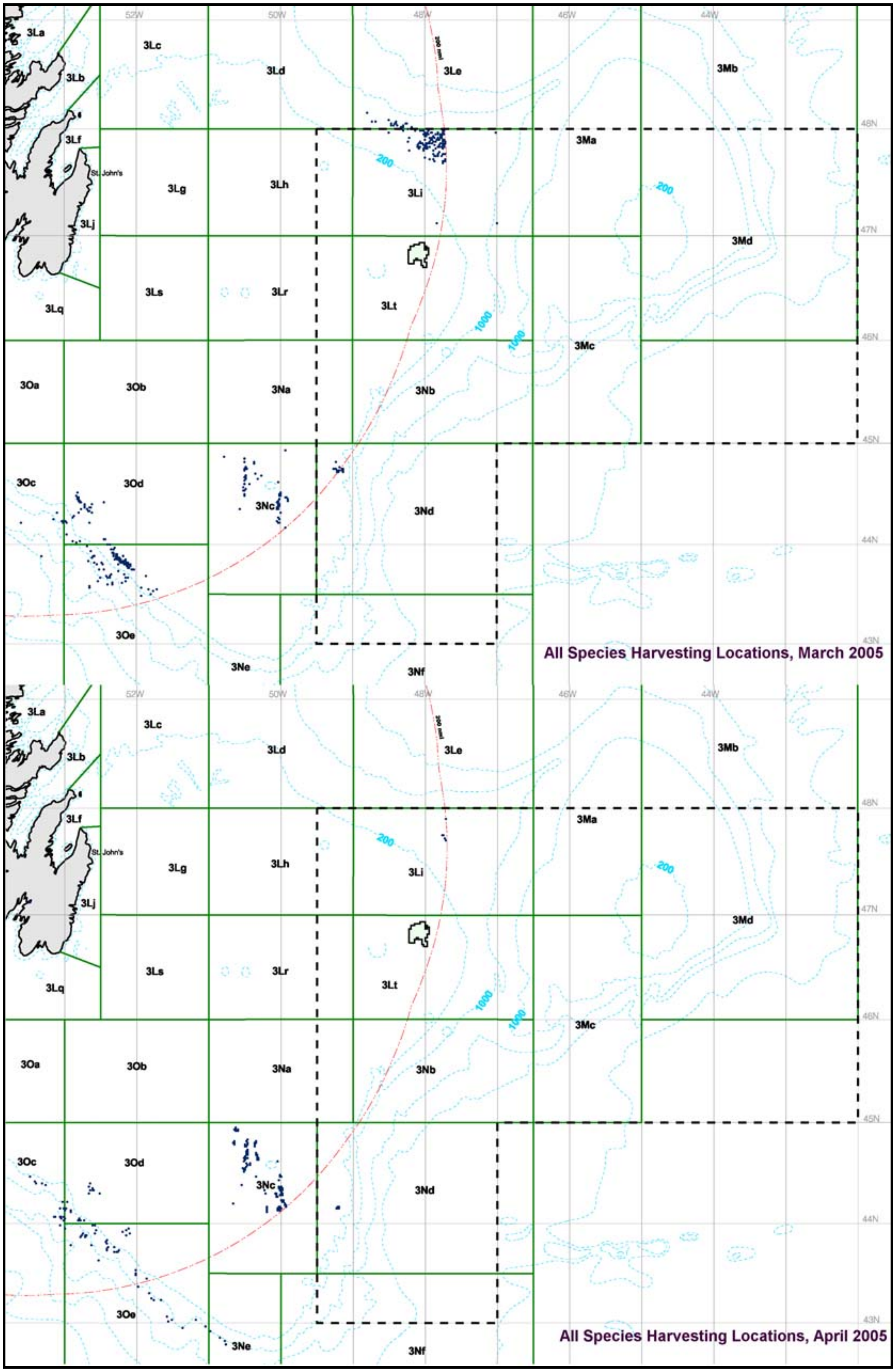

Figure 5.14. Domestic Harvesting Locations, All Species, March – April 2005.

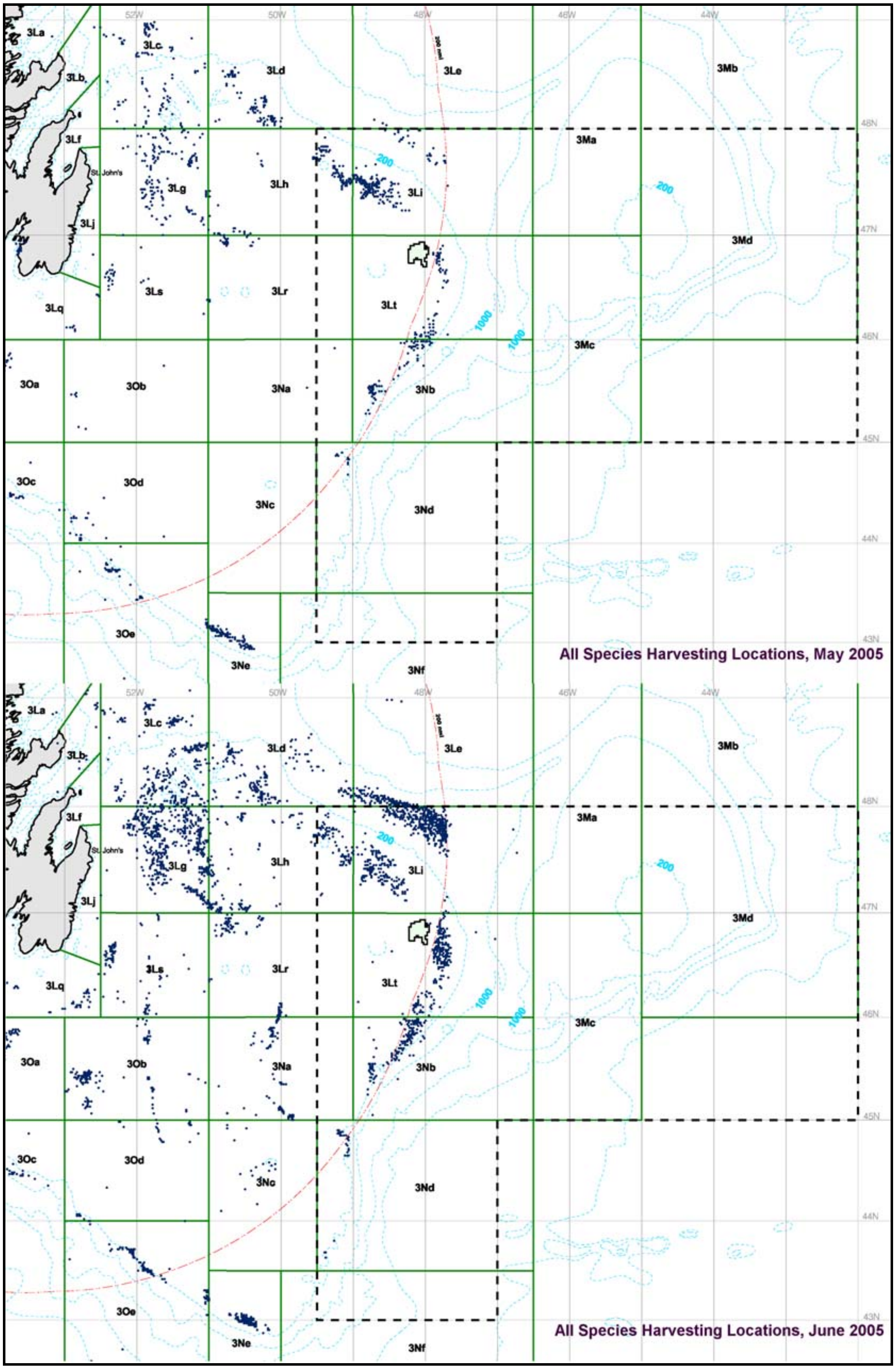

Figure 5.15. Domestic Harvesting Locations, All Species, May – June 2005.

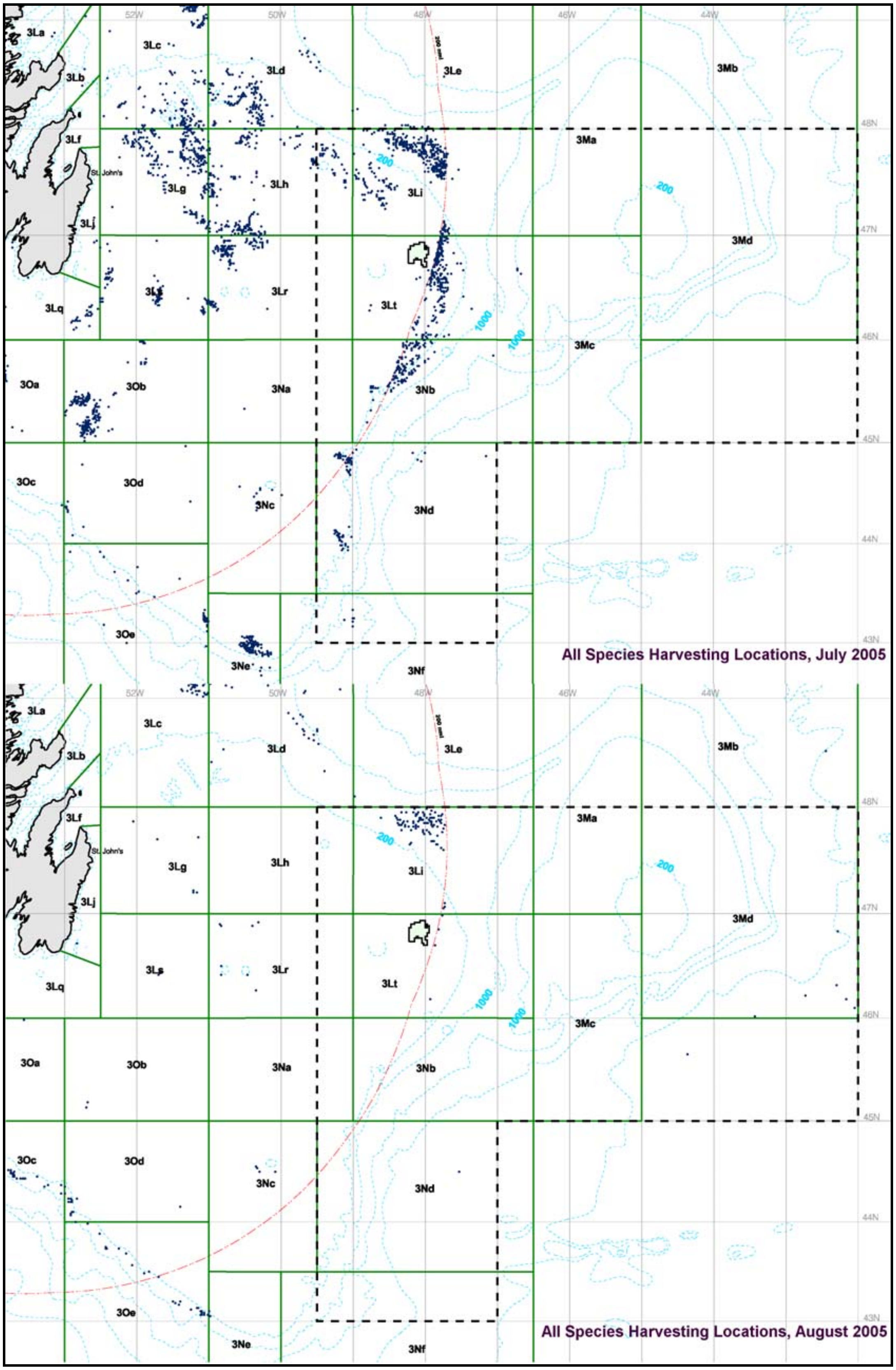

Figure 5.16. Domestic Harvesting Locations, All Species, July – August 2005.

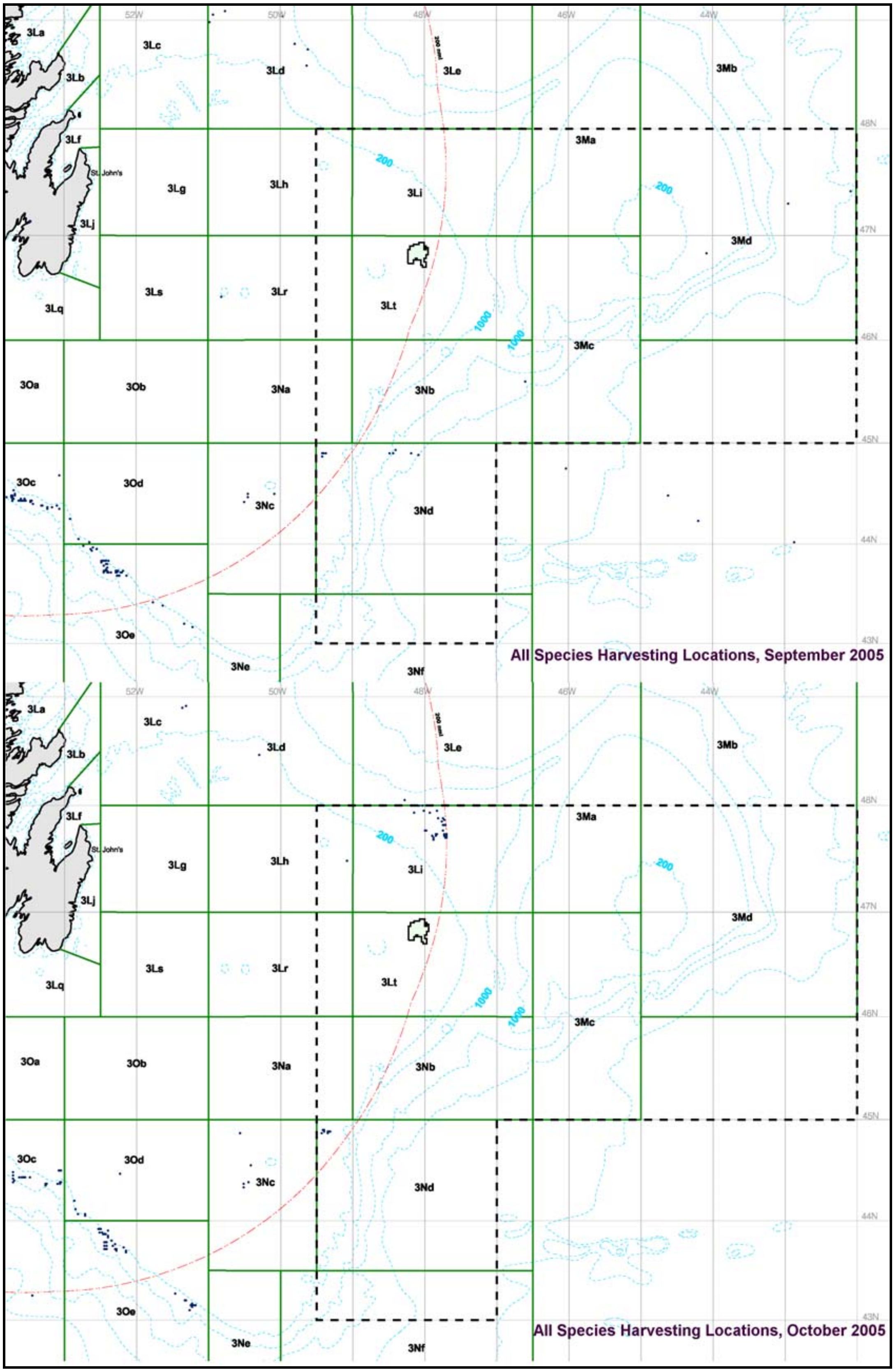

Figure 5.17. Domestic Harvesting Locations, All Species, September – October 2005.

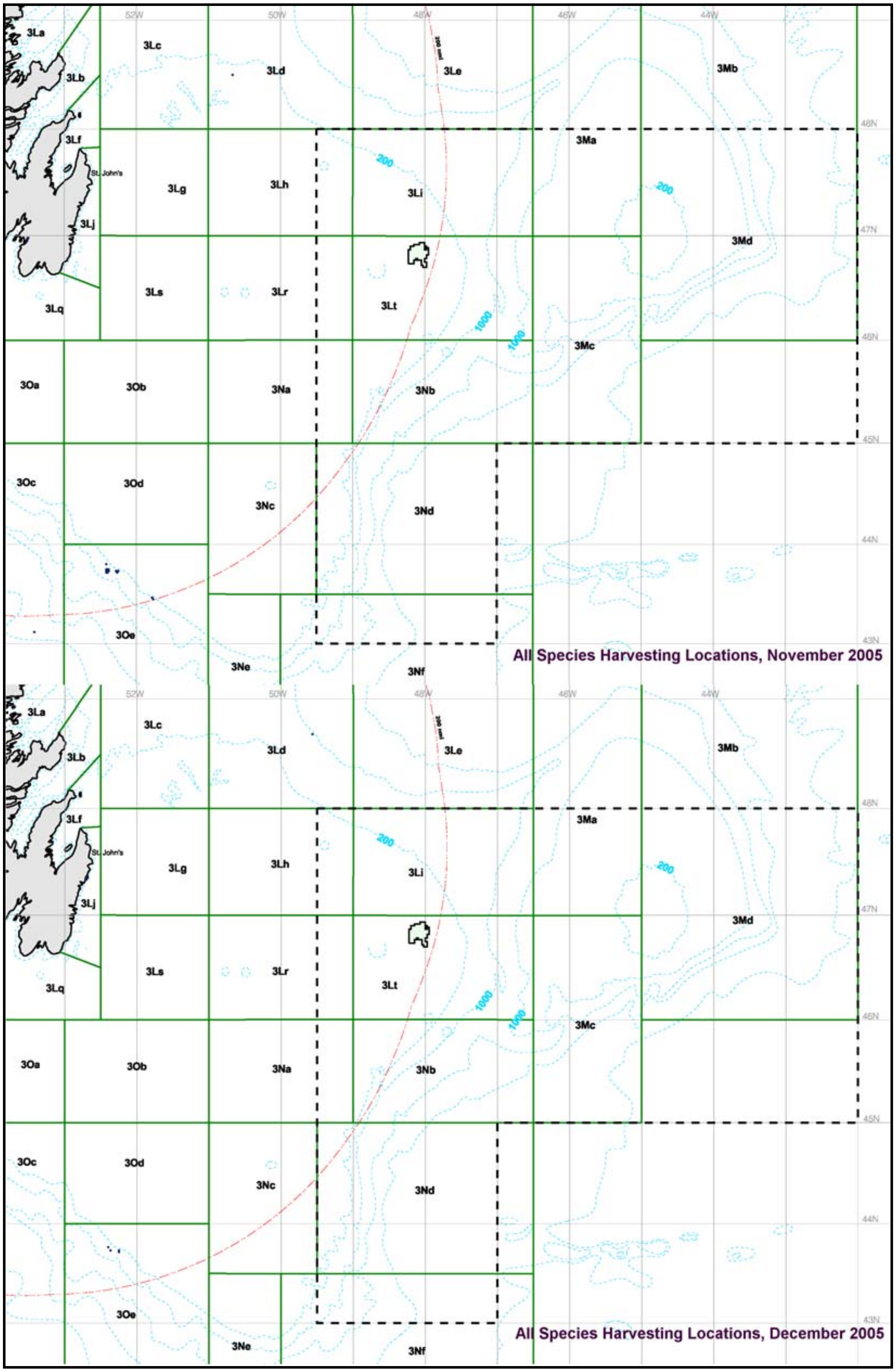

Figure 5.18. Domestic Harvesting Locations, All Species, November – December 2005.

5.6.3.3 Principal Species Fisheries

As indicated in the preceding tables, the domestic harvest within the Study Area has been almost exclusively shrimp, snow crab and offshore clams in recent years. This section describes these Study Area fisheries. In general, fisheries participants and DFO managers consulted expect the main 2005 fisheries in the Study and Project Areas will be similar to those of the past few years, and – as far as can be foreseen at this point - do not expect any major changes in fishing patterns or new fisheries in or near the Project Area in the near future.

5.6.3.3.1 Snow Crab

As noted, snow crab in recent years has constituted an important part (38%, by quantity) of the Study Area harvests in recent years. It is also the only significant fishery expected in or near the Project Area. Within 3Lt, since the mid-1990s, it has accounted for nearly all the annual harvest.

Overall, however, the Newfoundland and Labrador snow crab fishery has declined in both absolute and relative quantity during the past few years. As the most recent DFO status report notes, landings for 2J,3KLNOP,4R snow crab increased steadily from about 10,000 t annually during the late 1980s to 69,000 t in 1999 largely because of the expansion of the fishery in offshore areas. In 2000, landings decreased by 20% to 55,400 t, increased slightly to 59,400 t in 2002 and 2003 and declined to 55,700 t in 2004 with changes in TACs. In 2005, the harvest decreased by 21% to 43,900 t, primarily as the result of a drop in Division 3K landings where the TAC was not taken that year (historically, most of the snow crab landings have been from Divisions 3KL) (DFO 2006c).

DFO (2006c) also observes that, “Negative relationships between bottom temperature and snow crab CPUE have been demonstrated at lags of 6-10 years suggesting that cold conditions early in the life history are associated with the production of strong year classes. A warm oceanographic regime has persisted over the past decade implying poor long-term recruitment prospects.”

DFO (2006c) reports that in Divisions 2J3KLNOP4R the fishery is prosecuted by several fleet sectors under multiple quota-controlled management areas, with more than 3,300 licence holders under enterprise allocation in 2005. Stock status is assessed at the NAFO Division scale, and a vessel monitoring system (VMS) was fully implemented in the offshore fleets in 2004.

The FRCC’s recent *Strategic Conservation Framework for Atlantic Snow Crab* (FRCC 2005) describes the general conduct of the offshore sector: “Vessels fishing up to and beyond 200 miles from the coast conduct voyages up to four and five days and greater depending on the vessel’s holding system. Typically these vessels leave the traps for shorter periods, sometimes only a few hours, prior to retrieving the catch. Given that snow crab must be live at the time of landing and processing, the duration of fishing trips is limited, although some vessels are now able to keep crab live on board in tanks permitting them to extend the length of their trips. Upon landing the live catch, it is weighted at dockside and transferred to shore-based processing facilities where the catch is processed into market ready products on a timely basis. All snow crab catches are independently monitored."

In June 2005, the FRCC's Strategic Conservation Framework recommended to the Minister of Fisheries and Oceans a variety of conservation measures as well as changes to the fishery's management structure. In March 2006, the Minister announced that new management measures would be introduced and others continued for the Newfoundland and Labrador snow crab fishery owing to the uncertainty about future recruitment and the amount of exploitable biomass, as well as concerns about soft-shelled crab (DFO, BG-NL-06-01 and BG-NL-06-02, March 30, 2006). General measures include:

- Shortened fishing seasons in areas to provide additional protection during periods when the incidence of soft-shell crab is high;
- There will be no season extensions; Individual Quotas (IQs) are not a guarantee that the fisher will land that amount of crab;
- Enhanced soft-shell protocols;
- When areas are closed because of a high incidence of soft-shell crab, those areas will remain closed for the remainder of the year;
- Continue with increased observer coverage from 2005;
- In an effort to decrease the levels of wastage of soft-shell and undersized crabs being returned to the water, DFO will shorten fishing seasons and continue education programs with fishers on handling and discard practices;
- The Total Allowable Catch (TAC) for 2006 is 46,233t, reduced from 49,943t in 2005.

For 3LNO specifically, "The discard rate … remains at a lower level and no significant amount of soft shell has been encountered during the recent fisheries which end on July 31. The majority of quotas in these areas, both inside and outside the 200 mile limit, will be rolled over for 2006. In St. Mary's Bay the quota will be increased by 50 t." (DFO, BG-NL-06-02, March 30, 2006).

Figures 5.19 to 5.21 show 2003-2005 snow crab harvesting locations. As the maps indicate, the Project Area at its closest point is several kilometers from any usual concentrations of snow crab fishing, to the east. Most of the Project Area is much farther away than this.

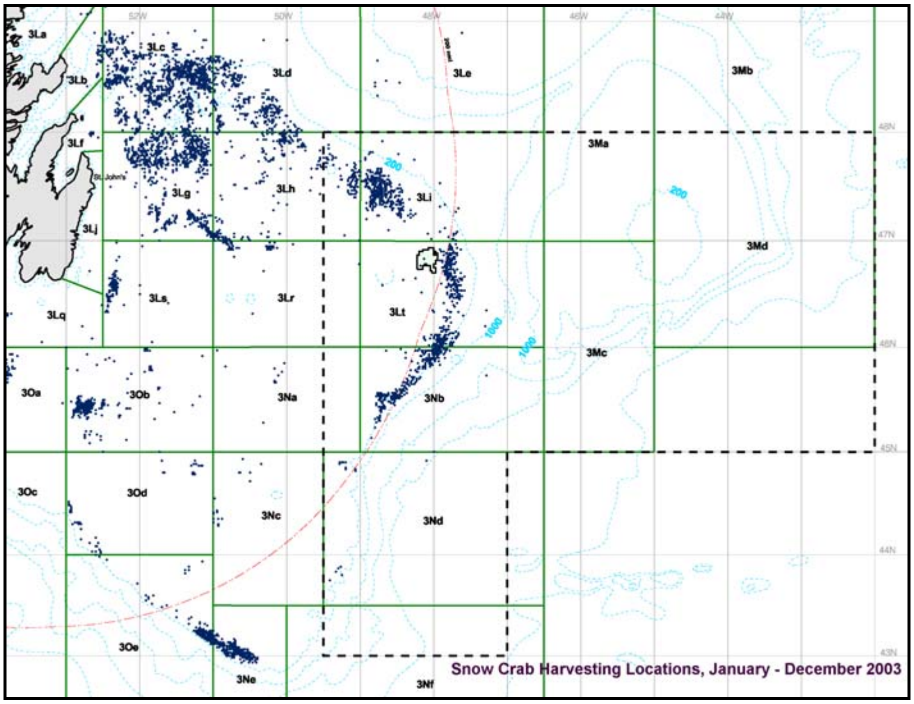

Figure 5.19. Domestic Snow Crab Harvesting Locations, 2003.

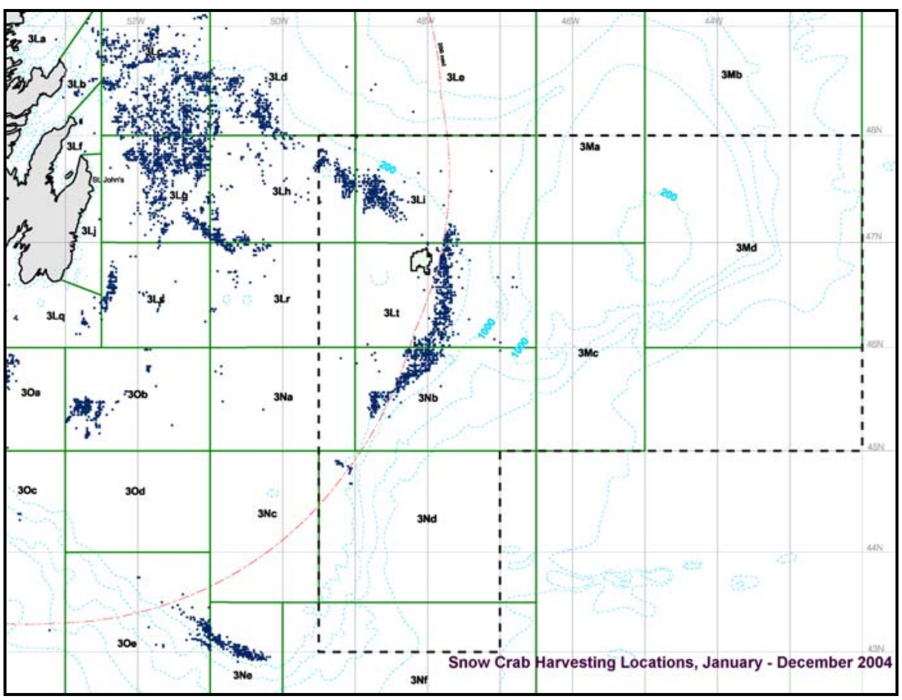

Figure 5.20. Domestic Snow Crab Harvesting Locations, 2004.

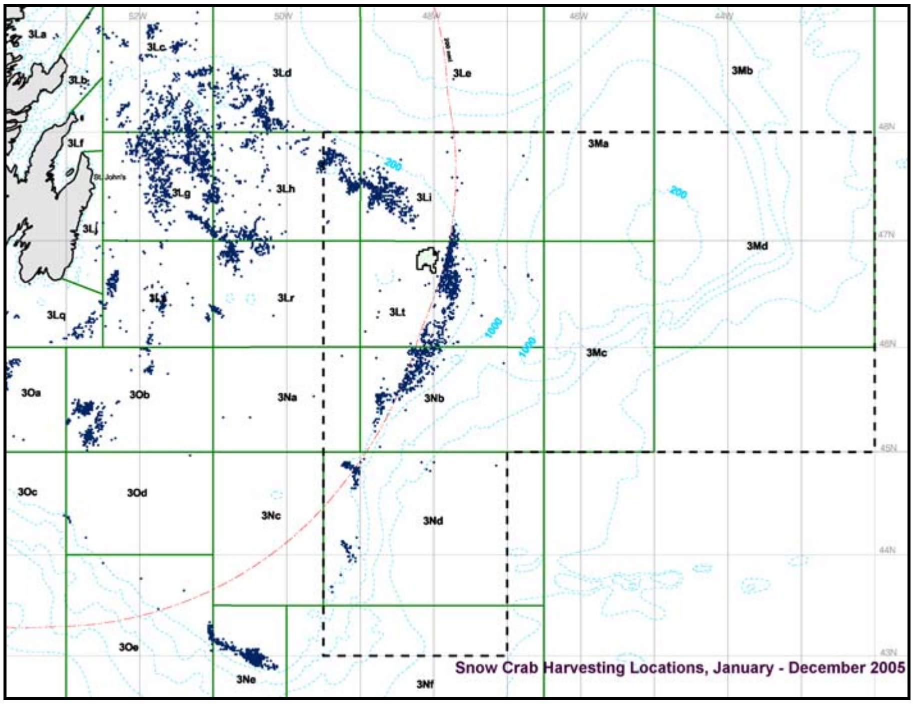

Figure 5.21 Domestic Snow Crab Harvesting Locations, 2005.

The above three figures plus Figure 5.22 show, the main snow crab fisheries in the Study Area occur in crab fishing areas (CFAs) 3Lex (from 170 miles to 200 miles) and 3L200 (beyond 200 miles).

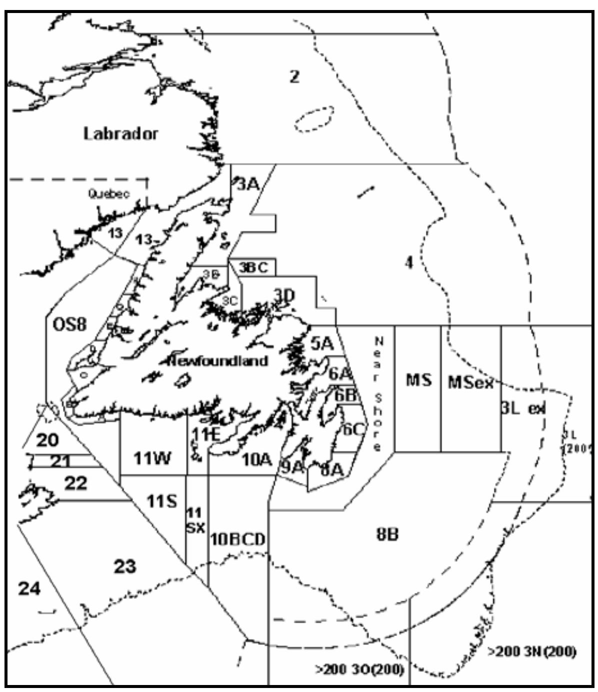

Figure 5.22. Newfoundland Snow Crab Fishing Areas.

The 2005 and 2006 quotas and seasons are shown in Table 5.4.

Table 5.4. 3LNO Snow Crab Quotas and Seasons, 2005-2006.

Year	Quota (Tonnes)	Season
2005	29,748	April 9 –July 31
2006	29,798	April 5 –July 31

Table 5.5 shows the quotas for the 2006 snow crab fishery in relevant portions of 3L.

Table 5.5. Relevant 3L 2006 Snow Crab Quotas.

Licence Category / Quota Definition	Quota (Tonnes)
Full-Time	
Midshore Extended (MSX)	1540
Outside 170 and Inside 200NM (3LX)	1110
Outside 200NM (3L200)	950
SL-Supplementary Large	
Midshore Extended (MSX)	1585
Outside 170 and Inside 200NM (3LX)	1585
Outside 200 NM (3L200)	1990

* See http://www.nfl.dfo-mpo.gc.ca/publications/reports_rapports/Crab_2006.htm

The following graph (Figure 5.23) shows the timing of the Study Area snow crab harvest, 2003 – 2005. In the 2005 season, the start of fishing was delayed owing to a dispute over prices.

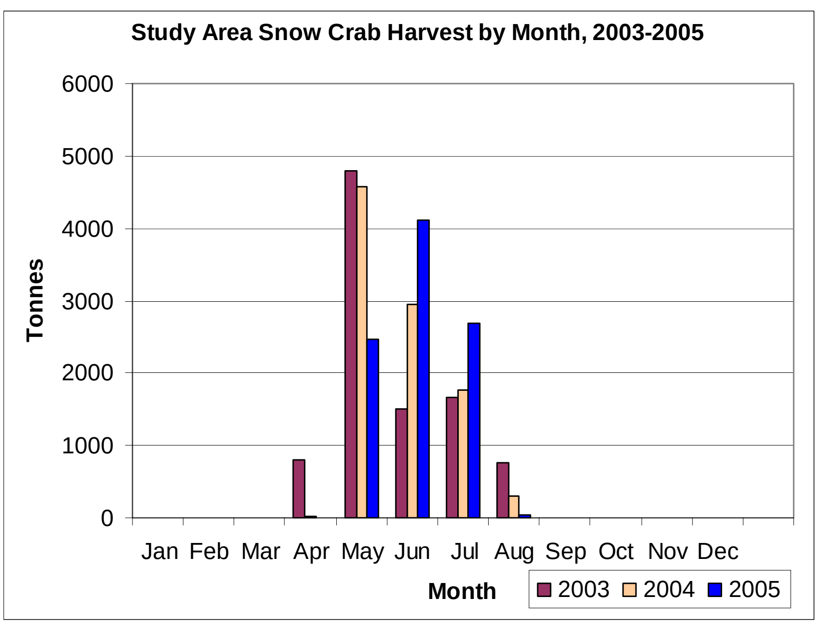

Figure 5.23. Study Area Snow Crab Harvest by Month, 2003-2005.

5.6.3.3.2 Clam Fishery

The second most important fishery (by quantity) in the Study Area in recent years is the clam fishery. This constituted about 34% of the Study Area harvest (2003-2005) (Table 5.3). However, the actual quantity of harvest of these various species over the years indicated is much higher, making it the primary domestic fishery by quantity. The georeferenced Study Area data set used for the present analysis does not capture approximately 60% of the offshore clam harvest in 3N in 2004 and 2005 (i.e. the dataset from DFO does not attach location co-ordinates for most of the 3N mollusc harvest in these two years).

This fishery is primarily for Stimpson's surf clam (*Mactromeris polynyma*), but subject to conservation needs, also allows an unlimited bycatch of Greenland cockles, quahaugs, propeller clams, and other non-quota molluscs (DFO 1998). In recent years, all of the Atlantic Canadian quota for this fishery has been held by Clearwater Partnership. This quota is divided between grounds on Banquereau Bank (30,000 t) on the eastern Scotian Shelf and those on the eastern Newfoundland Grand Banks, in 3N (20,000 t) (DFO 2004). The fishery may be conducted year-round commencing January 1 of each year. Clearwater usually fishes Banquereau first and then moves on to the Grand Banks. The majority of clams in the area has been harvested by a Newfoundland-based vessel (Grand Bank) in recent years, operated by Clearwater.

This fishery occurs in very localized concentrations on beds in the southern portion of the Study Area, near the eastern edge of the Bank. These are all southwest of the Project Area., as shown in Figures 5.24 to 5.26, based on the georeferenced datasets. Because it is a slow-growing species, the harvesting usually occurs on different beds from one year to the next to allow time for the grounds to recover.

According to the 1998-2002 management plan, the most recent for surf clams (DFO 1998), the vessels in the fishery are specialized factory freezer clam vessels, 300' or more, equipped to operate year round. Each vessel has equal allocations for each commercial fishing area (Banquereau and Grand Banks), and each lands product for further processing at separate plants.

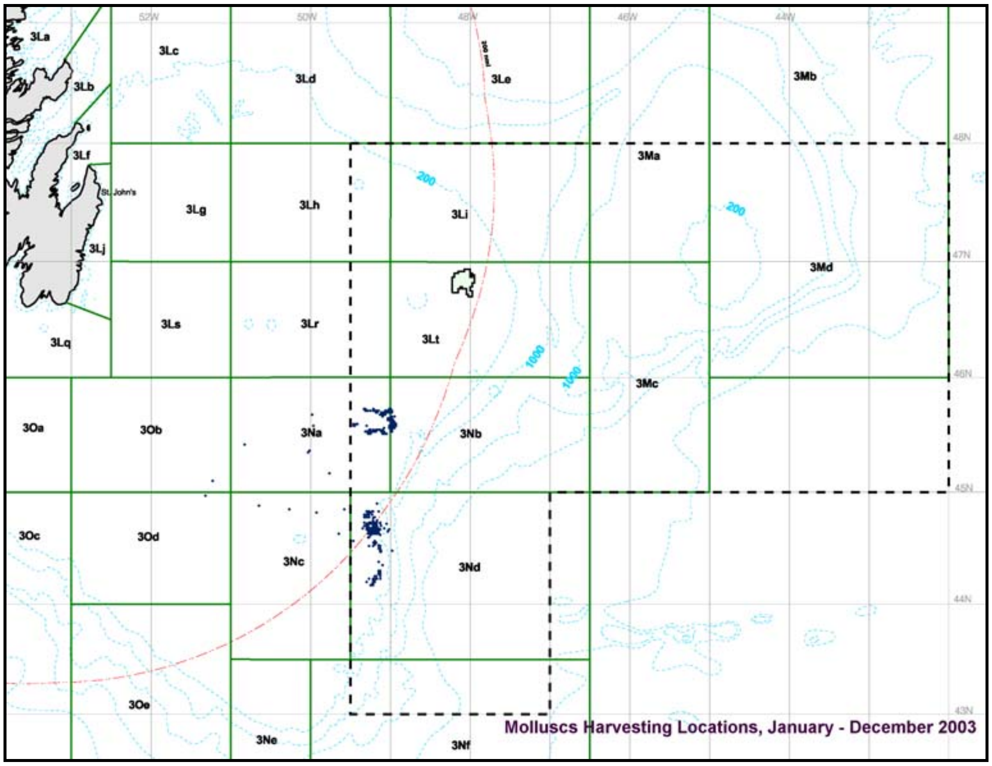

Figure 5.24. Offshore Mollusc Harvesting Locations, 2003.

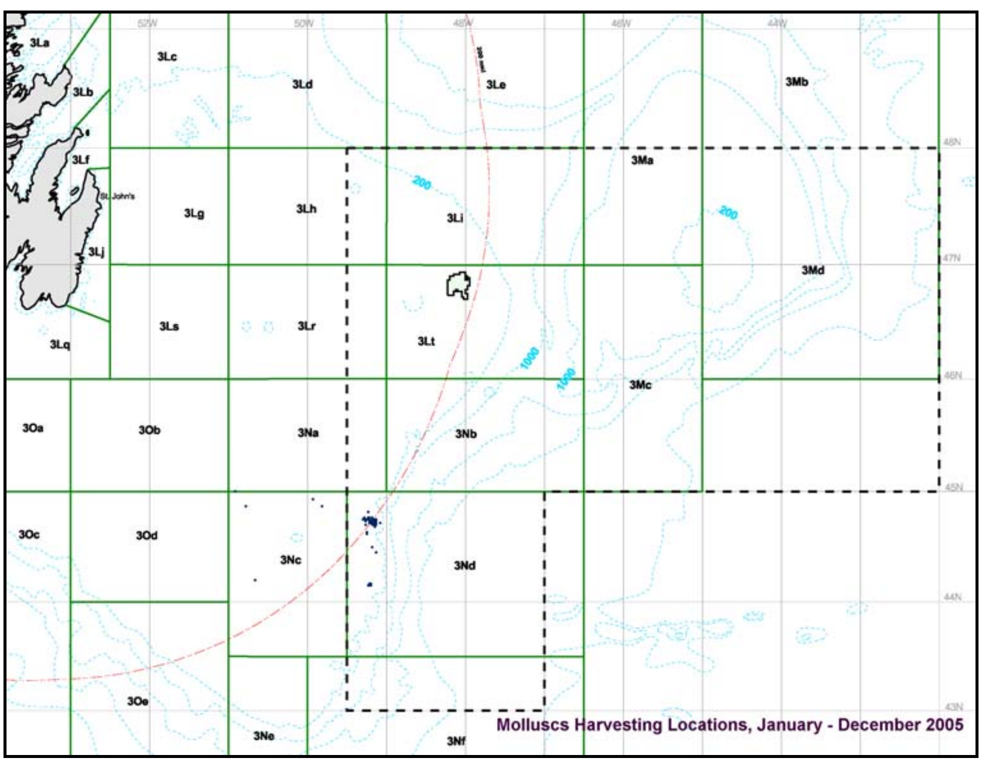

Figure 5.25. Offshore Mollusc Harvesting Locations, 2004.

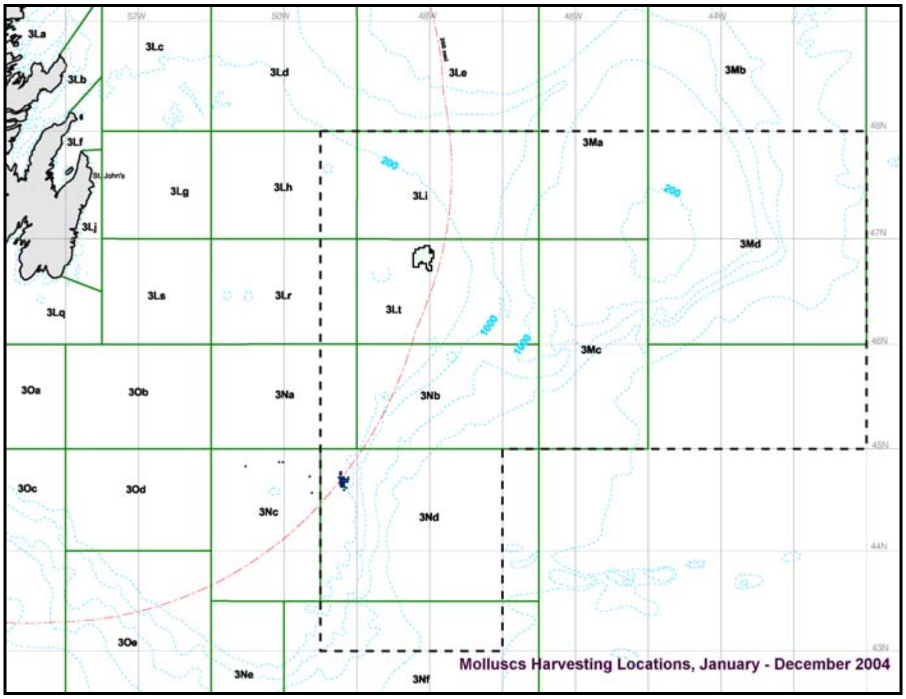

Figure 5.26. Offshore Mollusc Harvesting Locations, 2005.

The following graph (Figure 5.27) shows then Stimpson's surf clam and related species harvest for 2003 – 2004 by month for 3N (the georeferenced Study Area dataset is not used considering the missing georeferenced data in these years).

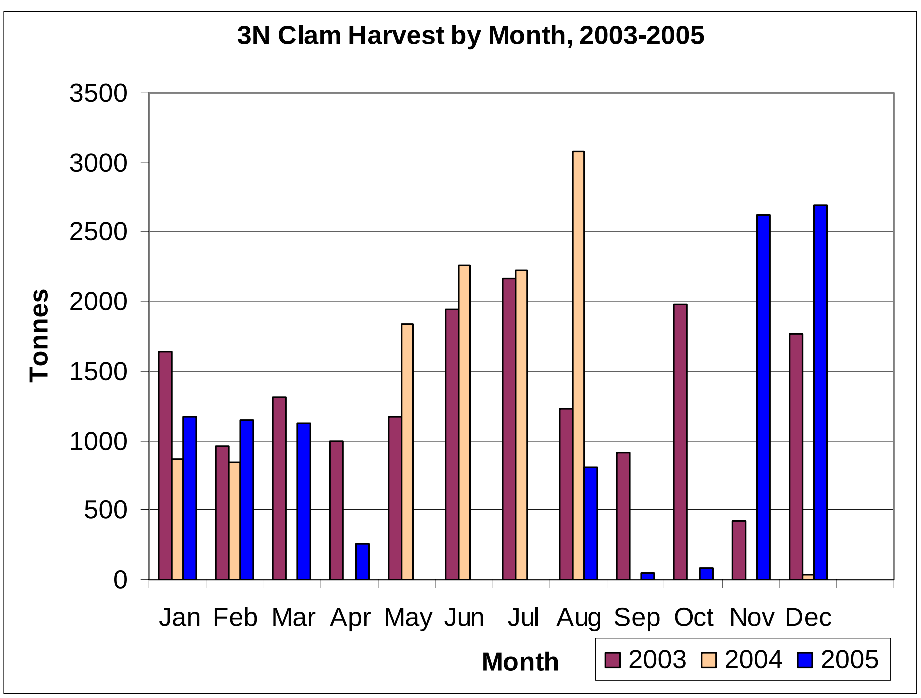

Figure 5.27. 3N Domestic Offshore Clam Harvest by Month, 2003-2005.

Clearwater managers were contacted and sent information on proposed project activities, but to date have not responded with any additional information or concerns.

5.6.3.3.3 Northern Shrimp

Shrimp is another significant species harvested within the Study Area in recent years, making up some 28% of the 2003-2005 harvest by quantity. As the DFO map in Figure 5.28 indicates, the Study Area overlaps with Shrimp Fishing Areas (SFA) 7 and 3M. The following maps (Figures 5.29 to 5.31) show 2003-2005 domestic harvesting locations in relation to the Project and Study Areas. As the maps illustrate, this fishery is quite concentrated in well-defined zones to the north of the Project Area in SFA 7 (3M has foreign harvesting).

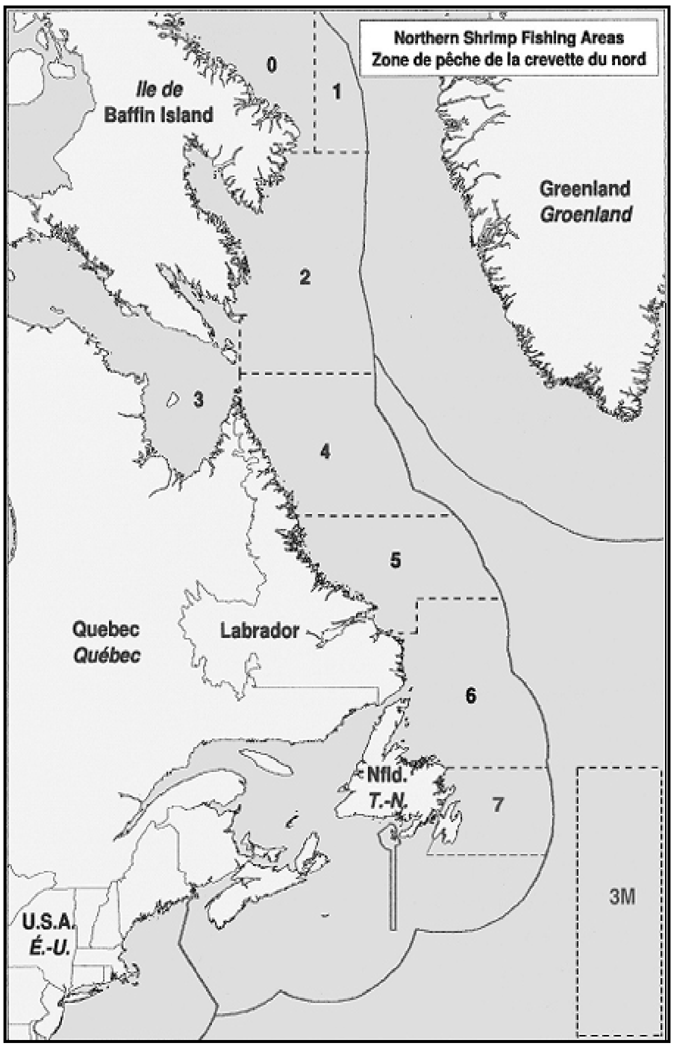

Figure 5.28. Northern Shrimp Fishing Areas.

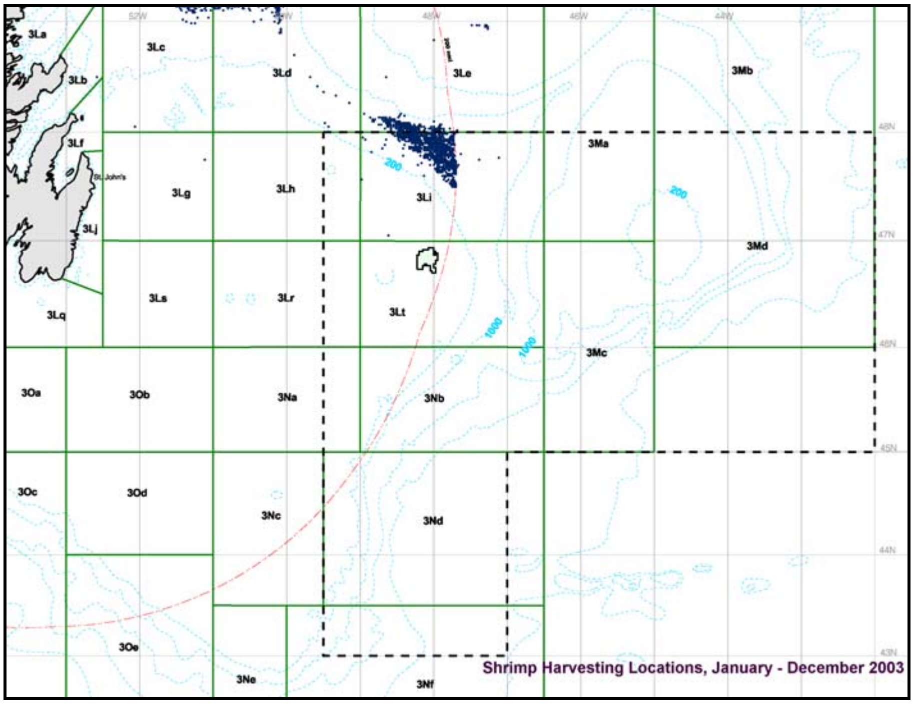

Figure 5.29. Domestic Northern Shrimp Harvesting Locations, 2003.

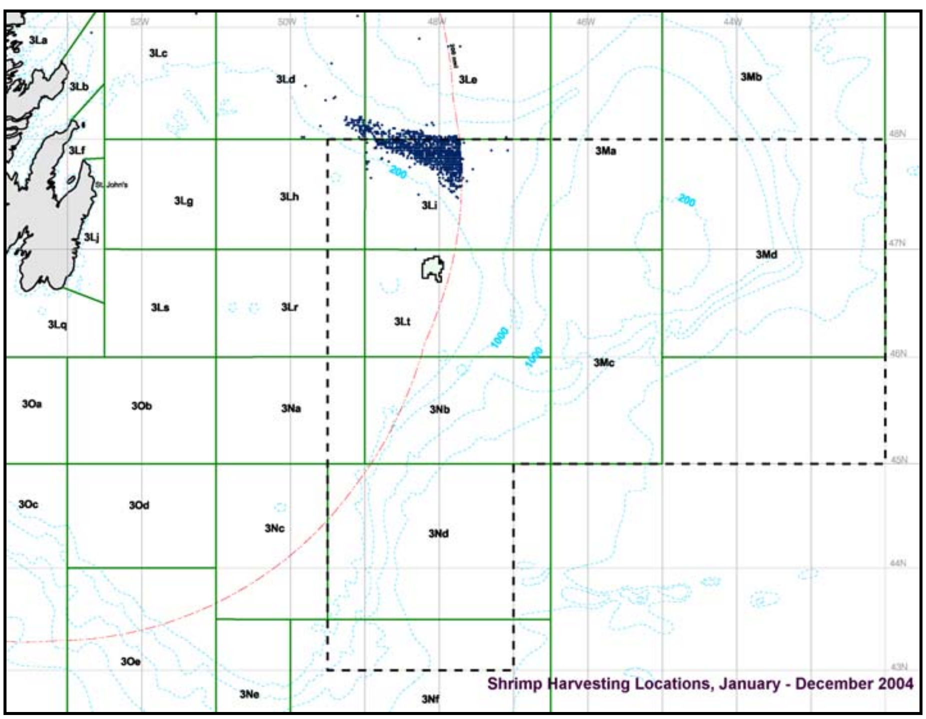

Figure 5.30. Domestic Northern Shrimp Harvesting Locations, 2004.

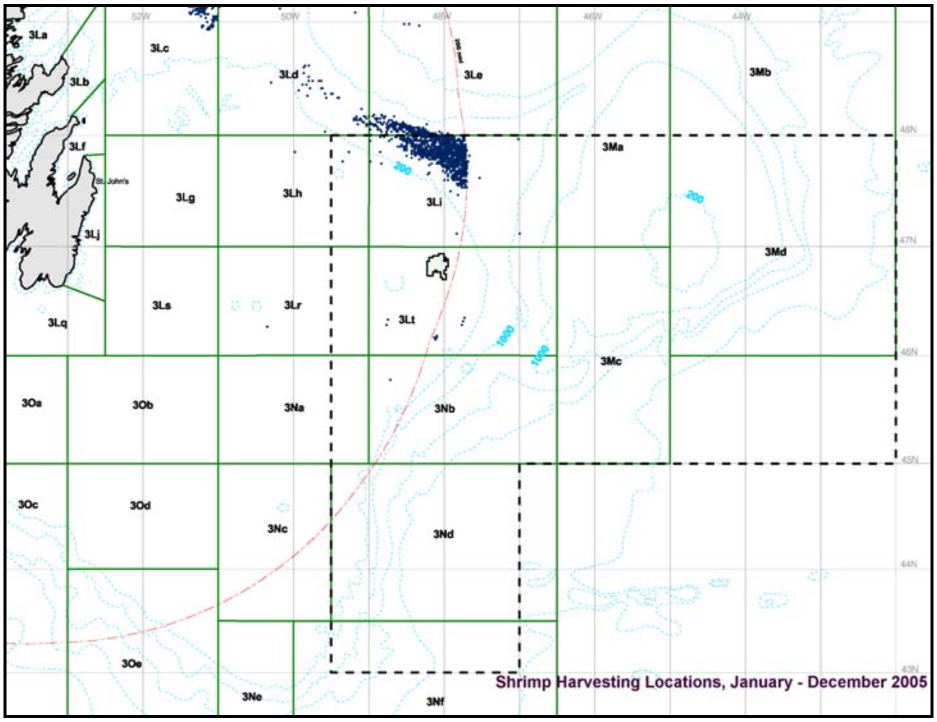

Figure 5.31. Domestic Northern Shrimp Harvesting Locations, 2005.

Table 5.6 shows the 2006 shrimp quotas for SFA 7. Over the anticipated Project timeframe, however, these amounts may change.

Table 5.6. SFA 7 Shrimp Quotas, 2006 (Tonnes).

Area 7 - Offshore > 100' and Special	6,028
Area 7 - 2J Fishers	395
Area 7 - 3K Fishers North of 50'30	395
Area 7 - 3K Fishers South of 50'30	2,886
Area 7 - 3L Fishers	8,621
Total	18,325

Source: http://www.nfl.dfo-mpo.gc.ca/publications/reports_rapports/shrimp_2006.htm

Figure 5.32 graphs the Study Area harvest by month for 2003-2005, indicating that the fishery may be spread throughout most of the year but has tended to be most concentrated (in 2004 and 2005) in June and July.

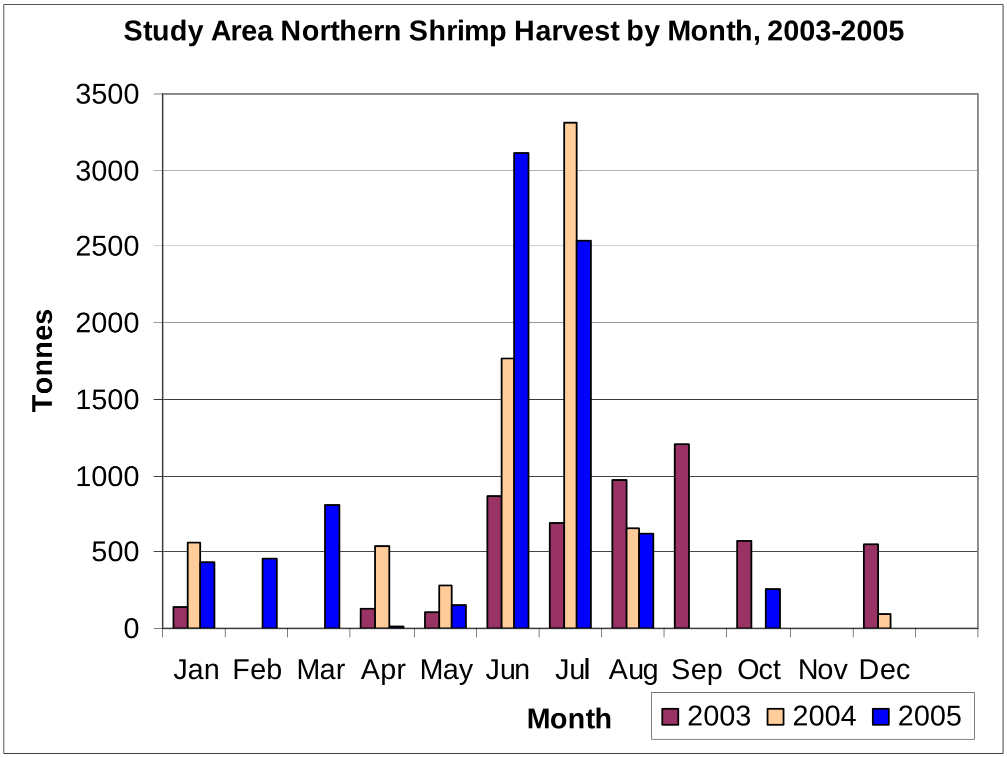

Figure 5.32. Study Area Shrimp Harvest by Month, 2003-2005.

No concerns or issues were raised with respect to Study Area shrimp fisheries during consultations with industry managers.

5.6.3.4 Fishing Gear

Fisheries within the Study and Project Areas are conducted using fixed (crab pots for snow crab) and mobile gear (shrimp trawls for northern shrimp and hydraulic dredges for offshore clams).

5.6.3.4.1 Snow Crab Pots

The amount of gear fishers are permitted to use varies by licence category, and by the area in which a licence holder may be fishing. Crab pots are set on the seabed in strings buoyed at the surface. Crab gear generally has a highflyer (radar reflector) at one end and a large buoy at the other. Some fishers use highfliers at both ends. Depending on weather, they may be left unattended for several days at a time.

Fishers typically try to leave about 20 fathoms (120 feet) on the seabed between each pot. Thus, allowing slack for the anchor ropes on either end of the string to extend upwards at an angle, the distance between the typical highflyer and end-buoy of, for example, a 50-60 pot string of crab gear would be 6,000 feet to 7,500 feet, or approximately 1.8-km to 2.3-km.

5.6.3.4.2 Clam Dredges

The gear used for surf clams is mobile hydraulic dredges, dragged along the sea bottom by the harvesting ship. Sea water is pumped through a large hose in front of the dredge as it is pulled along the sea floor. The jets of water temporarily fluidize the sand and allow the dredge to go through, picking up the clams.

5.6.3.4.3 Shrimp Trawls

The traditional shrimp fishing gear in Newfoundland and Labrador is the shrimp trawl, a modified stern otter trawl, for both inshore and offshore vessels, though some use beam trawls. Fishers are licenced to fish only one gear type (DFO 2003).

Since 1997, it has been mandatory to use a device called a Nordmore grate in shrimp trawls to reduce by-catch of other species. The Nordmore grate is now required in shrimp trawls in all SFAs at all times (DFO 2003a,b).

Previous consultations with the Canadian Association of Prawn Producers, and with relevant fishing companies such as FPI in the past, have indicated that, for the larger ships off Newfoundland and Labrador, tows are typically about 3 hours at speeds of 3-4 kts, but the length of the tow will depend on the rate of the on-board processing plant. In general, the aim is to catch just enough at a time to keep the ship's on board processing facilities well supplied.

5.6.4 DFO Science Surveys

Fisheries research surveys conducted by DFO, and sometimes by the fishing industry, are important to the commercial fisheries to determine stock status, as well as for scientific investigation. Table 5.7 provides the relevant 2006 DFO research survey schedule plan for Newfoundland and Labrador Region (B. Brodie, pers. comm. August 2006) which might overlap with the Study and/or Project Area, though this schedule might change from year to year in the future. For instance, the 2006 schedule and research vessel survey activities are currently being changed and updated as the DFO surveys proceed in response to the availability of relevant research vessels (B Brodie, pers comm., August 2006).

Table 5.7. DFO Survey Schedule, Relevant Areas, Newfoundland and Labrador 2006.

Scientist	Survey	Start	End
B. Brodie (Templeman/Needler)	Multi-species 3LNO	23-May-06	30-Jun-06
B. Brodie (Teleost)	Multi-species 2J 3KLMNO (and possibly 2H)	03-Oct-06	19-Dec-06