4.0 Biological Environment

This section describes the biological environment of the Study Area with emphasis on those components that were used in the assessment of potential effects.

4.1. Species at Risk

The *Species at Risk Act* (*SARA*) was assented to in December 2002 with certain provisions coming into force in June 2003 (e.g., independent assessments of species by 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 8 May 2006 on the websites for *SARA* (http://www.sararegistry.gc.ca/default_e.cfm) and COSEWIC (http://www.cosepac.gc.ca/index.htm).

Species are listed under *SARA* on Schedules 1 to 3 with only those listed as endangered or threatened on Schedule 1 having immediate legal implications. Nonetheless, attention must be paid to all of the *SARA*-listed species because of their sensitivities 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 four cetacean species/populations, one sea turtle species, and three fish species/populations that are legally protected under *SARA* and have potential to occur in the Study Area are listed in Table 4.1. Atlantic wolffish (*Anarhichas lupus*) and Ivory Gull (*Pagophila eburnea*) are listed as "special concern" on Schedule 1 (Table 4.1).

Schedules 2 and 3 of *SARA* identify species that were designated "at risk" by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) prior to October 1999 and must be reassessed using revised criteria before they can be considered for addition to Schedule 1. Species that potentially occur in the Study Area and are considered at risk but which have not received specific legal protection (i.e., proscribed penalties and legal requirement for recovery strategies and plans) under *SARA* are also listed in Table 4.1. 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 concern, are also included in Table 4.1.

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. ConocoPhillips 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.

Table 4.1. *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		
Northern bottlenose whale (SS[c] population)	*Hyperoodon ampullatus*	Schedule 1			X		
Leatherback sea turtle	*Dermochelys coriacea*	Schedule 1			X		
Atlantic salmon (Inner Bay of Fundy population)	*Salmo salar*	Schedule 1			X		
Beluga whale (StLE[d] population)	*Delphinapterus leucas*		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
Fin whale	*Balaenoptera physalus*			Schedule 3			X
Sowerby's beaked whale	*Mesoplodon bidens*			Schedule 3			X
Atlantic cod (LN[e] population)	*Gadus morhua*			Schedule 3		X	
Atlantic cod (NL[f] population)	*Gadus morhua*			Schedule 3	X		

Table 4.1 (cont'd)

SPECIES		*SARA*[a]			COSEWIC[b]		
Atlantic cod (M[g] population)	*Gadus morhua*			Schedule 3			X
Shortnose sturgeon	*Acipenser brevirostrum*			Schedule 3			X
Porbeagle	*Lamna nasus*				X		
White shark	*Carcharodon carcharias*				X		
Winter skate (SGStL[h] population)	*Raja ocellata*				X		
Winter skate (ESS[i] population)	*Raja ocellata*					X	
Cusk	*Brosme brosme*					X	
Shortfin mako	*Isurus oxyrinchus*					X	
American eel	*Anguilla rostrata*						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] St. Lawrence Estuary
[e] Laurentian North
[f] Newfoundland and Labrador
[g] Maritimes
[h] Southern Gulf of St. Lawrence
[i] Eastern Scotian Shelf

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

4.2. Sensitive/Special Areas

Although there may be important feeding areas for fish, marine-associated birds, sea turtles and marine mammals, particularly in localized upwelling areas that may be associated with channels and slopes, there are no designated Marine Protected Areas (MPAs) in the Study Area. The Stone Fence, about 20 km southwest of the southwestern corner of the Project Area, appears to be an important fishery area and concentrations of humpback whales have been observed there (Clapham and Wenzel 2002 *in* JWEL 2003). A four-square mile area of the Stone Fence was closed to bottom fishing by DFO in June 2004. Important redfish spawning and larval release areas may occur along some of the slopes and channels in or near the Study Area. Further discussions of special/sensitive areas are in the relevant sections that follow.

4.3. 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 5.0. The VECs and/or their respective groups are discussed in the following sections.

4.4. 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 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. It has been suggested that the Laurentian Channel is an area of enhanced copepod production (JWEL 2003). Copepods are animals that dominate the plankton of the northwest Atlantic and serve as important food for many species of fish, seabirds and marine mammals.

Since the proposed exploratory drilling has no potential to significantly affect phytoplankton or zooplankton at the ecosystem level, they are not discussed further in this EA except as they affect VECs such as commercial fish or marine mammals.

4.5. Benthos

Benthos include a wide variety of bottom-dwelling animals such as bryozoans, soft and hard corals, anemones, hydroids, sea cucumbers, sea squirts, urchins, sea stars, polychaete worms, clams, crab, lobster, bottom-associated fish (e.g., flounder), and others. A summary of the state of knowledge on benthic communities in the area is contained in the strategic environmental assessment (SEA) (JWEL 2003). While there has not been intensive sampling of the benthos in the area, it is clear that the Project Area contains a diversity of species from all of the above-named groups. This diversity is due to the wide variety of habitats in the Project Area including a wide variety of depths, steep slopes, flat shelves, abyssal plains, and several different substrates.

Some of the benthic invertebrate macrofauna that occur within the Project Area are important as commercial fishery species while others can be considered as potential commercial species. The bivalves known or assumed to occur on banks within the Project Area include deep-sea scallops (*Placopecten magellanicus*), Iceland scallops (*Chlamys islandica*), Arctic surf clams (*Spisula polynyma*), and propeller clams (*Cyrtodaria siliqua*). Crabs known to occur within the Project Area include snow crab (*Chionoecetes opilio*), toad crab (*Hyas* spp.), rock crab (*Cancer irroratus*) and stone crab (*Lithodes maia*). Iceland scallop, deep-sea scallop and snow crab were also highlighted as commercially important invertebrate species in the 'Gulf Block', a large percentage of which lies within this EA's Project Area (Christian et al. 1998). Other invertebrate species that probably occur within the

Laurentian Sub-basin Project Area and were profiled in JWEL (2003) include the northern shrimp (*Pandalus borealis*) and the green sea urchin (*Strongylocentrotus droebachiensis*). While sea urchins remain on bottom at all times (except for egg and larval stages), the northern shrimp migrates vertically between bottom water and the upper water column. However, for the purposes of this EA, northern shrimp is considered benthic. Spatial and temporal specifics regarding the occurrence and reproduction of these benthic invertebrates are presented in Tables 4.2 and 4.3. Two of the species included in these two tables (snow crab and short-finned squid) are considered in greater detail in subsequent sections.

Table 4.2. Notable Invertebrate Macrofauna Known or Likely to Occur within the Study Area.

Species	Location	Timing
Snow crab[1]	St. Pierre Bank Banquereau Bank Slope regions of Laurentian Channel	Year-round
Northern shrimp[2]	St. Pierre Bank Laurentian Channel	Year-round
Deep-sea scallop[2]	St. Pierre Bank	Year-round
Iceland scallop[2]	St. Pierre Bank	Year-round
Arctic surf clam[2]	Likely St. Pierre Bank Banquereau Bank	Year-round
Stone crab[2]	Laurentian Channel	Year-round
Toad crab[2]	Likely St. Pierre Bank	Year-round
Propeller clam[2]	Likely St. Pierre Bank Banquereau Bank	Year-round
Rock crab[2]	St. Pierre Bank	Year-round
Sea urchin[2]	St. Pierre Bank	Year-round
Ocean quahog[2]	Banquereau Bank	Year-round
Short-finned squid[2]	St. Pierre Bank Banquereau Bank Slope regions of Laurentian Channel	Summer: Banks Spring and fall: Slope regions

[1] DFO 2005a
[2] Adapted from Table 3.8 *in* JWEL (2003).

Table 4.3. Notable Invertebrate Macrofauna Known or Likely to Spawn within the Study Area.

Species	Location	Timing	Duration of Planktonic Stage
Snow crab[1]	St. Pierre Bank Banquereau Bank Possibly along some upper slope regions	Mating in early spring Fertilized eggs carried by female for 2 years Larval hatch in late spring/early summer	Larvae: 12 to 15 weeks
Northern shrimp[2]	St. Pierre Bank Laurentian Channel	Spawning in late summer/fall Fertilized eggs carried by female for 8 to 10 months Larval hatch in the spring	Larvae: 12 to 16 weeks
Deep-sea scallop[2]	St. Pierre Bank	August to October	30 to 60 days
Iceland scallop[2]	St. Pierre Bank	Late summer/early fall	~ 5 weeks between fertilization and settlement
Arctic surf clam[2]	St. Pierre Bank Banquereau Bank	Fall	3+ weeks
Stone crab[2]	Laurentian Channel	Unknown	Larvae: Up to 3 months
Toad crab[2]	Unknown	Unknown	Larvae: 1+ months
Propeller clam[2]	Unknown	Unknown	Unknown
Rock crab[2]	Likely St. Pierre Bank	Eggs extruded in October Larval hatch in spring/summer	Larvae: 5 to 8 weeks
Sea urchin[2]	St. Pierre Bank	Early spring	Eggs and larvae: 8 to 12 weeks

[1] DFO 2005a; 2006a

[2] Adapted from Table 3.9 *in* JWEL (2003).

Potentially important areas near the Project Area include the "Stone Fence" to the southwest and an area to the southeast where rare chemosynthetic communities have been found. The Stone Fence is about 20 km to the southwest of the western boundary of the Project Area whereas the chemosynthetic communities encompass an area of approximately 50 km^2, about 60 km southeast of the Project Area (Petrecca and Grassle 1987 *in* JWEL 2003). The Stone Fence, an area of rock and coral outcrop, is located on the southwestern side of the Laurentian Channel along the shelf break of Banquereau Bank.

It is important because it provides habitat diversity. The ecological significance of chemosynthetic communities is unknown but they are afforded protective status because of scientific interest in the Gulf of Mexico where they were discovered in 1984 (Gallaway et al. 2001).

Mayer et al. (1988) describe benthic communities occurring at a location approximately 50 km south of the Study Area and 120 km south of the Project Area. This site within the Laurentian Fan has a water depth of 3,850 m. Megafauna at this site included holothurians, asteroids, stalked organisms, shrimp, bivalves, gastropods, polychaetes, and crabs. The infauna-dominated communities described by Mayer et al. (1988) resemble those described from hydrothermal vent areas (Hessler and Smithey 1983, Paull et al. 1984 *in* Mayer et al. 1988). Mayer et al. (1988) suggest that the substantial biomass found at depths greater than 3,800 m on the Laurentian Fan implies that the biological communities there are sustained by chemosynthetic processes.

4.5.1. Deepwater Benthic Sampling at Other Locations

Knowledge of the biotic and abiotic features of deepwater areas is extremely limited. Some of the more notable work that has been done on deepwater benthos is briefly discussed in this section.

During the 1980s, the Mineral Management Services (MMS) funded benthic sampling on the US Atlantic continental shelf. This work has become a major source of knowledge of macrofauna on the continental slope. This MMS-sponsored sampling indicated that the number of species inhabiting deepwater sediment had been previously underestimated (Blake et al. 1985 1987; and Macoilek et al. 1987a,b *in* Gage 1996).

In the early to mid-1980s, the High Energy Benthic Boundary Layer Experiment (HEBBLE) was conducted at a deepwater location (>4,000 m) south of Nova Scotia, approximately 600 km southwest of the Study Area. HEBBLE's primary objective was to develop and test predictions about the response of marine sediments to imposed and controlled stresses. The experiment included investigations of deepwater benthic communities (Nowell and Hollister 1985).

Thistle et al. (1985) provided an overview of the structure of the benthic community at the deepwater site on the Nova Scotian continental rise. Abundances of polychaetes, bivalves, isopods and tanaids are conspicuously high compared to those reported at other locations around the world with comparable depths. Thistle et al. (1985) speculate that these high relative abundances result from enhanced food availability caused by strong near-bottom currents that flow through the area. Daily average current velocities at 10 m above bottom in this region have been measured at 20 to 25 cm s^{-1} (Weatherly and Kelley 1983 *in* Thistle et al. 1985), much higher than the 3 cm s^{-1} typical of abyssal conditions (Munk et al. 1975 *in* Thistle et al. 1985). Much of the sediment passage to the HEBBLE region is presumed to originate from the Laurentian Fan on the upper Nova Scotia Rise. Standing stocks of polychaetes, bivalves and tanaids appear to be relatively constant at the HEBBLE site despite the dynamic nature of the physical environment. This constancy reflects the burrowing nature of these benthic animals which prevents them from being swept away. Abundances of epibenthos such as isopods and harpacticoids, on the other hand, show considerable variability, indicating these animals' vulnerability to being swept away by bottom currents/sediment movement (Hollister and Nowell 1991; Thistle et al. 1991; Thistle and Wilson 1996). Based on findings by Wheatcroft et al. (1989 *in* Hollister and Nowell 1991), it appears that biologically produced sediment surface roughness (microtopography) likely plays an important role in initiating sediment transport at a site because the unevenness can locally increase boundary shear stress.

4.5.1.1. Deepwater Corals

There has been increasing interest in deepwater corals in recent years because of their likely sensitivity to disturbance, their long generation times, scientific interest, and other factors.

These benthic invertebrates generally occur on the ocean bottom at depths exceeding 150 m (often >200 m in Atlantic Canada). Some of these filter-feeding animals form reefs while others are much smaller and remain solitary. Corals add structural complexity to ocean bottom habitats that may otherwise be relatively featureless. It is generally accepted that coral habitats are areas of high biological diversity (Breeze et al. 1997; MacIssac et al. 2001).

The most widely accepted theory for the formation of deep-water reefs is that corals establish themselves at locations on the seafloor where there is a continuous and regular supply of concentrated food and/or nutrients, in the form of zooplankton, caused by the flow of a relatively strong current over special topographical formations which cause eddies to form. There is also belief that nutrient seepage from the sub-stratum might also promote a location for settlement (Hovland et al. 2002).

Four major groups of deep-water corals occur in eastern Canadian waters: (1) Alcyonacea (soft corals), (2) Gorgonacea (horny corals), (3) Scleractinia (stony corals), and (4) Antipatharia (black corals). Most deep-water corals are found in areas where water depths exceed 200 m (i.e., edge of continental slope, canyons, channels between fishing banks). Some soft corals do occur in shallower waters on the continental shelf (Mortensen et al. *in press*).

Mortensen et al. (*in press*) used numerous information sources in their summary of the research of deep-water corals and their habitats in Atlantic Canadian waters. These information sources include the following: (1) DFO trawl surveys, (2) fisheries observers, (3) interviews with fishers (i.e., local ecological knowledge or "LEK"), (4) imaging gear known as Campod, (5) video-grabs, and (6) ROV. Campod and ROV surveys were limited to a maximum depth of 500 m. These sampling methods have provided information on coral habitat and associated fauna, coral morphology, coral age, and coral behaviour.

Of the seventeen deep water stations (1,000-1,500 m to 2,500-3,000 m) located off the Scotian Shelf that were characterized using sediment grabs and underwater photography during an environmental assessment of exploration drilling for Marathon Canada Limited (JWEL 2003), corals were observed at six of them. Primary coral habitat was observed at stations where depths were ≤ 1,500 m. Deep-water corals are known to occur in regions off the west coast of Ireland (e.g., Rockall Trough, Porcupine Seabight). Water depths where corals occur in this region typically range from 150 to 1,000 m.

DFO Trawl Surveys

Between 1999 and 2001, research trawl surveys conducted off Nova Scotia, Newfoundland and Labrador, and in the Arctic region collected 57 deep-water coral specimens (Gass 2002). There were seven species comprising this collection:

- *Acanella arbuscula*
- *Acanthogorgia armata*
- *Flabellum* spp.
- *Keratoisis ornate*
- *Paragorgia arborea*
- *Paramuricea* spp.
- *Primnoa resedaeformis*

The corals were generally distributed along the edge of the continental shelf. All but *Flabellum* spp. and *K. ornate* were collected during trawl surveys in waters off Newfoundland and Labrador. Table 4.4 presents information relating to those coral specimens (all gorgonian) collected in Newfoundland and Labrador waters.

Table 4.4. Depth Ranges of Corals Based on DFO Groundfish Trawl Surveys and the Fisheries Observer Program.

Species[1]	Average Depth (m)	Minimum Depth (m)	Maximum Depth (m)	Standard Deviation
Acanella arbuscula	622	281	1,400	365
Acanthogorgia armata	551	164	1,400	579
Paragorgia arborea (Bubblegum coral)	361	249	720	107
Paramuricea spp. (Black coral)	598	154	1,159	411
Primnoa resedaeformis (Sea corn)	319	166	467	75

[1] Only species found to date in Newfoundland and Labrador waters are considered.

Edinger et al. (2005) mapped coral distributions in Newfoundland and Labrador waters using coral samples and records from DFO research vessel survey trawls between fall 2003 and winter 2005, and fisheries observers aboard commercial fishing vessels during the April 2004 to March 2005 period. A total of nineteen species of corals were recorded, including seven horny corals (gorgonians), three soft corals (alcyonareans), six seapens (pennatulaceans), two cup corals (scleractinians), and one black coral (antipathians). The corals were broadly distributed along the edge of the continental shelf, mostly at depths exceeding 300 m. Only soft corals were found at depths less than 170 m and temperatures less than 1.1ºC. Locations of multi-coral species assemblages (a.k.a. "coral hotspots") in Newfoundland waters included the mouth of Haddock Channel which occurs within the east side of the Project Area, and on the slope of the southwestern Grand Bank, just east of the Study Area. Both Gorgonians and soft corals have been found at these locations. The authors indicate the need for further research on the distributions of deep-sea corals in Newfoundland and Labrador waters.

Fisheries Observers

During 2000 and 2001, fisheries observers recorded the instances of coral ensnared in commercial fishing gear. Bottom longlines accounted for the greatest number of coral captures, compared to otter trawls, shrimp trawls, and bottom gillnets (Gass 2002)

Fisher Information (LEK)

Local ecological knowledge (LEK) of fishers is also an important source of information on corals occurring in Newfoundland waters. Some of the coral occurrence locations indicated by fishers include the following:

- Slope at southern Laurentian Channel
- Slope at southern St. Pierre Bank and Halibut Channel
- Slope near South Whale
- Slope on southeastern 'Tail' of Grand Bank
- Slope on eastern side of northern Flemish Pass (near southern limit of Orphan Basin Project Area)
- Shallow slope area of northeastern Newfoundland shelf (northern 3L and southern 3K)
- Slope off southern Labrador
- Slope off Cape Chidley

Based on interviews with fishers, shrimp trawls caught at least 49 coral specimens off Newfoundland between 2000 and 2001.

Litvin and Rvachev (1963 *in* Gass 2002) mapped the locations of corals with respect to Newfoundland and Labrador fishing areas. According to their work, corals are found on the southern edge of St. Pierre Bank, on the northeastern edge of the Grand Banks across from the Flemish Cap, on the Flemish Cap, and on the continental shelf between 51º and 52º N.

Video Imagery

Results from video imagery were provided by quantitative analyses of video collected along 195 transects in various geographic regions including the Northeast Channel, the Scotian Slope, The Gully, The Stone Fence, the Laurentian Channel, and the southern edge of the Grand Banks (Mortensen et al. *in press*).

Imaging gear from BIO was used to directly observe the corals in their natural habitat, associated species, and community structure (MacIsaac et al. 2001). Reviews of video and photos did not indicate any disproportionate concentrations of fish near corals or any unique fish species associated with corals. Adult fish fauna consisted of species that were expected to be common along the shelf and slope at similar depths. No fish were observed interacting directly with any coral colony (i.e., feeding off or holding up among the branches). No juvenile fish were observed in the vicinity of coral colonies. Only redfish were observed consistently co-occurring with deep-water corals in Atlantic Canadian waters. There was not any strong direct evidence to suggest that the densities and types of corals observed are locally important feeding and/or nursery areas for fish. Invertebrates, on the other hand, were observed interacting with various corals but the specifics of these interactions are still not understood.

Coral Species Found off Newfoundland and Labrador

Acanella arbuscula

Colonies of this coral are characterized by small branches and an anchor-like, branched base structure which anchors the colony in soft substrates. Colonies are stiff but delicate and are usually less than 15 cm high. This coral typically occurs on muddy or sandy-muddy bottom.

During trawl surveys conducted between 1999 and 2001, there was only one record of this species in waters off Newfoundland and Labrador. It occurred at a location on the ‘Tail’ of the Grand Bank at a water depth of 1,400 m. The Atlantic Canadian depth range of collected specimens is 281 to 1,400 m (Table 4.4).

Acanthogorgia armata

This coral occurs in branched colonies which are flexible and resemble a small bush. Most colonies of this coral stand less than 20 cm high although there are reports of colonies as high as 50 cm. *A. armata* typically occurs on muddy or sandy-muddy substrate.

Mortensen and Buhl-Mortensen (2004) described the study of the distribution and abundance of deep-water gorgonian corals along 52 camera/ROV transects at a depth range of 183 to 498 m in the Northeast Channel between Georges Bank and Browns Bank. One of the coral species observed was *A. armata*. This coral were more common in the outer part of the channel along the shelf break and slope than on the inner shelf. Transects with highest abundances of coral were characterized by depths

>400 m, maximum water temperatures <9.2ºC, and a relatively high percentage of coverage of cobble and boulder (i.e., more than 19% and 6%, respectively). Observations also indicated that the coral abundance is also controlled by such factors as larger-scaled topographic features governing current regimes (i.e., supply of food and larvae). During trawl surveys conducted between 1999 and 2001, there was only one record of this species in waters off Newfoundland and Labrador. It occurred at a location on the 'Tail' of the Grand Bank with a water depth of 1,400 m. The Atlantic Canadian depth range of collected specimens is 164 to 1,400 m (Table 4.4).

Paramuricea spp.

The two species (known as 'black coral') of this genus are difficult to distinguish without microscopy. Colonies are fan-like and the branches are arranged in loose and irregular patterns in one plane. The skeleton of this coral is flexible. The colonies, which stand as high as 50 cm, are typically attached to gravel and bedrock. Three Newfoundland region DFO survey sets conducted between 1999 and 2001 collected specimens of this coral. All catches were made on the continental slope east of Newfoundland in water as deep as 1,159 m. The Atlantic Canadian depth range of collected specimens is 154 to 1,159 m (Table 4.4).

Primnoa resedaeformis

This coral ('sea corn') is characterized by densely branched colonies that give the appearance of small trees or bushes. The 'trees/bushes' can be as high as one metre. *P. resedaeformis* is typically attached to gravel and bedrock, especially in channels and canyons.

Mortensen and Buhl-Mortensen (2004) described the study of the distribution and abundance of deep-water gorgonian corals along 52 camera/ROV transects at a depth range of 183 to 498 m in the Northeast Channel between Georges Bank and Browns Bank. One of the coral species observed was *P. resedaeformis*. The highest abundance of colonies for *Primnoa* was found along transects with average temperatures between 5.3 and 6.5ºC. *Primnoa* occurred over a wider temperature range (maximum temperature = 12.1ºC) than co-occurring *Paragorgia* (maximum temperature = 9.7ºC). Salinities ranged from 33 to 35‰.

Manned submersible observations of *Primnoa* spp. were also made in the Gulf of Alaska (Krieger and Wing 2002). *Primnoa* colonies were attached to boulders or bedrock, although less than 1% of the boulders had *Primnoa* colonies. Predators on the *Primnoa* polyps included sea stars, nudibranchs, and snails. Suspension-feeders occurring on the coral included crinoids, basket stars, anemones, and sponges. Various protection seekers, including rockfish, crab and shrimp were also observed in apparent association with the coral colonies. Mating king crabs were observed.

Specimens of this coral species were collected during three survey sets conducted between 1999 and 2001 in waters off Newfoundland and Labrador. There were 33 records off Cape Chidley, Labrador, and one further south on the edge of the Labrador Shelf. Almost 70% of the records off the northern tip of Labrador were collected in water depths ranging from 381 to 463 m. The remaining specimens were collected from locations with water depths ranging from 324 to 380 m. The Atlantic Canadian depth range of collected specimens is 166 to 467 m (Table 4.4).

Paragorgia arborea

The colonies of this coral ('bubblegum coral') are tree-like, fan-shaped, brittle and easily broken. Colonies are known to grow as high as three metres, with unconfirmed reports of even greater heights. *P. arborea* typically grows on gravel, particularly in canyons and channels.

Mortensen and Buhl-Mortensen (2004) described the study of the distribution and abundance of deep-water gorgonian corals along 52 camera/ROV transects at a depth range of 183 to 498 m in the Northeast Channel between Georges Bank and Browns Bank. One of the coral species observed was *P. arborea*. The highest abundance of colonies for *Paragorgia* was found along transects with average temperatures between 5.3 and 6.5ºC. The co-occurring *Primnoa* occurred over a wider temperature range (maximum temperature = 12.1ºC) than *Paragorgia* (maximum temperature = 9.7ºC). Salinities ranged from 33 to 35‰.

Various fauna were observed in association with *P. arborea* samples collected in the Northeast Channel off Nova Scotia. These fauna included amphipods (dominant crustacean), isopods, cirripeds, copepods, ostracods, decapods (e.g., shrimp), euphausiids and hydroids (Buhl-Mortensen and Mortensen 2004).

Two Newfoundland trawl survey sets have collected *P. arborea*. There has also been one observer record from the southwestern Grand Banks (720 m) and 15 observer records from areas off Labrador. Eleven of the 13 records off Cape Chidley, Labrador were taken at depths ranging between 391 and 463 m. The other two records occurred at locations with water depths ranging between 353 and 390 m. The Atlantic Canadian depth range of collected specimens is 249 to 720 m (Table 4.4). This species has been reported frequently on the fishing banks off Newfoundland over the past number of years.

Coral Associations

In Atlantic Canada, *P. resedaeformis* and *P. arborea* are commonly found on *Lophelia pertusa* 'forests' or 'fields' (Mortensen 2000 *in* Gass 2002). However, these species do not always occur together. Consideration of habitat requirements for *L. pertusa* (scleractinian) could possibly shed some light on the habitat requirements of the two gorgonian corals. *L. pertusa* requires hard substrate, strong currents, 200-1,000 m depths, 4 to 12ºC water temperatures, and salinities ranging from 35 to 37‰.

Deep Sea Corals and Fish Habitat

There is some thought that deep-water corals provide habitat for some commercially fished species (Gass 1999 *in* Gass 2002). Recent studies have assessed this idea and determined that these corals are important habitat for several commercial species including redfish (Furevik et al. 2000 and Fosså and

Mortensen 1998 *in* Gass 2002). Some fishers in Nova Scotia have described areas with deep-water corals as important Atlantic halibut grounds (Gass 2002). Deep-water corals have been caught during Nova Scotia and Newfoundland fisheries for Greenland halibut, Atlantic cod, redfish, pollock and grey sole (Gass 2002).

The video imagery data discussed in MacIsaac et al. (2001) are spatially limited and lacking a time series. Their video imagery did not provide any evidence to suggest that the densities and types of corals that were viewed functioned as locally important feeding and/or nursery areas for fish. The authors concluded that more detailed analyses on benthic habitat are required for closer examination of the direct and indirect links between fish, habitat and corals. Edinger et al. (2005) also performed some preliminary examinations of relationships between corals and fish using data collected in Newfoundland and Labrador waters. They found some co-occurrences of fish diversity hotspots and coral hotspots but did indicate the requirement for more detailed investigation of these relationships.

Historically, corals were not generally caught during the cod fishery in waters off Newfoundland. With the onset of the moratorium in 1992, fishers began to target other species that occurred at different, often deeper areas, with different gear. Both of these changes in the fishery would likely increase the probability of interaction with deep-water corals. During recent years (i.e., since 2000), there have been relatively high coral catches east of Cape Chidley, Labrador. These catches have been reported in the northern shrimp fishery that employs shrimp trawls (Gass 2002).

Existing Impacts on Corals

Trawl Fishing

Bottom trawling has long been suspected of causing considerable damage to marine benthic habitat. Considering the vulnerability of deep-water corals, as described in earlier species profiles, fishing probably remains the primary threat to corals.

Oil and Gas Activities

Potential sources of impacts of oil and gas activities on deep-water corals include structures or activities that might physically damage corals, or discharges that increase sedimentation. The discharge of drill cuttings and muds could potentially increase sedimentation and cause toxic conditions for sensitive coral. However, it should be noted that the potential zones of impact of oil and gas activities on deep-water corals are much smaller than the potential impacts of trawling/dragging/dredging associated with commercial fishing.

In summary, much of the benthic fauna of Newfoundland and Labrador remains to be inventoried (Gilkinson 1986) and there are considerable data gaps for certain geographic regions and deep-sea environments such as the continental margin and slope environments and deep sea abyssal habitats.

4.6. Important Fish and Invertebrates

4.6.1. Marine Habitats

Based on physical habitat characteristics, the Laurentian Sub-basin SEA Study Area of JWEL (2003) can be divided into four primary areas: (1) the St. Pierre Bank, (2) the Laurentian Channel, (3) the Banquereau Bank, and (4) the slope regions associated with each of the above. All but the Banquereau Bank area occur within the present CPC exploratory drilling Study Area. The following brief descriptions of the three habitat areas relevant to this EA are based on descriptions contained in the Laurentian Sub-basin SEA (JWEL 2003).

The St. Pierre Bank is relatively shallow (i.e., <200 m) and typically has a bottom temperature of 0 to 2°C. The substrate on the St. Pierre Bank consists predominantly of fine to coarse sand except in the west-central part where it is rockier. The Laurentian Channel has water depths ranging between 200 and >400 m but water temperatures here tend to be higher than those on the adjacent banks. The substrate in the Channel consists predominantly of silt and clay. Slope regions in the Study Area have variable depths. For example, the continental slopes on the southern edges of St. Pierre Bank and Banquereau Bank have depths ranging from 200 to >3,000 m while the channel-associated slopes of the banks are shallower. The eastern slope of St. Pierre Bank is adjacent to the Halibut Channel that separates St. Pierre Bank and Green Bank. Halibut Channel is considerably shallower than the Laurentian Channel. The slope region substrates often consist of coarse sands.

The CPC exploratory drilling Study Area extends slightly further east than the Laurentian Sub-basin SEA Study Area and, therefore, includes the southern and west central portion of Green Bank and the associated slope region south of Green Bank. Similar to St. Pierre Bank, Green Bank is relatively shallow compared to the associated slope regions and can be considered similar habitat.

4.6.2. Species Profiles

Based on DFO commercial fishery landings data for Newfoundland and Labrador Region and Maritimes Region, specific fish and invertebrate species have been selected and described in the following sections. Profiles of the commercially relevant species are followed by descriptions of other fish species that are ecologically important. These include fish that are listed by the *SARA* as well as other species that are considered at risk by COSEWIC. Two invertebrate species, snow crab and short-finned squid, are included in the species profiles.

A comprehensive list of fish species that are known or likely to occur in or near the Study Area is included in the Laurentian Sub-basin SEA (JWEL 2003). Various commercially important fish species, and the description of the biological setting have also been discussed in Christian et al. (1998) [Gulf Canada Resources Report], Buchanan et al. (2004) [ConocoPhillips 2-D Seismic EA], and Christian et al. (2005) [ConocoPhillips 3-D Seismic EA].

Distribution maps of 18 commercial or common demersal fish species found throughout the Grand Bank area off Newfoundland and Labrador are available in Kulka et al. (2003). DFO spring and fall research survey catch data collected between 1980 and 2000 were used as the basis for these maps. Only the 1992-2000 survey data presented in Kulka et al. (2003) are considered in this EA.

4.6.2.1. Commercially Important

Redfish

Redfish typically occur in cool waters (3 to 8ºC) along the slopes of fishing banks and deep channels in depths of 100 to 700-m. In the western Atlantic, redfish species range from Baffin Island in the north to the waters off New Jersey in the south. The three redfish species that occur in the Northwest Atlantic include *Sebastes mentella*, *S. fasciatus*, and *S. marinus*. The latter species is relatively uncommon except in the area of the Flemish Cap so for the purposes of this assessment, only *S. mentella* and *S. fasciatus* will be considered. *S. mentella* is typically distributed deeper than *S. fasciatus* (Gascon 2003).

There has been some concern expressed by DFO scientists regarding redfish larval extrusion along the slope regions south of Newfoundland. This slow-growing and long-lived species of fish exhibits an ovoviviparous reproductive strategy whereby the eggs are fertilized internally by stored sperm. The larvae feed exclusively on energy stored in the yolk, develop inside the female and eventually are released as young fish sometime between April and July (Gascon 2003; Ollerhead et al. 2004). While mating is thought to occur in late fall/early winter, fertilization and embryogenesis is likely delayed until late winter, followed by larval extrusion during April to July period (Table 4.5). This speculated larval extrusion period is based on reproductive assessments of redfish collected during spring DFO research surveys. According to Ollerhead et al. (2004), redfish larval extrusion likely occurs all along the continental slope from the eastern slope of the Laurentian Channel off southwest Newfoundland to the eastern slope of the Grand Banks near Carson Canyon. It is likely that extrusion also occurs along the western slope of the Laurentian Channel. In other words, the slope areas that occur within the Study Area are not unique areas for redfish larval extrusion. It is important to note that redfish larval extrusion probably occurs over a prolonged period (~ four months). It is unknown whether redfish also mate in these areas (D. Power, DFO biologist, pers. comm.).

The live young aggregate in the surface waters at night but during the day they are found in or below the thermocline at a depth of 10 to 20 m (Fortier and Villeneuve 1996 *in* JWEL 2003). Smaller redfish often inhabit shallower waters while the larger redfish occur at greater depths (McKone and LeGrow 1984 *in* JWEL 2003). Redfish are pelagic predators, feeding primarily on copepods, amphipods, and shrimp (Rodriguez-Marin et al. 1994 *in* JWEL 2003), and sometimes on capelin (Frank et al. 1996 *in* JWEL 2003).

Table 4.5. Fish Species Known or Likely to Reproduce within or Near the Project Area.

Species	Locations of Reproductive Events	Times of Reproductive Events	Duration of Planktonic Stage
Redfish[1]	Primarily along western slope of St. Pierre Bank and in deeper areas of the Laurentian Channel Slope region from southern St. Pierre Bank to southern Green Bank	Mating in late winter and release of young between April and July (peak in April)	N/A
White hake	Southwestern slope of St. Pierre Bank	June to August	1 month
Snow crab	St. Pierre Bank	Spring and summer	3-4 months
Pollock	NAFO Unit Areas 3Psg, 3Psh	Late summer and fall	
Monkfish	Egg cases found along slope region from southern St. Pierre Bank to southern Green Bank	Late spring/summer	Uncertain
Atlantic cod[1]	Western and southern slopes, and shelf of St. Pierre Bank Deep areas of Laurentian Channel Banquereau Bank Southern Halibut Channel and associated slope region Southern Green Bank and associated slope region	March to June	10 to 12 weeks
Atlantic halibut	Likely at slope of St. Pierre Bank	February to April	3 to 4 months
Skates	NAFO Unit Area 3Ps	Year-round	
Greenland halibut	Laurentian Channel	Winter months	Uncertain
Wolffish	Likely along the slope regions of St. Pierre Bank	September to November	
Cusk	Southwestern slope of Laurentian Channel	May to August	Uncertain
Porbeagle shark	St. Pierre Bank Laurentian Channel	Mating in late summer and pupping during the winter	

Table 4.5 (cont'd)

Species	Locations of Reproductive Events	Times of Reproductive Events	Duration of Planktonic Stage
American plaice[1]	Western and southern slopes, and shelf of St. Pierre Bank Southern slopes of Halibut Channel and Green Bank	April to May	12 to 16 weeks
Atlantic herring	Banquereau Bank	August to November	
Haddock[3]	Western slope of St. Pierre Bank Slope region south of Halibut Channel and Green Bank	March to May	
Mackerel	Southern Laurentian Channel	June to July	1 week
Witch flounder[1]	Slope regions of western and southern St. Pierre Bank, and southern Halibut Channel Halibut Channel	March to May	
Yellowtail flounder[1]	Western slope and shelf of St. Pierre Bank	April to May	

Adapted from Table 3.11 *in* JWEL (2003)
[1] DFO research vessel survey data, 1972-2002 (Ollerhead et al. 2004).

Redfish have large swimbladders and exhibit semi-pelagic shoaling behaviour. Gauthier and Rose (*in* Gascon 2003) reported that redfish perform regular diel vertical migrations. They exhibited consistent patterns of vertical migration in winter, spring and summer that appeared to be limited by hydrostatic pressure. Gauthier and Rose (2003) found that the hydrostatic pressure at the upper range of the vertical migration was never less than 67% of the pressure at the bottom. This vertical migration seemed to be a foraging strategy used to follow the movement of their euphausiid prey. The authors reported that redfish were on or near bottom during the day and higher up in the water column at night. Gascon (2003) indicated that the migration and movement patterns of redfish in the Laurentian Channel are poorly understood.

Large portions of 3Ps and 4Vs overlap with the Unit 2 management area for the Laurentian Channel redfish stock. Essentially all of the Project Area located inside the 1,000-m contour is in the Unit 2 management area (DFO 2004a). DFO Unit 2 summer trawl surveys between 1994 and 2000 indicated that the highest concentrations of redfish were found along the western and southern slope regions of St. Pierre Bank and the eastern and southern slope regions of Banquereau Bank. There was also indication of redfish in the deep areas of the Laurentian Channel (Power and Mowbray 2000). During an acoustic sampling effort in 2000, redfish marks were most consistent in the waters of the Laurentian Channel greater than 350-m deep. Phenomena commonly referred to by commercial fishermen as 'redfish balls' were noted in a number of locations (Power and Mowbray 2000). The redfish balls are spherical or columnar patches of high signal intensity, usually either up to 50 m off bottom or extending right to bottom. They were noted throughout the portion of the Laurentian Channel occurring within the Project Area. Breeze et al. 2002 (*in* JWEL 2003) also reported that redfish occur along the lower slope region of the Laurentian Channel and in the deeper areas of the Laurentian Channel, possibly indicating that the Channel is an important migration route for these fish.

Based on Newfoundland and Labrador and Maritimes Regions commercial fishery landings data for May to November, 2002-2004, Study Area locations of most concentrated redfish harvesting include the southern end of the Laurentian Channel in Unit Area 4Vsc, the Laurentian Channel at the eastern end of Unit Area 4Vsb, the southern slope region of St. Pierre Bank in Unit Areas 3Psgh, and the slope region at the southern end of Halibut Channel in Unit Area 3Psh. During DFO spring research vessel (RV) surveys conducted between 1992 and 2000, redfish were caught in relatively low numbers in the eastern portion of the Study Area (Kulka et al. 2003).

White Hake

Concentrations of this fish species occur on the southwestern Grand Banks, in the southern Gulf of St. Lawrence, on the Scotian Shelf, and in the Gulf of Maine (Kulka et al. 2004a). White hake (*Urophycis tenuis*) is a benthic species that tends to prefer warmer (5 to 11ºC) slope waters at depths greater than 200 m. At the same time, this fish does display considerable seasonal variability in depth of occurrence (Kulka and Simpson 2002). In the Study Area, white hake are typically most abundant on the southern edge of the St. Pierre Bank and on the eastern edge of the Laurentian Channel. White hake spawning within the Study Area is known to occur on the southwestern slope of the St. Pierre Bank between June and August (Kulka 1996a *in* JWEL 2003) (Table 4.5). The planktonic eggs and larvae drift in the upper 50 m of the water column (Markle et al. 1982 *in* JWEL 2003). In Newfoundland waters, white hake prey upon silver, red, and longfin hake, Atlantic cod, herring and flatfish (Kulka and Simpson 2002).

Kulka and Simpson (2002) state that the limited number of studies on hake distribution and abundance on the Grand Banks show that white hake on the Grand Banks are at the limit of their temperature range and are therefore spatially restricted to a small section on the southwestern Grand Banks and in the Gulf of St. Lawrence due perhaps to their preference for warmer water that is restricted to the outer parts of the southern Grand Banks. Spring research surveys conducted between 1996 and 2003 in Subdivision 3Ps indicated white hake concentrations along the slope regions of the Project Area (i.e., along the slopes of St. Pierre Bank, Laurentian Channel and Banquereau Bank) (Kulka et al. 2004a).

During DFO spring RV surveys conducted between 1992 and 2005, white hake were most concentrated along the western slope of the Laurentian Channel (DFO 2005b), southern St. Pierre Bank/Halibut Channel/Green Bank slope areas of the Study Area. Smaller catches were also made along the western St. Pierre Bank slope during these spring RV surveys. Fall RV surveys caught white hake along the southern Green Bank slope. The fall surveys did not extend any further west than Green Bank. The white hake RV survey catch in the proposed Study Area exhibited a decrease between 1992 and 2000 (Kulka et al. 2003).

Newfoundland and Labrador and Maritimes regions' commercial fishery landings data indicate that groundfish harvesting locations within the Study Area in 2003 were distributed primarily in the deeper water of the Laurentian Channel, along the slope region at the mouth of Laurentian Channel, along the slope region extending from the southern tip of St. Pierre Bank eastwards to the Study Area boundary, and on St. Pierre Bank in the north-central portion of the Study Area at the boundary between Unit Areas 3Psf and 3Psh (DFO 1984-2003).

Snow Crab

Snow crab (*Chionoecetes opilio*) is a decapod crustacean that occurs over a broad depth range (20 to 700 m) in the Northwest Atlantic. Large male snow crab occur primarily on soft bottoms (mud or mud-sand) (DFO 2006a), particularly in water depths of 70 to 280 m (Elner 1985 *in* JWEL 2003). Smaller snow crab is common on harder substrates (DFO 2006a). 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 2006a). Snow crab feed on fish, clams, polychaete worms, brittle stars, shrimp and crustaceans, including smaller snow crab.

Most of the snow crab fishery in Subdivision 3Ps occurs north of the Study Area except for in the northernmost part of the Halibut Channel (southern 3Psf and northern 3Psh). There are no estimates of an exploitable biomass index in 3Ps because research survey data for this area are unreliable (DFO 2006a).

Part of the western boundary of the Study Area occurs on the eastern and southern slope regions of Banquereau Bank but the western Project Area boundary does not. There have been experimental trap surveys conducted on the outer Banquereau Bank and shallow slope between 2001 and 2003. These surveys have been undertaken in an attempt to determine the distribution, density and movement pattern of snow crab in the area. The surveys indicated the presence of adolescent and adult male snow crab, mostly at depths of 60 to 200 m. Spatial plot of snow crab counts per trap on the Banquereau Bank slope has indicated more crab in the spring and summer compared to the fall, perhaps indicating seasonal migration. These trap surveys and restricted commercial fisheries between 2001 and 2003 were limited to showing only the presence of adolescent and adult snow crab along the slope but did not provide any sound scientific basis for a viable commercial fishery in the area (DFO 2005a).

Pollock

Although considered groundfish, pollock (*Pollachius virens*) spend much of their time swimming off the bottom in mid-water (DFO 2005c). They do not remain inactive on the bottom as do cod and haddock at times. Pollock typically occur within a depth range of 110 to 180 m but they have been found as deep as

365 m (Scott and Scott 1988 *in* JWEL 2003). Based on the variety of maturity stages caught, there are indications that pollock may spawn in 3Ps (DFO 2002b). Murphy 1996 (*in* JWEL 2003) reported that pollock spawn along the slope of the St. Pierre Bank in NAFO Unit Areas 3Psg and 3Psh in the late summer and early fall.

One-year-old pollock in the Laurentian Channel feed almost entirely on small fishes including herring, sand lance and redfish. In addition to these prey, adult pollock feed on crustaceans and larger fish. Pollock have relatively few natural predators, but are sometimes victim to cannibalism, as well as to harbour seals (Scott and Scott 1988). Larval pollock are eaten by a number of predators.

The distribution of pollock in 3Ps is restricted mainly to the slope waters of Burgeo and St. Pierre Banks, and inshore waters. Of these areas, only the slope waters of St. Pierre Bank occur in the Project Area. Despite being at the northern extent of their range in the Northwest Atlantic, pollock are reported in the 3Ps catch statistics of every month and are caught during both winter and spring research surveys. DFO research vessel catch data indicated a decrease in abundance from the early 1990s (most noticeable in 1991) to the late 1990s, with a slight increase from 1998 to 2000 (Kulka et al. 2003).

Newfoundland and Labrador and Maritimes Regions commercial fishery landings data indicate that groundfish harvesting locations within the Project Area in 2003 were distributed primarily in the deeper water of the Laurentian Channel, along the slope region at the mouth of Laurentian Channel, along the slope region extending from the southern tip of St. Pierre Bank eastwards to the Project Area boundary, and on St. Pierre Bank in the north-central portion of the Project Area at the boundary between Unit Areas 3Psf and 3Psh (DFO 1984-2003).

During DFO spring RV surveys conducted between 1992 and 2000 in the Study Area, pollock was caught along the western slope of St. Pierre Bank and along the southern St. Pierre Bank/Halibut Channel/Green Bank slope region (Kulka et al. 2003). The limited fall RV surveys in the Study Area between 1992 and 2000 resulted in low pollock catches along the slope of the eastern Study Area.

Monkfish

Monkfish (*Lophius americanus*) occur along the southwest slope of the St. Pierre Bank and in the Laurentian Channel (Kulka and Miri 2003) to depths of 650 m. There is some migration to shallower shelf waters during the summer. Some evidence exists to support the occurrence of monkfish spawning in the Study Area. Known inshore summer spawning produces floating egg masses up to 12-m long (Kulka and Miri 2003). Fishermen who are active in the Study Area have reported these egg masses, particularly in slope areas (Pierre D'Eon, fisherman, pers. comm.). Larvae spend several months in the surface waters before settling to the bottom (Scott and Scott 1988). Adult monkfish are voracious predators, consuming most invertebrates and fishes that that can be attracted by the "lure" on the top of the head.

There are deficiencies in the knowledge of monkfish in Subdivision 3Ps. Spring research vessel surveys in recent years have indicated that monkfish are distributed primarily along the slope regions of the Study Area and in the Laurentian Channel (DFO 2003a). Based on Newfoundland and Labrador and Maritimes regions' commercial fishery landings data for June to November, 2002 to 2003, the locations within the Study Area of most concentrated monkfish harvesting occurred along the upper slope region at the southern end of Halibut Channel and eastwards (Unit Area 3Psh), at the southern slope of St. Pierre Bank, and on the western side of the mouth of the Laurentian Channel (DFO 1984-2003).

During DFO spring RV surveys conducted in the Study Area between 1992 and 2000, monkfish was caught along the western slope of St. Pierre Bank and along the southern St. Pierre Bank/Halibut Channel/Green Bank slope region (Kulka et al. 2003). Catches were highest along the southern slope. The spatially limited fall RV surveys in the Study Area during the same period resulted in some monkfish catches along the slope of the eastern Study Area. Research survey monkfish biomass and abundance data show considerable fluctuation among years. The variable catchability or availability of this species makes monitoring difficult (DFO 2003a; Kulka and Miri 2003).

Atlantic Cod

The 3Ps Atlantic cod (*Gadus morhua*) stock off southern Newfoundland extends from Cape St. Mary's to just west of Burgeo Bank, and over St. Pierre Bank and most of Green Bank. This stock is a complex mixture of sub-components, possibly including fish that move seasonally between adjacent areas and others that migrate seasonally between the inshore and offshore areas. Historically, offshore fish of this stock have been harvested with both fixed and mobile gear. The fishery in 3Ps was under moratorium between 1993 and 1997. Since then, the Total Allowable Catch (TAC) has ranged from 15,000 to 30,000-t (DFO 2005d).

Spawning is spatially widespread in 3Ps, occurring close to shore as well as on Burgeo Bank, St. Pierre Bank and in the Halibut Channel (Table 4.5). Spawning fish are typically present in Placentia Bay from March to August (DFO 2005d). Hutchings et al. (1993 *in* JWEL 2003) reported that the primary spawning ground in the Laurentian Sub-basin is on the St. Pierre Bank, in NAFO Unit Areas 3Psf, 3Psg, and 3Psh (rather than on the slope of the St. Pierre Bank), between March and June (Hutchings et al. 1993, Ouellet et al. 1997 *in* JWEL 2003). Based on DFO research vessel survey data collected between 1998 and 2002, peak Atlantic cod spawning in the Study Area occurs in April, primarily on the shelf of southern St. Pierre Bank, in southern Halibut Channel including its upper slope region, and the shelf and slope of southern Green Bank (Ollerhead et al. 2004). Ollerhead et al. (2004) also indicated April spawning by Atlantic cod on the western shelf and slope of St. Pierre Bank, and in the deeper areas of the Laurentian Channel. Between 1972 and 2002, Atlantic cod spawning in the Study Area during May was less intense than April spawning, occurring primarily on the shelf and slope of southern St. Pierre Bank, and in the southern Halibut Channel/Green Bank area (Ollerhead et al. 2004). Based on DFO survey data collected between 1972 and 1997, Atlantic cod were still spawning in the Study Area, primarily along the western slope of St. Pierre Bank and in southern Halibut Channel (Ollerhead et al. 2004).

Atlantic cod fertilized eggs, larvae and early juvenile stages remain in the plankton for 10 to 12 weeks. Young juveniles move to coastal areas at night, spending the daytime in deeper waters (i.e., 20 m). Older juveniles (aged three to four years) overwinter along the edge of the Laurentian Channel (Breeze et al. 2002 *in* JWEL 2003).

Cod larvae feed on a variety of small crustaceans, including copepods, amphipods, and barnacle larvae. Juvenile and young adult cod eat crustaceans such as small lobsters, mysids, shrimps, toad and hermit crabs. As cod reach maturity (at approximately 50 cm), fish become prominent in their diet. Cod are opportunistic feeders, and depending on availability, capelin, sand lance, redfish, and herring are the preferred prey. Adult cod are eaten by seals and toothed whales, while adult cod, squid, and pollock prey on juvenile cod (Scott and Scott 1988).

During the April 2003 Canadian research vessel trawl survey, the observed distribution of cod was similar to those seen in 2001 and 2002. The largest catches in 2003 were localized in the southern Halibut Channel (within eastern part of the Project Area in Unit Area 3Psh), Fortune Bay and in the Burgeo Bank-Hermitage Channel area (Brattey et al. 2003). As with the previous five industry surveys, the fall 2002 industry survey showed aggregations of cod in the southern Halibut Channel and on or adjacent to St. Pierre Bank (within eastern part of the Project Area in Unit Area 3Psh) (DFO 2005d).

There are presently three indices of abundance for the eastern Scotian Shelf cod stock: (1) the July research vessel survey; (2) the March research vessel survey; and (3) the September-October sentinel survey. All three surveys use stratified random survey designs. Spatial distribution of catches in all three surveys has become quite restricted. Concentrations of fish occur on Sable/Western Banks and inshore during the fall sentinel survey but none of the three surveys indicated concentrations of cod on Banquereau Bank (DFO 2003b).

Based on Newfoundland and Labrador and Maritimes regions' commercial fishery landings data for June to November, 2002 to 2003, the locations within the Study Area of most concentrated Atlantic cod harvesting included the slope region at the southern end of Halibut Channel, on St. Pierre Bank at the boundary between 3Psf and 3Psh, at the slope regions of southern St. Pierre Bank and southern Halibut Channel, and scattered catches in the Laurentian Channel (DFO 1984-2003).

During DFO spring RV surveys conducted between 1992 and 2000, Atlantic cod were distributed across most of the central and northern parts of the Study Area (i.e., southern slope and northwards), including the deeper regions of the Laurentian Channel. The highest catches were recorded along the southern St. Pierre Bank/Halibut Channel/Green Bank slope as well as on southern regions of St. Pierre Bank, Halibut Channel and Green Bank. During the spatially limited fall surveys, lesser catches of cod were reported for the northeastern part of the Study Area (i.e., southern Green Bank) (Kulka et al. 2003).

During the April 2004 DFO research survey in 3Ps, the distribution of cod was similar to that during the 2001-2003 surveys (DFO 2005d). One of the largest catch areas in 2004 was located in the southern Halibut Channel. This area coincides with the northern half of the eastern part of the Project Area.

Substantial bycatches of cod occur in the otter trawl fisheries for witch flounder and redfish conducted on the slope at the southern ends of St. Pierre Bank, Halibut Channel and Green Bank (Chen 2004).

Four Atlantic cod populations (Arctic, Newfoundland and Labrador, Maritimes, Laurentian North) are listed as 'special concern' on Schedule 3 of *SARA*.

Atlantic Halibut

Atlantic halibut (*Hippoglossus hippoglossus*), the largest of the flatfishes, is found along the slope of the St. Pierre Bank and in the Laurentian Channel. DFO research vessel catch data indicated a decrease in abundance between the mid-1980s and the late 1990s, followed by a slight increase from 1998 to 2000 (Kulka et al. 2003). 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. However, it is likely that these fish spawn within the Study Area on the slope between St. Pierre Bank and the Laurentian Channel during the February to April period at depths of 1,000 m or more. 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).

During DFO spring RV surveys conducted in the Study Area between 1992 and 2000, Atlantic halibut was caught along the western slope of St. Pierre Bank and along the southern St. Pierre Bank/Halibut Channel/Green Bank slope region (Kulka et al. 2003). The spatially limited fall RV surveys in the Study Area during the same period resulted in some Atlantic halibut catches along the slope of the eastern part of the Study Area (Kulka et al. 2003).

Recent research vessel survey results have indicated a general stability in both biomass and abundance indices for Atlantic halibut in the southern Grand Banks. Up to 2002, the industry/DFO longline halibut survey (initiated in 1998) has indicated a consistent catch rate in regions of the Project Area (Zwanenburg et al. 2003; DFO 2005e).

Skates

Two species of skate are considered in this document: (1) thorny skate (*Amblyraja radiata*), and (2) smooth skate (*Raja senta*). Based on Newfoundland and Labrador and Maritimes regions' commercial fishery landings data for June to November, 2002, the primary locations of skate harvesting within the Study Area included the slope region from the southern tip of St. Pierre Bank to the eastern boundary of the Study Area.

Thorny Skate

Of the ten species of skate that occur in Newfoundland waters, the thorny skate is by far the most common. At one time, thorny skate were relatively evenly distributed over the entire Grand Bank but now about 90% of the biomass is concentrated near the southwest edge of the Bank. This area of concentration includes the Laurentian Channel and St. Pierre Bank slopes occurring within the Study Area (DFO 2003c). Thorny skate are likely most common in water depths ranging from 90 to 200 m (Gomes et al. 1992) over both hard and soft bottoms (Kulka et al. 1996 *in* JWEL 2003). These skate are considered sedentary, rarely moving more than 100 km during their lifetime (Templeman 1984 *in* JWEL 2003). DFO research vessel catch data indicated a continuing reduction in thorny skate density from the late 1980s to the early 1990s in the northern part of their distribution) (Kulka et al. 2003). Mating is by internal fertilization and occurs year-round (Scott and Scott 1988) on the St. Pierre Bank. Thorny skate egg cases are released by the female and hatching occurs approximately six months later. Young skate leave the egg case as free-swimming fish (McKone and Legrow 1983 *in* JWEL 2003). Thorny skate are known to feed on polychaetes, crabs, whelks, sculpins, redfish, sand lance and haddock, with fish being more important prey items for larger skate (Rodriguez-Marin et al. 1994 *in* JWEL 2003).

During DFO spring RV surveys conducted between 1992 and 2000, thorny skate were distributed across most of the central and northern parts of the Study Area (i.e., southern slope and northwards), including the deeper regions of the Laurentian Channel. The highest catches were recorded along the western slope of St. Pierre Bank, southern St. Pierre Bank/Halibut Channel/Green Bank slope as well as on southern regions of St. Pierre Bank, Halibut Channel and Green Bank. During the spatially limited fall surveys, lesser catches of thorny skate were reported for the northeastern part of the Study Area (i.e., southern Green Bank) (Kulka et al. 2003).

Approximately 90% of the thorny skate biomass on the Grand Banks appears to be concentrated in 20% of the area, primarily near the edge of the southwestern Grand Banks (Kulka et al. 2004b). Based on spring surveys between 2001 and 2003, the densest concentrations of thorny skate within the Study Area occurred along the slope region at the southern St. Pierre Bank and Halibut Channel. Fall surveys during this same period found a less concentrated distribution of this skate in these areas. Kulka et al. (2004b) also presented distributions of thorny skate young of the year (YOY) during spring surveys, 2001-2002. YOY were found primarily in the region of the southern St. Pierre Bank and southern Halibut Channel. The fall surveys did not cover much of the Study Area.

Colbourne and Kulka (2004) presented the spatial distributions and abundance of thorny skate in relation to their thermal habitat in 3Ps during spring research surveys between 1971 and 2003. During the last half of the 1990s, there appeared to be a distributional shift towards warmer bottom temperatures. Changes in shelf stratification arising from variations in salinity also likely play a fundamental role in overall ecosystem productivity affecting lower trophic level production and ultimately the food source for many marine species, including thorny skate.

Smooth Skate

Smooth skate is found on the St. Pierre Bank and its eastern slope (McKone and LeGrow 1983 *in* JWEL 2003) at depths ranging between 45 and 91 m. They appear to prefer soft substrates consisting of mud and clay. The timing of smooth skate spawning is unknown but it is thought that mating occurs over the entire range. The young skate leaves the egg case as a free-swimming animal (McKone and LeGrow 1983 *in* JWEL 2003). The thorny skate and the smooth skate are sympatric species, and compete for the same food sources including decapod crustaceans, mysids and euphausiids (Scott and Scott 1988).

Swordfish

Swordfish (*Xiphias gladius*) is a large migratory pelagic fish that is distributed worldwide. Individuals of this species typically occur in Canadian waters during the June to November period and can be found throughout the Study Area during that time. Swordfish may be present in surface waters or as deep as 500 m, although their presence at surface tends to occur during darkness. These large pelagic fish do not reproduce within the Study Area (Scott and Scott 1988). 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* JWEL 2003). Newfoundland and Labrador and Maritimes Regions' commercial fishery landings data indicate that large pelagic fish harvesting locations within the Study Area in 2003 were distributed primarily along the upper slope region from Banquereau Bank to the Study Area's eastern boundary (DFO 1984-2003).

Greenland Halibut

Greenland halibut (*Reinhardtius hippoglossoides*), also known as turbot, inhabits deeper parts of the slope of the St. Pierre Bank and the Laurentian Channel (Gomes et al. 1992). Unlike most flatfishes, Greenland halibut spends much of its time swimming off the bottom as a pelagic fish. Reported over a depth range of 90 to 1,600 m, Greenland halibut is typically found at around 450 m (Scott and Scott 1988). Spring and fall DFO research vessel catch data indicated a decrease in abundance between the late 1980s and the early 1990s (Kulka et al. 2003). Greenland halibut spawning is believed to occur in waters near the southern Esquiman Channel and the Laurentian Channel during the winter (Templeman 1973 *in* JWEL 2003). This flatfish is a bathypelagic predator and feeds on a variety of fish and invertebrates, including capelin, Atlantic cod, redfish, sand lance, crustaceans (e.g., shrimp), squid and young Greenland halibut.

Based on 1992-2000 spring research surveys, relatively few Greenland halibut catches were reported within the Study Area. Most reported catches occurred in deep water areas, including all slope areas, Laurentian Channel and Halibut Channel (Kulka et al. 2003).

4.6.2.2. *SARA*-Listed Species

For legal purposes, the *SARA* establishes Schedule 1 as the official list of wildlife species at risk. Species that were designated at risk by COSEWIC prior to October 1999 must be reassessed using revised criteria before they can be considered for addition to Schedule 1 of *SARA*.

Atlantic Salmon

Inner Bay of Fundy Atlantic salmon is included as 'endangered' on Schedule 1 of *SARA*. Atlantic salmon (*Salmo salar*) is an anadromous fish that lives in freshwater rivers for the first two years of life before migrating to sea. During the spring and summer, salmon migrate from northeastern North America to waters off Labrador and Greenland to feed for one or more years. They return to coastal North America in the fall, possibly passing through the Laurentian Channel during their migration from sea (Ritter 1989 *in* JWEL 2003). Atlantic salmon have been caught during annual DFO research vessel surveys in 3Ps but that data have yet to be extracted from the research survey database (D. Reddin, DFO research scientist, pers. comm.). Those data would provide some valuable temporal and spatial information regarding Atlantic salmon in the area. In the ocean, adult salmon consume euphausiids, amphipods, and fishes such as herring, capelin, small mackerel, sand lance, and small cod. While at sea, adult salmon are preyed upon by seals, sharks, pollock and tuna (Scott and Scott 1988). There is some thought that the Inner Bay of Fundy salmon feed in the Gulf of Maine and therefore probably do not migrate through the Project Area. However, there is still considerable uncertainty associated with the migratory specifics of these fish. It is possible that Atlantic salmon migrate through the proposed Study Area during movements to and from the ocean feeding grounds. However, specifics such as dimensions and location of a migratory corridor, size and timing of migration through the area, and the origins of the migrating salmon are unknown.

Wolffishes

There are three wolffish species that may occur in the deep waters of the Study Area. Northern wolffish and spotted wolffish are listed on Schedule 1 of *SARA* under Threatened Species. The Atlantic wolffish is listed on Schedule 1 of *SARA* under Special Concern Species.

Northern wolffish (*Anarhichas denticulatus*) occurs in the Laurentian Channel (Simpson and Kulka 2001), along the slope of the St. Pierre Bank at intermediate depths of between 90 to 200 m (Gomes et al. 1992), and have been found to depths of 600 m (Scott and Scott 1988). Tagging studies have shown that northern wolffish do not migrate long distances, and do not form large schools. The northern wolffish is a benthic and bathypelagic predator, preying upon jellyfish, comb jellies, crabs, brittle stars, seastars, and sea urchins. Predators of the northern wolffish include redfish and Atlantic cod (Scott and Scott 1988).

Spotted wolffish (*Anarhichas minor*) occurs in the deep waters of the Laurentian Channel and Hermitage Channel (Simpson and Kulka 2002), at depths of 475 m or more (DFO 2002c). Tagging studies have shown that spotted wolffish only migrate locally, and do not form schools (DFO 2002c). Spatial analysis of DFO research vessel catch data indicated that spotted wolffish abundance declined from the late 1980s to the mid- 1990s, with an increase in abundance during both survey seasons since the mid-1990s (Kulka et al. 2003). 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).

Atlantic wolffish (*Anarhichas lupus*) is found further south than either northern or spotted wolffish, occurring in low numbers at intermediate depths (90 to 200 m) along the slope of the St. Pierre Bank (Gomes et al. 1992), and in the Laurentian Channel during the spring (Simpson and Kulka 2002). They have been found at depths of up to 350 m (Scott and Scott 1988). It is the most abundant wolffish in the Study Area (DFO 2002c). There is no evidence that Atlantic wolffish migrate long distances, or form schools in Newfoundland waters (DFO 2002c). In the northwest Atlantic, Atlantic wolffish feed primarily on benthic invertebrates such as echinoderms, molluscs and crustaceans, as well as small amounts of fish. No predators of adult Atlantic wolffish have been identified, but juveniles have been found in the stomachs of Atlantic cod (Scott and Scott 1988).

It is not known with certainty if any of these three wolffish species spawn in the Study Area, although it is probable given the limited migration of the species. If spawning does occur in the Laurentian Sub-basin, it would most likely take place on the slope of the St. Pierre Bank. 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 2002c).

Incidental wolffish catches within the eastern part of the proposed Project Area during the 2001 to 2004 period occurred at locations with water depths ranging from 200 to >1,000 m (primarily 200 to 1,000-m depth range) at the southern end of Halibut Channel. Catch values were negligible.

Based on spring research surveys conducted between 1992 and 2000, reported spotted wolffish catches were minimal within the eastern part of the Project Area during the 1992 to 1995 period and nonexistent between 1996 and 2000. No spotted wolffish catches were reported in the western part during DFO research surveys conducted during the 1992-2000 period. Striped wolffish, on the other hand, were commonly caught between 1992 and 2000, especially in the slope area of the eastern Project Area. Catches in and proximate to the western part of the Project Area were lower but consistent over the nine-year period (Kulka et al. 2003, 2004c).

Both northern and spotted wolffish are incidentally captured in fisheries directed at other commercial species, particularly in those for Greenland halibut and snow crab. Incidental capture in the commercial fishery is considered the dominant source of human induced mortality for these two wolffish species. Permitting, education on live release, and gear modification have been identified as the key issues in ensuring the survival of these fish (DFO 2004b).

Atlantic Cod

There are presently four populations listed on Schedule 3 of *SARA* under the category of 'special concern'. They include the Arctic population, the Newfoundland and Labrador population, the Maritimes population, and the Laurentian North population. A profile of this species is provided in a preceding section.

COSEWIC-Listed Species Not Presently Under SARA

Cusk

In May 2003, cusk were designated a threatened species by COSEWIC but this species is not on the official *SARA* list (Schedule 1) of wildlife at risk. An allowable harm assessment for cusk in Atlantic Canada was recently prepared by DFO (DFO 2004c). Cusk (*Brosme brosme*) are solitary, slow-swimming groundfish that occur on both sides of the North Atlantic. In Canadian waters, this species is 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. In the Project Area, cusk have been found along the slopes of the southern end of the Laurentian Channel, and the slope region at the southern end of St. Pierre Bank and Halibut Channel (Harris et al. 2002). Spawning occurs from May to August, peaking in June. In the Project Area, cusk spawn along the western slope of the Laurentian Channel (Harris et al. 2002). 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).

According to spring research surveys conducted during the 1992-2000 period, reported cusk catches were restricted to the southern Halibut Channel/Green Bank slope region (Kulka et al. 2003). Cusk are presently listed as threatened by COSEWIC (2004).

Porbeagle Shark

Although not an official species at risk under *SARA*, the porbeagle shark was designated as endangered by COSEWIC in May 2004 (Table 4.1) (DFO 2005f,g). The porbeagle shark is a large cold-water pelagic animal known to occur on St. Pierre Bank and in the Laurentian Channel during the spring and summer (Scott and Scott 1988). This shark mates within NAFO Subdivision 3Ps during late summer, followed by the release of live young (pups) during the following winter (Campana et al. 2001). The pupping occurs outside of the Project Area.

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).

Winter Skate

This benthic species typically occurs in areas with water depths less than 120 m but it has been caught in areas as deep as 375 m (Scott and Scott 1988). Like other elasmobranches, the winter skate is slow growing and produces relatively few young each year (DFO 1998). Winter skate mating likely occurs throughout the year although details are lacking. Eggs are deposited in egg cases and subsequently released into the ocean environment. Development continues in the egg cases until the young skates emerge at lengths of approximating 11 to 13 cm. Winter skate prey includes amphipods, polychaetes, sand lance, isopods and bivalves. Predators of this skate species include sharks, rays and seals.

The Southern Gulf of St. Lawrence and 4VsW (Eastern Scotian Shelf) winter skate populations are presently listed by COSEWIC as endangered and threatened, respectively (Table 4.1). The latter population is presently being considered as an addition to the List of Species under *SARA*.

There are records of winter skate occurrence on the Eastern Scotian Shelf and Slope, in the Laurentian Channel, and on the southern St. Pierre Bank and Slope (DFO East Coast of North America Strategic Assessment Project [ECNASAP] database). It is at the northern limit of its distribution on the offshore banks of the Eastern Scotian Shelf. The winter skate is the target species of a fishery in 4VsW, with thorny skate being taken as bycatch.

4.6.2.3. Other Species of Note

Short-finned Squid

Cephalopods represent an important component of most major continental shelf ecosystems. They may act as important indicators of anomalous events that would otherwise remain undetected, especially in ecosystems where environmental variation is not extensively monitored. Commercially exploited pelagic squids of the families *Ommastrephidae* (short-finned squids) and *Loliginidae* (long-finned squids) tend to dominate the cephalopod fauna in most of these ecosystems. The short-finned squids are typically oceanic and more migratory than the long-finned squids. The most studied short-finned squid in the northwest Atlantic is *Illex illecebrosus*. Unlike long-finned squid, this short-finned squid species occurs in Newfoundland waters at abundances that sometimes support a commercial fishery. There have been recent indications that the long-finned squid *Loligo pealeii* has been expanding its range northward (Dawe et al. 2002). According to Hendrickson et al. (2003), the northern short-finned squid stock component in Subareas 3 (Newfoundland) and 4 (Scotian Shelf and Gulf of St. Lawrence) were still in a low state of productivity in 2002, based on below average abundance and biomass indices and squid size.

Typically inhabiting deeper waters, short-finned squid are found along the slopes of the Laurentian Channel during the spring and fall and on the Scotian and St. Pierre Banks during the summer (Breeze et al. 2002). With a lifespan of only one and a half years, squid have an extremely high growth rate and spawn only once. Short-finned squid spawning does not occur in the Project Area. All of its spawning occurs south of Cape Hatteras during the winter and the larvae are subsequently carried northward by the Gulf Stream (Breeze et al. 2002). Squid seem to prefer bottom temperatures ranging between nine and 13ºC and surface temperatures ranging between 13 and 20ºC (Breeze et al. 2002). Squid compete with other species, such as silver hake, for prey that include fish, crustaceans and molluscs. Squid are an important food source for commercial fish (silver hake, haddock, cod, pollock, and tuna), marine mammals and seabirds (Breeze et al. 2002).

Northern Sand Lance

The northern sand lance (*Ammodytes dubius*) is a small benthic fish typically found in shallow shelf areas at depths less than 90 m (Scott and Scott 1988). Northern sand lance occur on the St. Pierre Bank but do not appear to spawn within the Project Area. During the winter, northern sand lance migrate to shallower areas to spawn. During spawning, the eggs fall to the bottom and adhere to sand grains. After hatching in early spring, the larvae rise to the surface waters where they remain for several weeks (Scott and Scott 1988) feeding principally on planktonic copepods. These larvae are an important food for predators such as Atlantic cod, haddock, pollock and seabirds. Sand lance migrate up into the water column at night to feed and return to the bottom during the day (Scott and Scott 1988). Adult sand lance are a very important food source for many commercial fishes, including Atlantic cod, haddock, American plaice, pollock and yellowtail flounder (Scott and Scott 1988). Because it is a burrowing species, the sand lance is particularly susceptible to substrate disturbances. Sand lance do not have swim bladders (Robards and Piatt 1999).

4.6.2.4. Other Fish Species that Spawn Within or Near the Project Area

Other fish species that spawn within or close to the Study Area include American plaice, Atlantic herring, haddock, mackerel, and witch flounder (JWEL 2003) (Table 4.5). DFO RV surveys conducted within the Study Area between 1992 and 2000 identified the occurrence of other species including yellowtail flounder and lumpfish.

Fish Observed By MMOs During 2005 Seismic Program in Laurentian Sub-basin

Between 6 July and 24 August, 2005, marine mammal observers (LGL marine biologists) associated with the 2005 3-D seismic program in the Laurentian Sub-basin recorded numerous sightings of fish (Moulton et al. 2006). These sightings and the associated water depth of area being surveyed at the time are as follow:

- Swordfish (*Xiphias gladius*): 800 - >2,900 m
- Yellowfin (*Thunnus albacares*) and bluefin tuna (*T. thynnus*): 370 - >1,700 m
- Unspecified tuna: > 2,300 m
- Ocean sunfish (*Mola mola*): 370 - >2,800 m
- Pilot fish (*Naucrates ductor*): 300 – 1,800 m

4.7. Commercial Fisheries

The Study Area encompasses a variety of commercial fisheries, involving both Nova Scotian and Newfoundland-based fishing vessels. These are primarily groundfish fisheries, though in specific areas, snow crab is also an important harvest. The area's fisheries are conducted using both fixed and mobile gear. This section describes the past and anticipated commercial fisheries in the area of the proposed survey. The preceding sections describe the biological characteristics and status of the main commercial fish and invertebrate species.

4.7.1. Fisheries Data Sources

The following describes the data sources for the description of the commercial fisheries in and adjacent to the Study Area.

4.7.1.1. Fisheries Data Analysis

Data derived from the Department of Fisheries and Ocean's (DFO) Newfoundland Region (Newfoundland and Labrador) and Maritimes Region (Nova Scotia) catch and effort datasets (DFO 1986-2005)[5] provide the basis for the fisheries maps and the catch analysis in this report. Datasets for 1986 to 2005 are used to provide a historical overview, while the detailed analysis of fishing activity in the Study Area focuses on DFO data in more recent years, primarily 2003 - 2005[6], since fishing activities in the area have changed significantly in the last decade and a half. In addition, for the historical overview, datasets from the Northwest Atlantic Fisheries Organization (NAFO) are used for principal species in NAFO Sub-Divisions 4VS and 3PS for the period 1984 - 2001 (NAFO 2006). The NAFO datasets capture harvest by Canadian fishers and non-Canadian NAFO states, which in this area is primarily France, harvesting species in association with the French territorial waters and exclusive economic zone (EEZ) extending from St. Pierre et Miquelon.

Much of the DFO catch data for the Project Area in recent years is georeferenced,[7] which allows plotting of past harvesting locations. Areas farther from shore tend to have a great proportion of their catch georeferenced, while those closer to shore have less, though this varies from year to year in the DFO

[5] 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.

[6] The data for these years are still classified by DFO as preliminary though the species data shown in this report are not likely to change to any significant extent when the data are finalized. The Maritimes Region data were accessed in May 2004 (for 2003), February 2005 (2004) and February 2006 (2005), and the Newfoundland Region data in April 2004 (2003), February 2005 (2004) and February 2006 (2005).

[7] The location given 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 approximately .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 large pelagic 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.

datasets. For instance, >99% (by quantity) of the recorded catch from offshore Unit Area 3PSh was georeferenced in 2003, while less than 25% was georeferenced in that year in 3PSc (Placentia Bay), which is inshore, northeast of the Study Area.[8] However, in the 2005 dataset provided by DFO, 56% of the 3PSh harvest was georeferenced, and just over 2% of the 3PSc quantities. Consequently, when characterizing the historical domestic fisheries, this report also describes the fisheries in Unit Areas 3PSf, 3PSg, 3PSh, 4VSc and 4VSb. These "Adjacent Unit Areas" are those within which some part of the Study Area is located.

4.7.1.2. Document Sources

In addition to the databases and consultations described, the report also draws on a variety of published sources, mainly from DFO, such as species management plans, status reports and research documents. These are listed in Section 8.0.

4.7.1.3. Fisheries Consultations

For this EA report, consultations with fisheries industry representatives (2006) included telephone and email contacts, supply of information for comment, and/or meetings with One Ocean, Fish, Food and Allied Workers Union (FFAWU), Association of Seafood Producers, Fishery Products International, the Groundfish Enterprise Allocation Council, Clearwater Seafoods Limited Partnership, Icewater Seafoods, Seafood Producers of Nova Scotia , the Nova Scotia Swordfish Association and W. T. Grover Fisheries Ltd.

Interviews were also undertaken with relevant DFO managers and scientists about the area's fisheries and fisheries resources.

In addition, consultations with Newfoundland and Labrador and Nova Scotian stakeholders in 2004 and 2005 (for the seismic survey programs in these areas) provided further valuable information and perspectives.

4.7.2. Overview

Figure 4.1 shows the Study Area and Project Areas in relation to marine features and fisheries management zones (Unit Areas) and other boundaries. As the map indicates, these areas straddle parts of NAFO Subareas 3 and 4.

The fisheries in the southern Laurentian Channel and on the south western Grand Banks, over many decades, have been dominated by groundfish harvesting. Today, the harvest is primarily redfish species (ocean perch) and cod, though skates, white hake, halibut, American plaice and greysole flounder also account for important commercial landings. A little farther north on the western Grand Banks, the snow

[8] A general exception to this is the offshore clam harvest from 4VSc, where much of the harvest of those species is not georeferenced in the dataset provided, though this occurs outside the Study area on the Scotian Shelf.

crab is extensively harvested, and some large pelagic species (swordfish, tunas and sharks) are also important (though to a much lesser extent) within certain parts of this area.

To the west, on the Scotian Shelf and beyond the Study Area, snow crab, shrimp and – since the mid-1990s in particular – various deep-sea clams have become very important commercial species. The latter fishery, mainly for Stimpson surf clams, propeller clams and quahaugs, accounted for 70% of the 4VSc harvest by quantity in 2005. However, this is pursued by one harvesting company (Clearwater Limited Partnership) on specific beds in 4VSc well outside of the Study Area.

Running north-south through the Project Area is the "French Corridor", a portion of France's EEZ extending southward from the French islands St. Pierre et Miquelon off Newfoundland's south coast. This 10.5-mile wide zone was awarded by an international court of arbitration in 1992, settling an offshore boundary dispute between Canada and France. Within this corridor, which extends through NAFO 3PS into 4VS, France has quota for most commercial species. However, Canada's DFO manages fisheries in the zone and French quotas in and around the EEZ are set under a treaty signed in 1994 (JWEL 2003).[9]

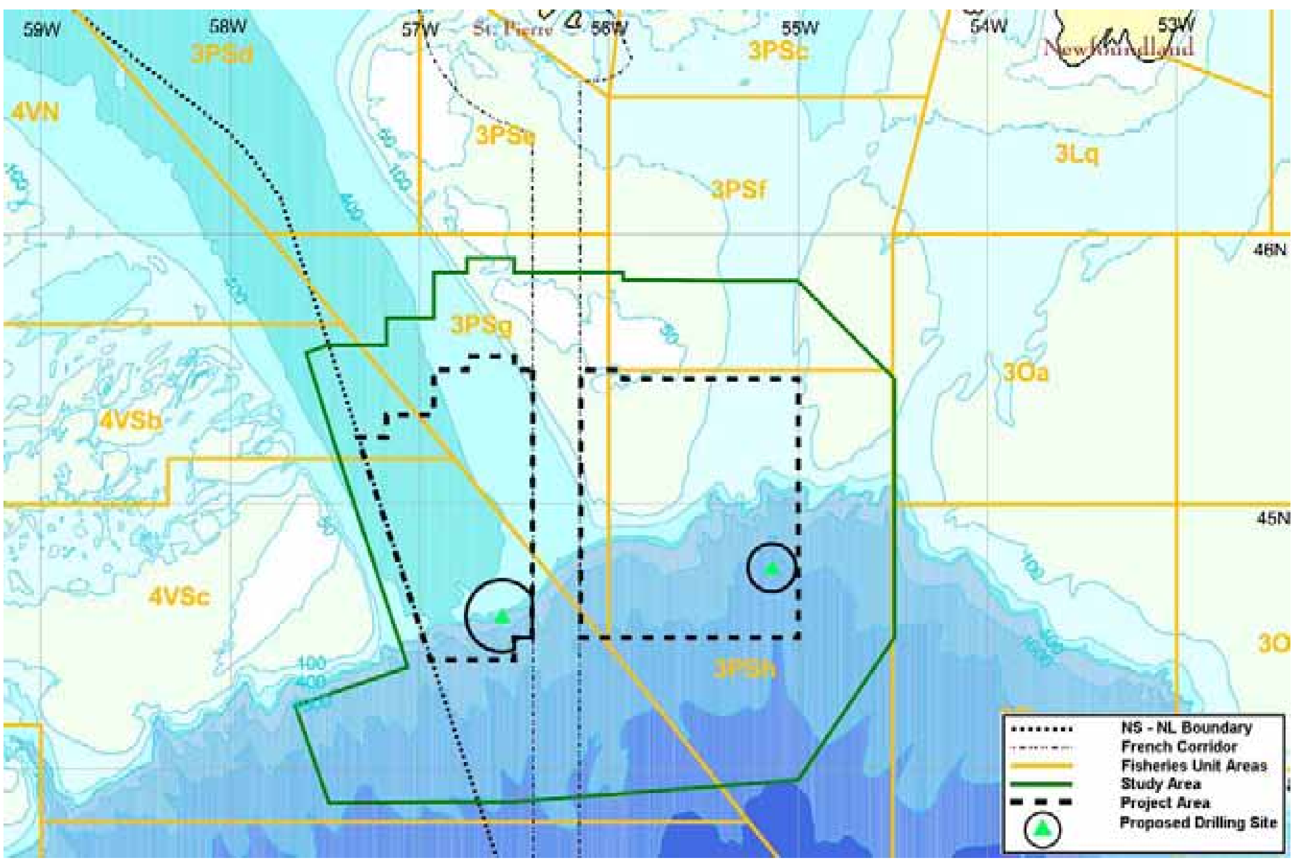

Figure 4.1. Study and Project Areas in Relation to Fishing Zones, Boundaries and Marine Features.

[9] JWEL (2003) Appendix C, Table 7, provides French quotas in the area by species for 1995 to 2001.

As JWEL (2003) notes, both NAFO and DFO manage fisheries in the general area, with DFO assuming primary responsibility for stocks that do not usually cross (straddle) the 200-mile EEZ limit, and those that are sedentary (e.g., snow crab). While NAFO has the primary responsibility for stocks outside the 200-mile EEZ and for straddling stocks, DFO provides scientific and management advice. The large pelagic species are managed by the International Commission for the Conservation of Atlantic Tunas (ICATT). Within the Canadian management system, DFO's Newfoundland Region is generally responsible for 3PS, and DFO Maritimes Region for fisheries in 4VS.

The composition of the catch in recent years in the Adjacent Unit Areas (3PSf, 3PSg, 3PSh, 4VSc and 4VSb; see discussion above) is shown in Table 4.6.

Table 4.6. Adjacent Unit Areas Domestic Harvest, 2003-2005 Average.

Species	Tonnes	% of Total
Groundfish	9,194	25.3%
Swordfish	117	0.3%
Deep sea clams	18,917	52.0%
Scallops	149	0.4%
Whelk	37	0.1%
Squid	114	0.3%
Icelandic scallops	419	1.2%
Unspecified mollusks	51	0.1%
Shrimp	1,032	2.8%
Snow Crab	6,342	17.4%
All other	17	0.0%
Total	36,390	100.0%

Excluding the clam fishery, groundfish species (including skates, which are managed under groundfish management plans) continue to make up the majority of the harvest as they have in the past, though today this occurs almost exclusively in the 3PS portions of this area. During 2003-2005, cod, redfish, skate and white hake have made up more than 80% on average of the domestic groundfish harvest in the Adjacent area (Table 4.7).

Table 4.7. Adjacent Unit Areas Domestic Groundfish Harvest, 2003-2005 Average.

Species	Tonnes	% of Total
Atlantic Cod	2,897	31.5%
Haddock	104	1.1%
Redfish (spp.)	2,741	29.8%
Halibut	415	4.5%
American Plaice	408	4.4%
Greysole Flounder	341	3.7%
Turbot (Greenland Halibut)	106	1.2%
Skate (spp.)	975	10.6%
Pollock	180	2.0%
White Hake	818	8.9%
Monkfish	208	2.3%
All other groundfish	78	0.9%
Groundfish Total	9,194	100.0%

4.7.3. Historical Fisheries (Adjacent Unit Areas)

Since the Atlantic cod moratoria were declared in most east coast waters during 1992 and 1993, 3PS has been one of the few open cod fisheries remaining, though quotas are now lower than in previous decades. Within the 4VS, the once extensive cod fishery has been closed to directed fishing since 1993, though small catches have been allowed as by-catch in other fisheries and, since 1996, in a sentinel commercial index fishery. For example, the 4VSc cod harvest in 1986 was more than 29,000 tonnes; in 2005 it was 12 tonnes. The following graphs show the harvest for all species (excluding deep-sea clams from the Scotian Shelf) (Figure 4.2) and for groundfish (Figure 4.3) over the last 20 years within the Adjacent Unit Areas, based on DFO data. Figures 4.4 to 4.7 show the changes in the quantity of harvest for the more important groundfish species over the past 20 years.

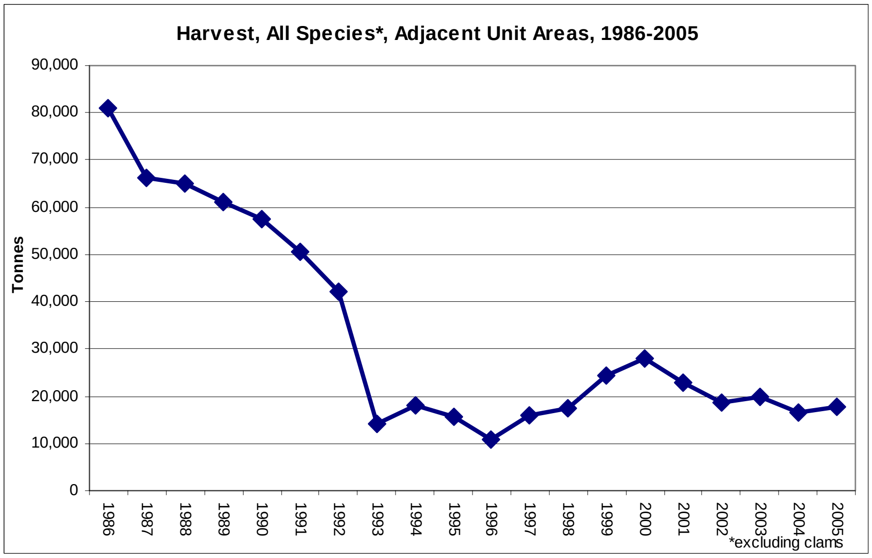

Figure 4.2. 1986 – 2005 Harvest, All Species, Adjacent Unit Areas.

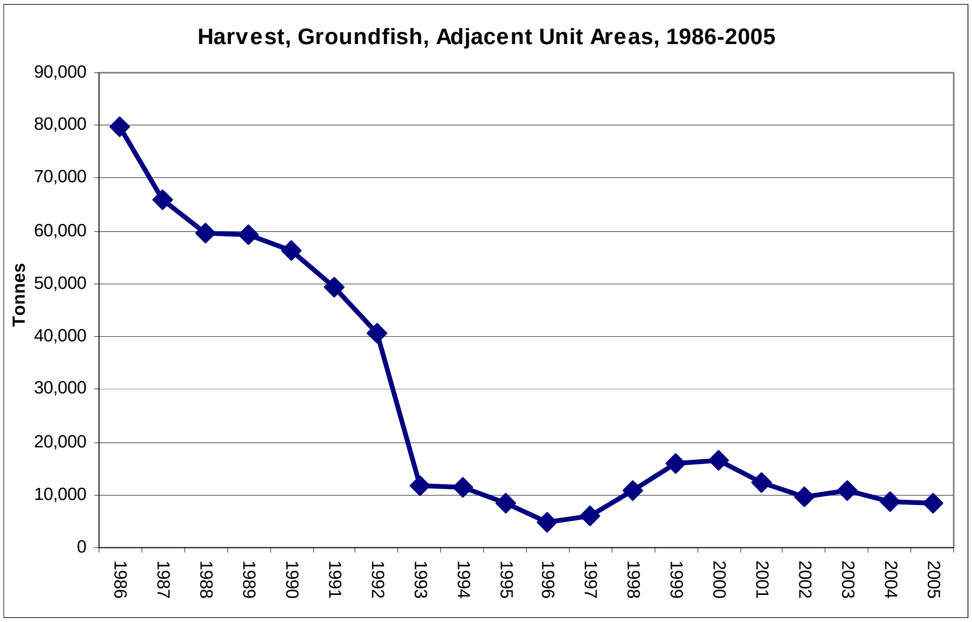

Figure 4.3. 1986 – 2005 Groundfish Harvest Adjacent Unit Areas.

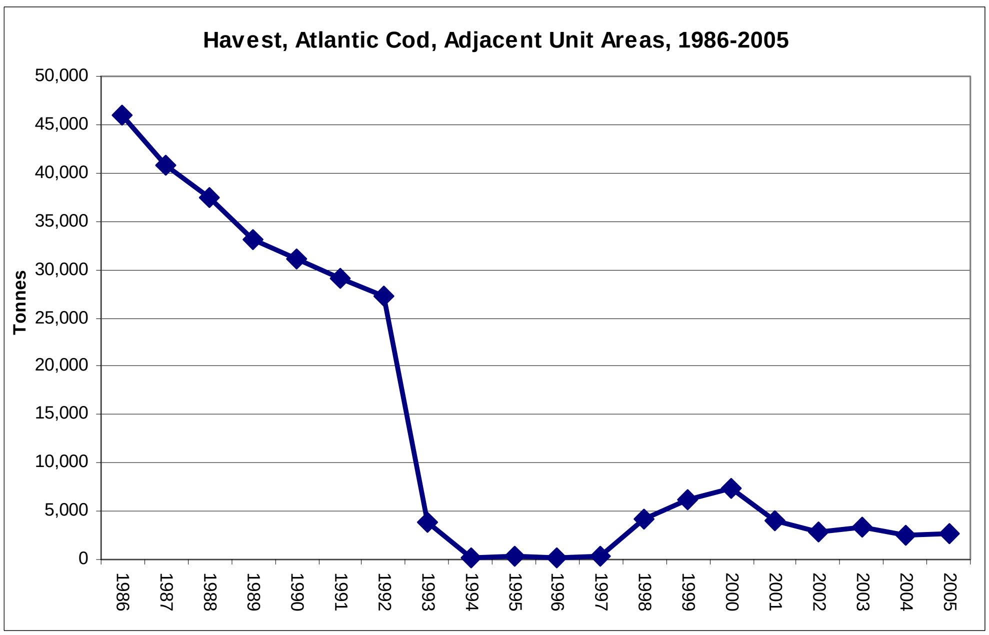

Figure 4.4. 1986 – 2005 Cod Harvest, Adjacent Unit Areas.

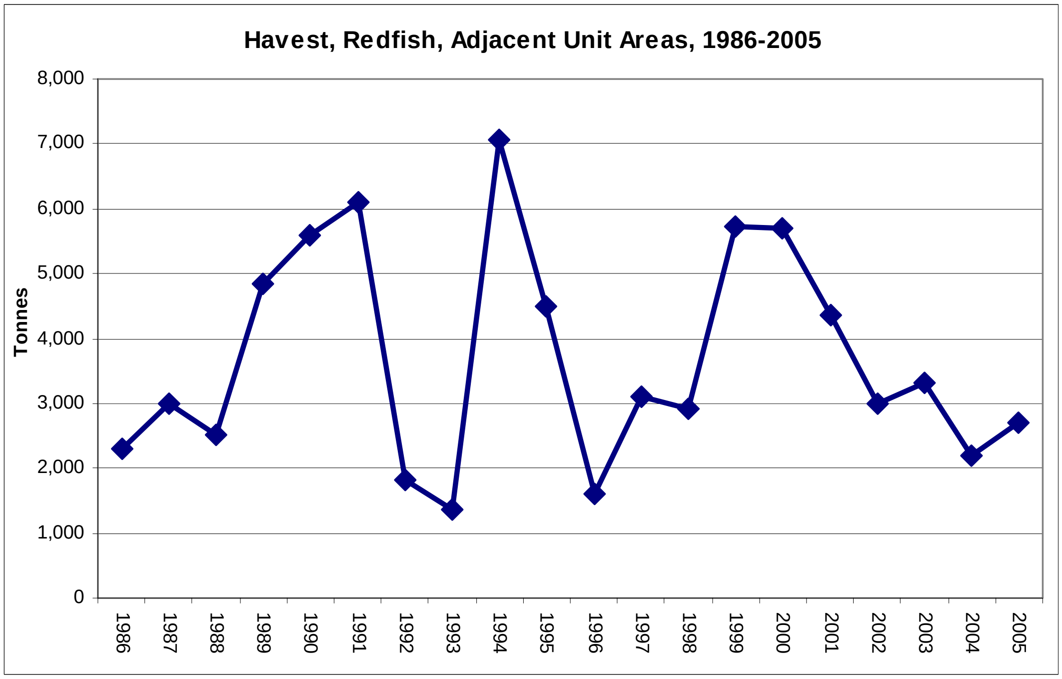

Figure 4.5. 1986 – 2005 Redfish (spp.) Harvest, Adjacent Unit Areas.

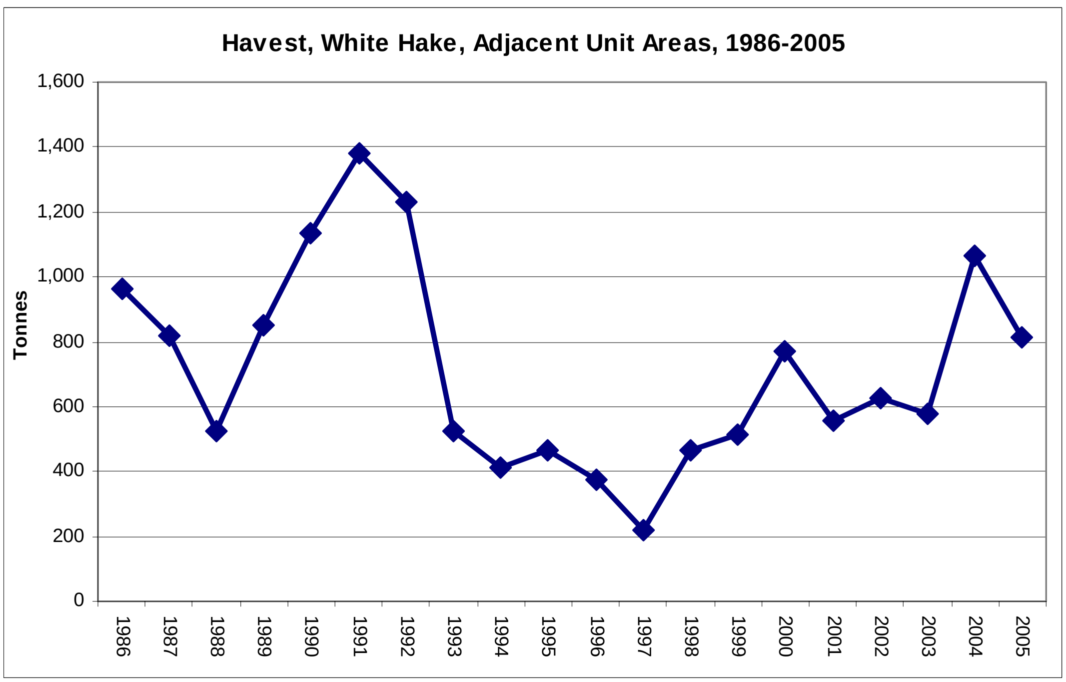

Figure 4.6. 1986 – 2005 White Hake Harvest, Adjacent Unit Areas.

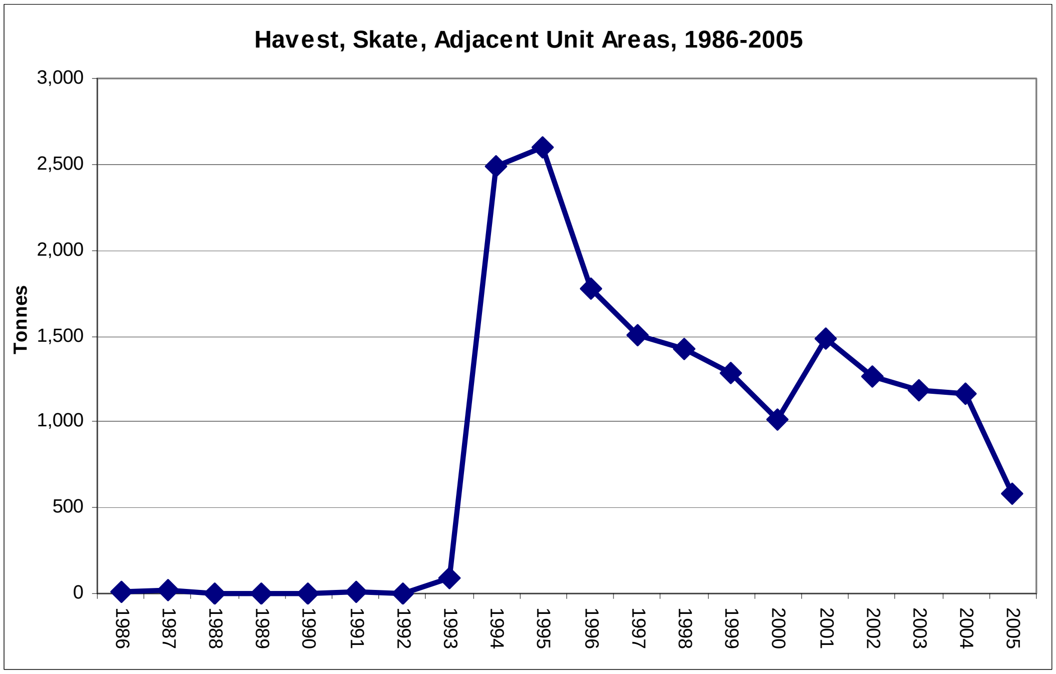

Figure 4.7. 1986 – 2005 Skate (spp.) Harvest, Adjacent Unit Areas.

After groundfish, snow crab has been the next most important species over the past decade, though catches have been declining somewhat in recent years (Figure 4.8). This is discussed further, below.

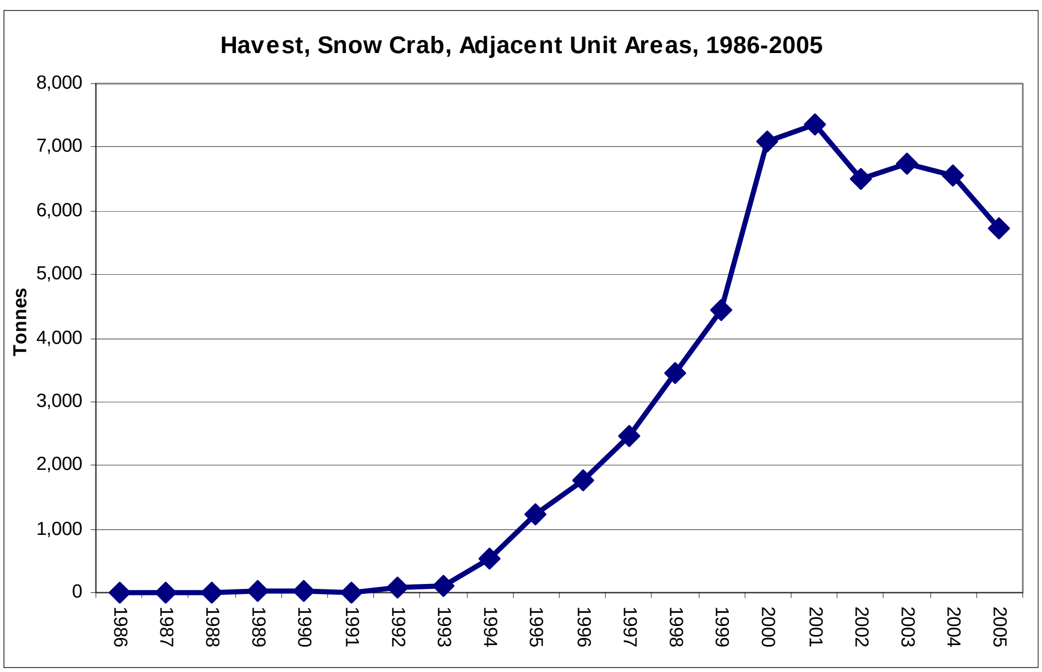

Figure 4.8. 1986 – 2005 Snow Crab Harvest, Adjacent Unit Areas.

The EAs for the 2004-5 ConocoPhillips seismic programs (Buchanan et al. 2004; Christian et al. 2005) contain additional historical graphs based on catch data from NAFO and DFO. The NAFO recorded data are for 1984 to 2001 (NAFO 2004), and the Canadian (DFO) data are for 1984 to 2003 (DFO 1984-2003). The NAFO data presented in that report include harvests from all NAFO nations, though these are primarily Canadian (4VS and 3PS) and Canadian and French (within 3PS). While some other European nations and Japan recorded relatively smaller catches to about 1988, there have been virtually none in 4VS and 3PS since then.

Over the past two decades the seasonal pattern has also changed somewhat in this area. Figure 4.9 presents the Adjacent Unit Area harvest by month for 1986-1988 (average) and for 2003-2005 (average). As this indicates, harvesting is spread throughout the year, but has tended to be more concentrated in the summer months (May – August) in recent years than it was in the latter 1980s.

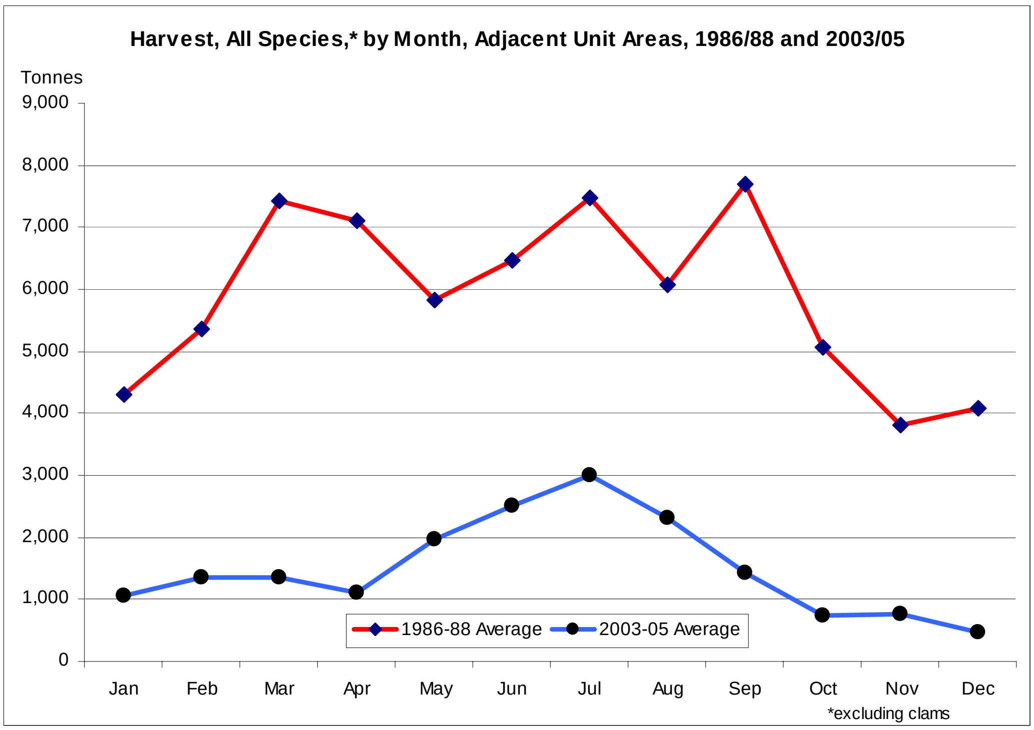

Figure 4.9. Harvest by Month 1986-1988 vs 2003-2005, Adjacent Unit Areas.

4.7.4. Study Area Commercial Fisheries

Table 4.8 shows the quantity of the domestic harvest by species recorded within the Study Area (as indicated in Figure 4.1) from 2003 to 2005. This is based on the georeferenced dataset from DFO. The last column of Table 4.8 indicates the percentage of the total harvest each species represents, by quantity, averaged over the three year period.

Table 4.8 indicates that during this period nearly 86% of the catch was groundfish species (including skates). As in the Adjacent Unit Areas, Atlantic cod and redfish species made up more than half of the overall harvest in both years, while skates, white hake and monkfish constituted approximately a further 25% of the total. Halibut catches were also important within the Study Area in those years.

Of the non-groundfish species, the snow crab harvest made up the largest catch by quantity. Although the large pelagic harvests (swordfish, tunas and sharks) and scallops are not large, they are of relatively high value. Further information on the important commercial species fisheries in the Study Area, including seasonality and the fishing gear employed, are provided in following sections.

Table 4.8. Study Area Harvest by Species, 2003 – 2006 (January – December).

Species	2003		2004		2005		2003-05
	Tonnes	% of Total	Tonnes	% of Total	Tonnes	% of Total	% over all
Atlantic Cod	3,005.8	30.7%	2,232.8	28.5%	1,738.7	27.6%	29.1%
Haddock	44.7	0.5%	99.7	1.3%	99.2	1.6%	1.0%
Redfish (spp.)	2,463.7	25.1%	1,718.3	21.9%	2,280.7	36.1%	27.0%
Halibut	347.9	3.5%	264.7	3.4%	181.2	0.0	3.3%
Plaice	313.4	3.2%	177.2	2.3%	55.6	0.9%	2.3%
Yellowtail Flounder	31.0	0.3%	1.3	0.0%	0.0	0.0%	0.1%
Greysole Flounder	362.5	3.7%	318.2	4.1%	107.3	1.7%	3.3%
Turbot (Greenland Halibut)	74.7	0.8%	55.8	0.7%	42.0	0.7%	0.7%
Skate (spp.)	1,122.9	11.5%	381.5	4.9%	377.7	6.0%	7.9%
Pollock	218.8	2.2%	140.9	1.8%	24.2	0.4%	1.6%
White Hake	526.3	5.4%	909.2	11.6%	370.1	5.9%	7.5%
Cusk	8.8	0.1%	9.1	0.1%	3.6	0.1%	0.1%
Catfish (wolffish)	1.3	0.0%	0.0	0.0%	0.0	0.0%	0.0%
Monkfish	226.4	2.3%	175.5	2.2%	45.5	0.7%	1.9%
Total Groundfish	8,748.1	89.2%	6,484.1	82.8%	5,325.7	84.4%	85.8%
Swordfish	6.1	0.1%	36.6	0.5%	5.3	0.1%	0.2%
Bluefin Tuna	0.0	0.0%	0.0	0.0%	1.2	0.0%	0.0%
Argentine	5.0	0.1%	0.0	0.0%	0.0	0.0%	0.0%
Porbeagle Shark	2.5	0.0%	2.3	0.0%	0.0	0.0%	0.0%
Mako Shark	1.6	0.0%	2.7	0.0%	0.0	0.0%	0.0%
Scallops	0.0	0.0%	54.1	0.7%	194.6	3.1%	1.0%
Whelk	0.0	0.0%	39.5	0.5%	36.6	0.6%	0.3%
Icelandic Scallops	0.0	0.0%	0.0	0.0%	26.2	0.4%	0.1%
Northern Shrimp	1.5	0.0%	0.0	0.0%	0.0	0.0%	0.0%
Snow Crab	1,006.2	10.3%	1,208.5	15.4%	718.2	11.4%	12.2%
All Other	35.2	0.4%	2.0	0.0%	2.5	0.0%	0.2%
Total	9,806.1	100.0%	7,829.8	100.0%	6,310.4	100.0%	100.0%

4.7.4.1. Harvesting Locations

Figures 4.10 to 4.12 indicate the georeferenced domestic fishing locations in relation to the Study and Project areas, and the two likely drilling sites, for 2003 to 2005. As these maps indicate, most of the fish harvesting in the general area is concentrated on the Scotian Shelf and the Grand Banks, particularly on the shallower shelf banks (e.g., St. Pierre Bank, Banquereau Bank) and on the shelf edge and upper slope. Within the Laurentian Channel, most activity is focused north of the Project Area, or at the Channel mouth, and near the Stone Fence, while the deeper waters (>1,000-m depth) to the south see relatively less fishing activity. [In June 2004, an area at the southwestern mouth of the Laurentian Channel, near the Stone Fence, was closed to bottom-tending fishing, e.g., otter trawls, by a DFO variation order; G. Herbert, pers. comm., June 2004].

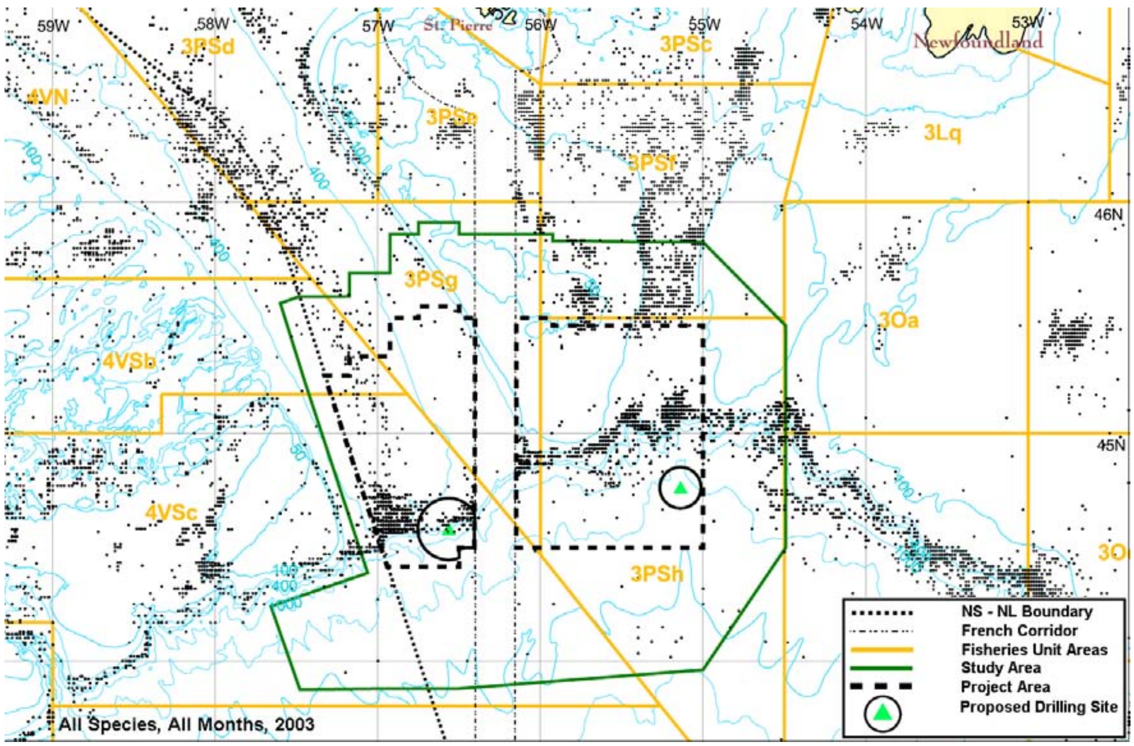

Figure 4.10. Harvesting Locations, All Species, January – December 2003.

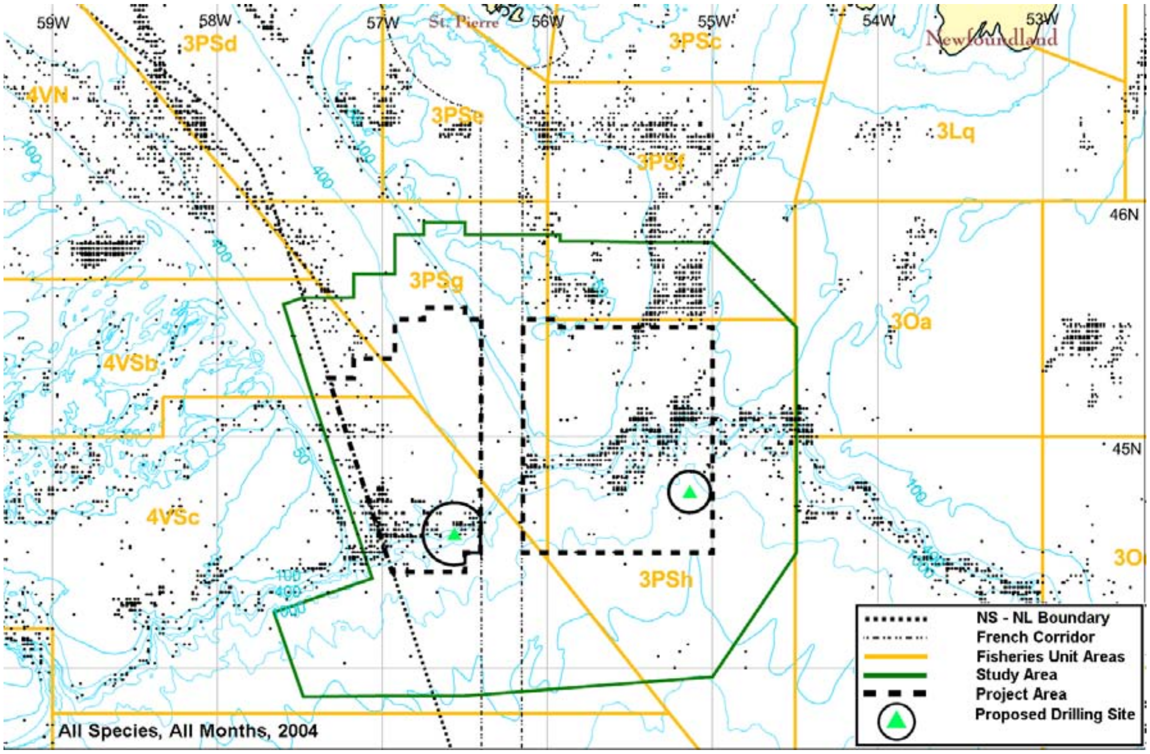

Figure 4.11. Harvesting Locations, All Species, January – December 2004.

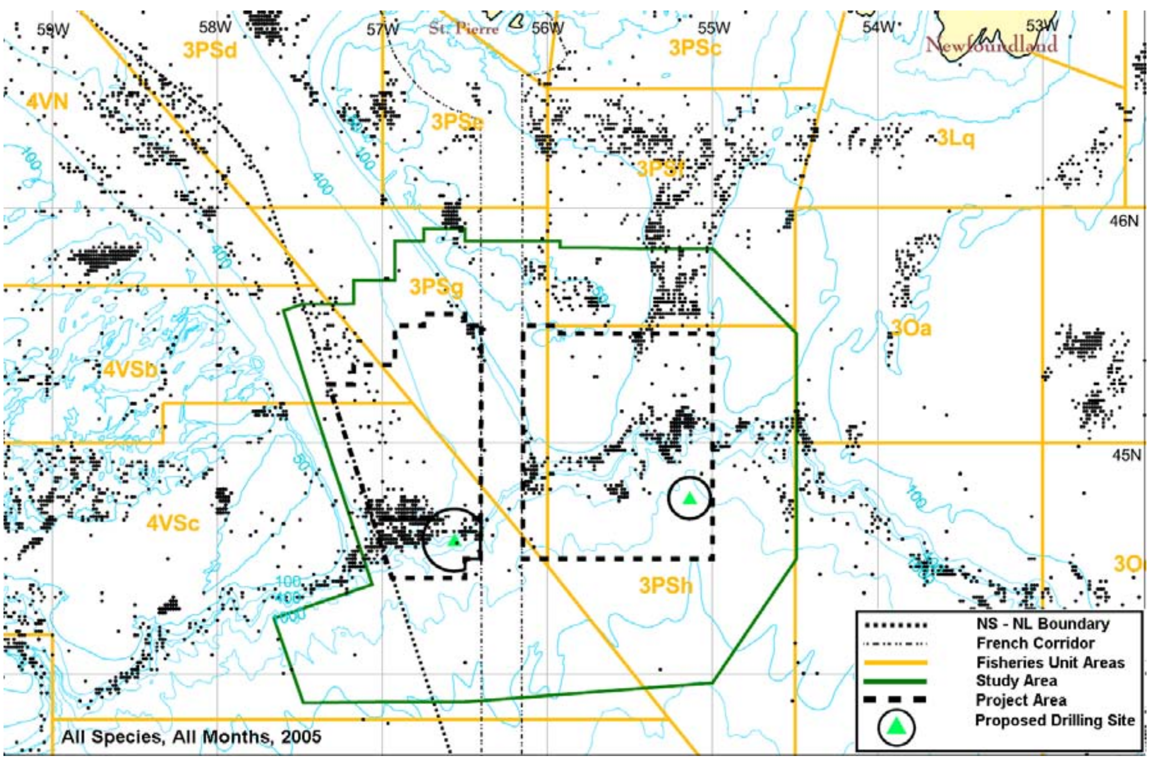

Figure 4.12. Harvesting Locations, All Species, January – December 2005.

As the maps indicate, the locations of activities from year to year have been generally consistent especially within the Study Area, where they are concentrated in fairly specific zones.

4.7.4.2. Seasonal Distribution

Fishing seasons may change depending on regulations set by DFO, the harvesting strategies of fishing enterprises, or on the availability of the resource itself. Figure 4.13 shows the 2003 – 2005 catch by month from the Study Area. As the data indicate, the earlier months of the year generally have been the most productive during that period, in terms of quantity of harvest, though there has been a fair amount of variability. This is different from the pattern observed for the same timeframe in the Adjacent Unit Areas, where the overall harvest was more concentrated in the summer.

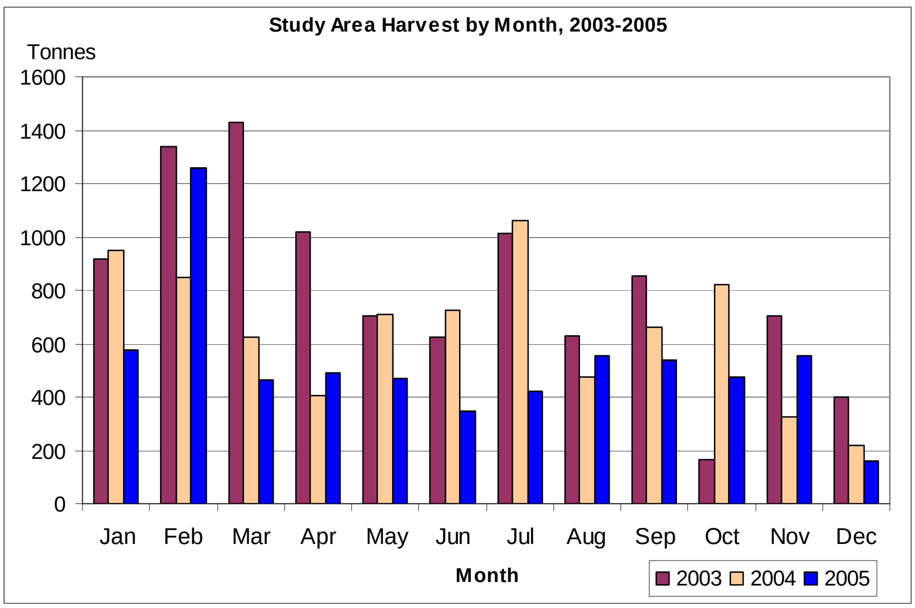

Figure 4.13. Study Area Harvest by Month, All Species, 2003-2005.

The following maps (Figures 4.14 to 4.25) show the reported domestic harvesting locations, all species, by month for January to December 2005, in relation to the Study Area, the Project Area and the two potential initial drilling sites.

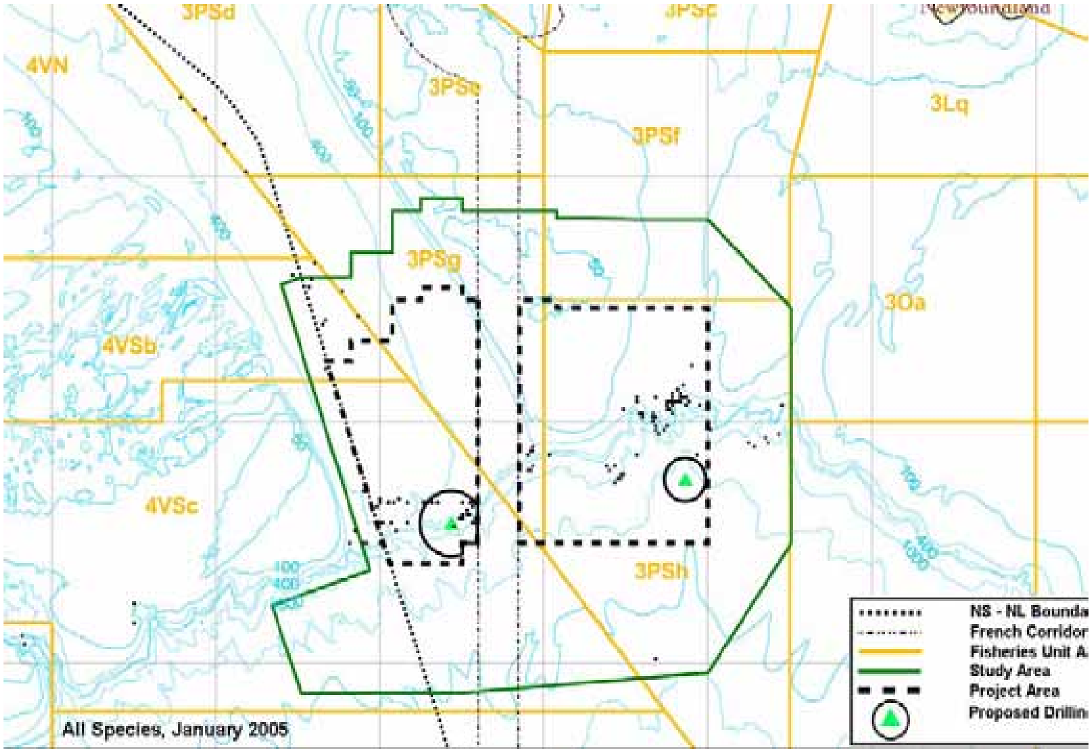

Figure 4.14. All Species Harvesting Locations, January 2005.

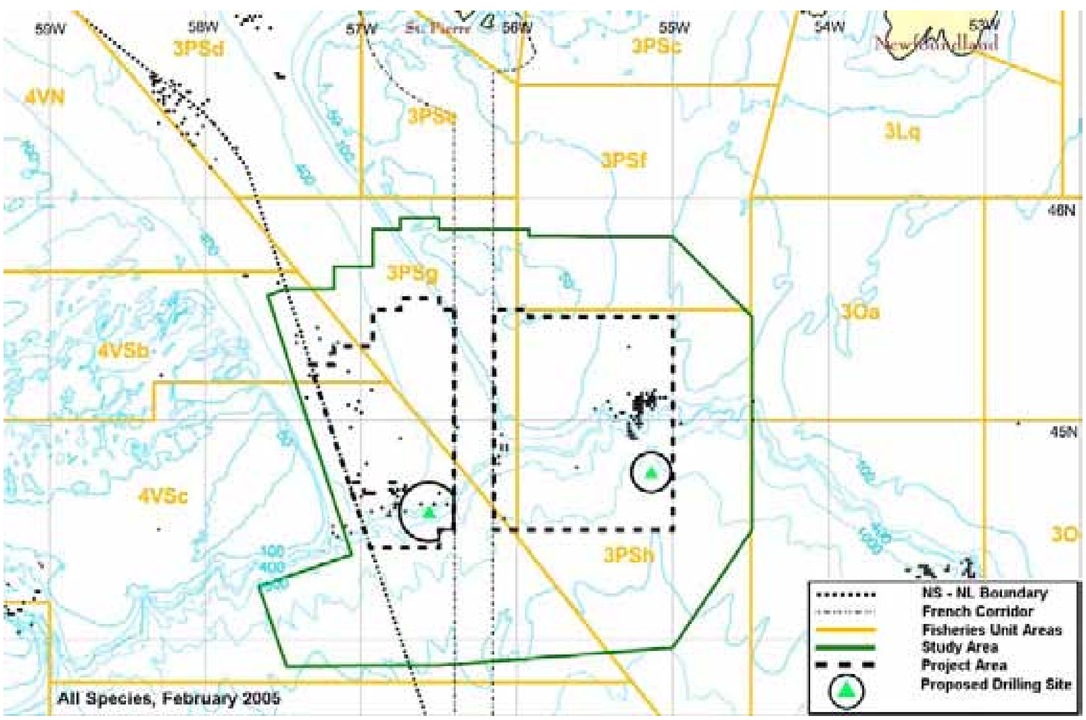

Figure 4.15. All Species Harvesting Locations, February 2005.

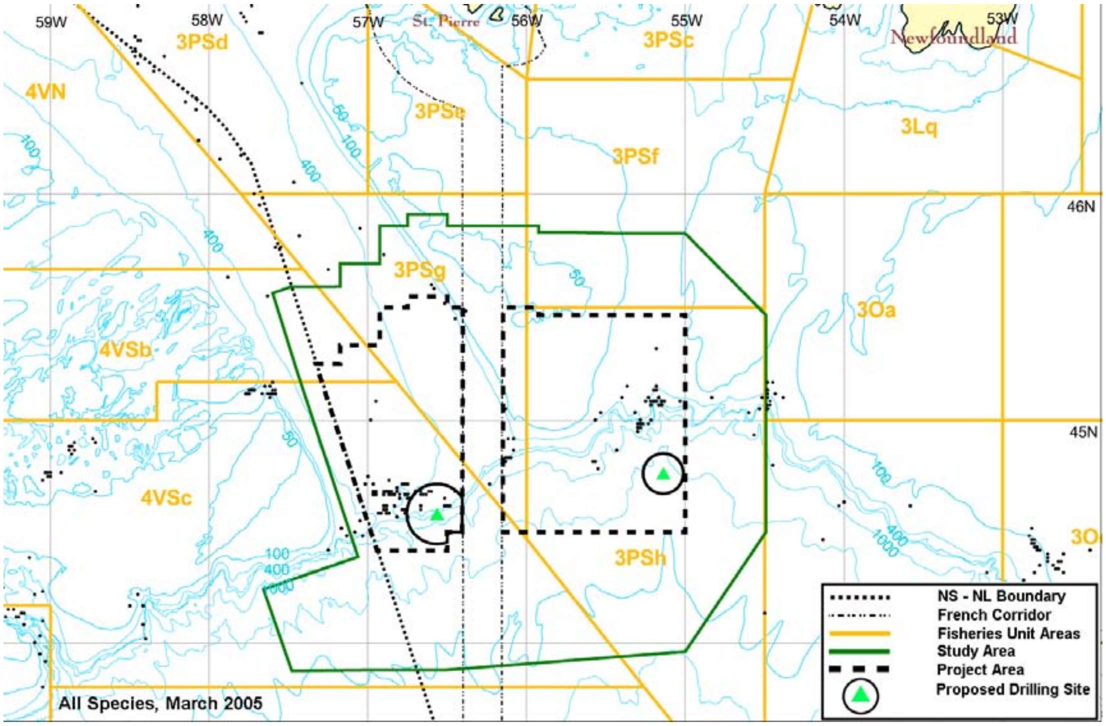

Figure 4.16. All Species Harvesting Locations, March 2005.

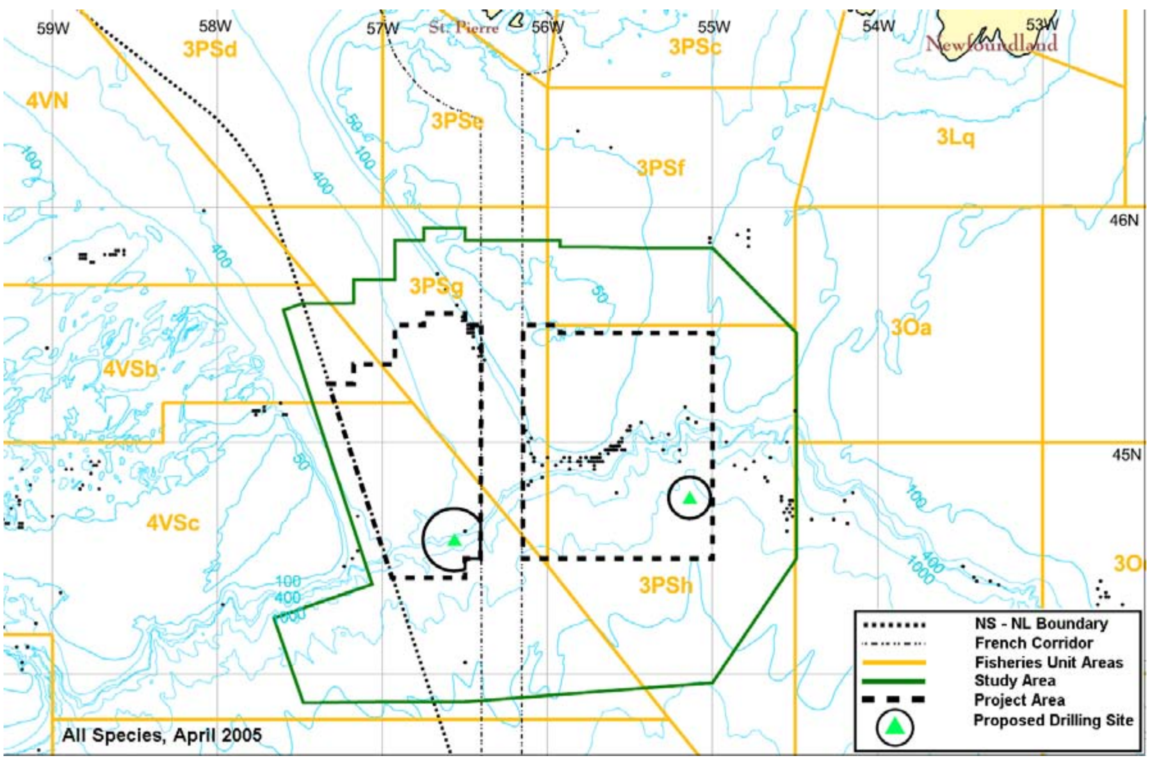

Figure 4.17. All Species Harvesting Locations, April 2005.

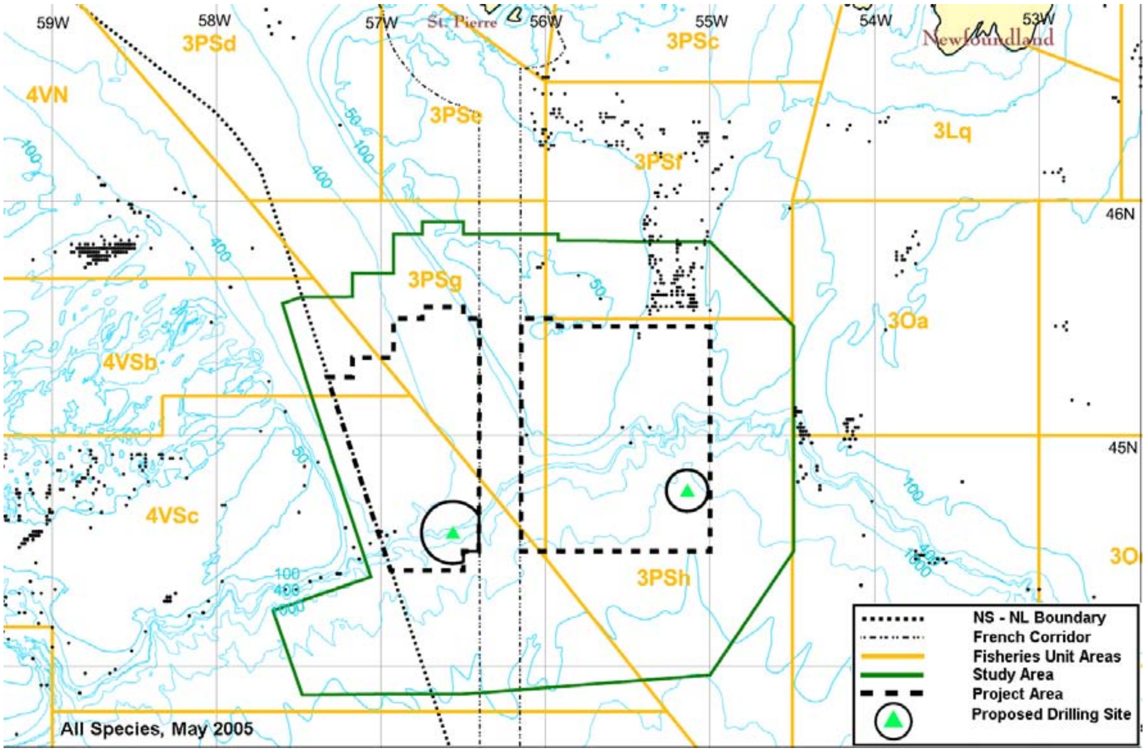

Figure 4.18. All Species Harvesting Locations, May 2005.

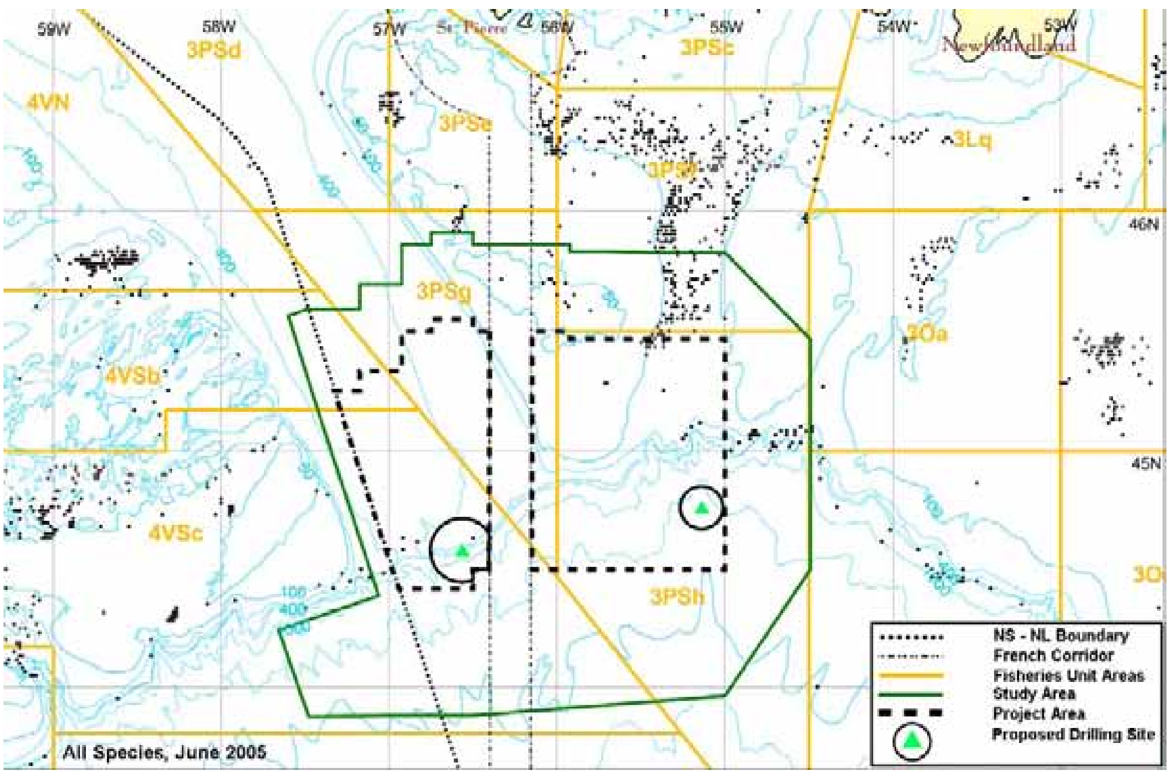

Figure 4.19. All Species Harvesting Locations, June 2005.

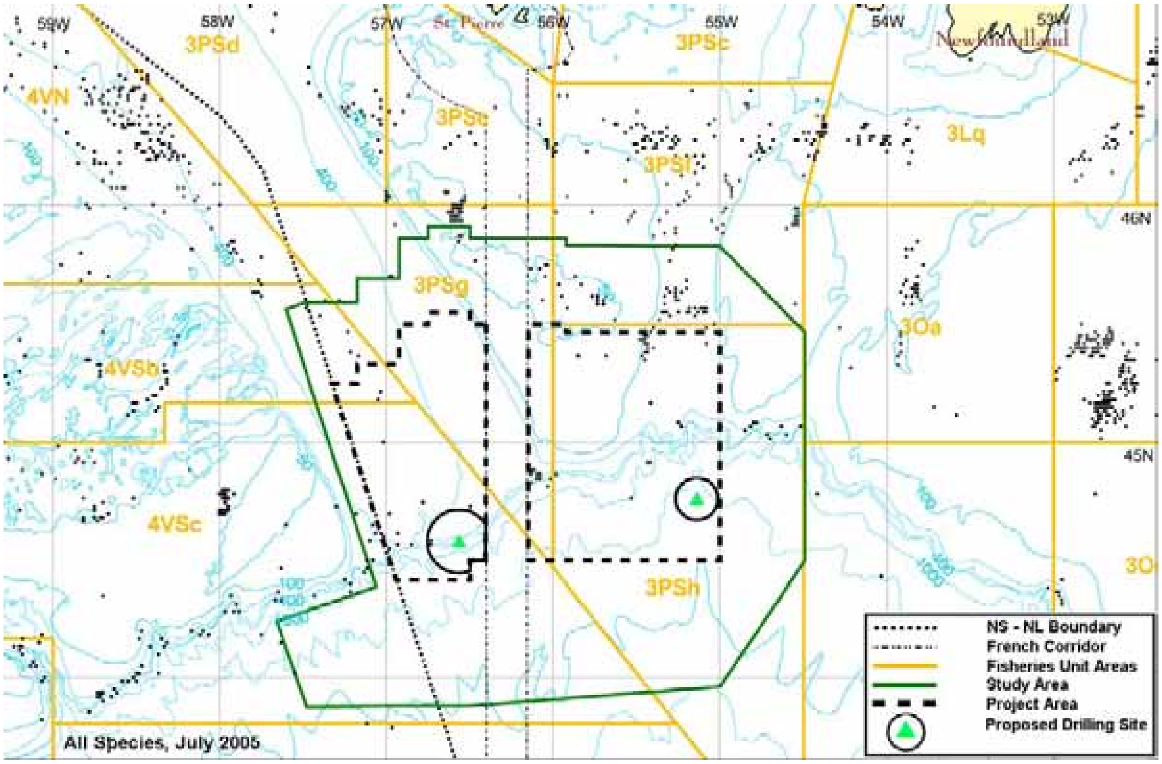

Figure 4.20. All Species Harvesting Locations, July 2005.

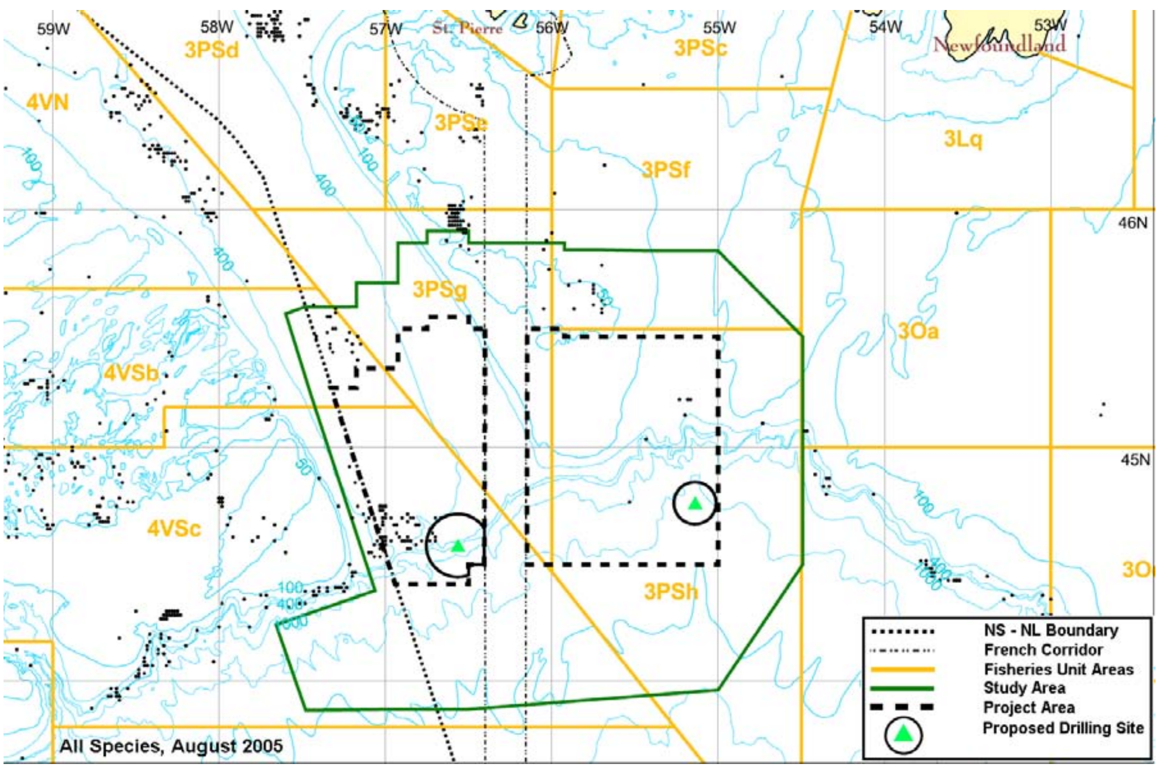

Figure 4.21. Species Harvesting Locations, August 2005.

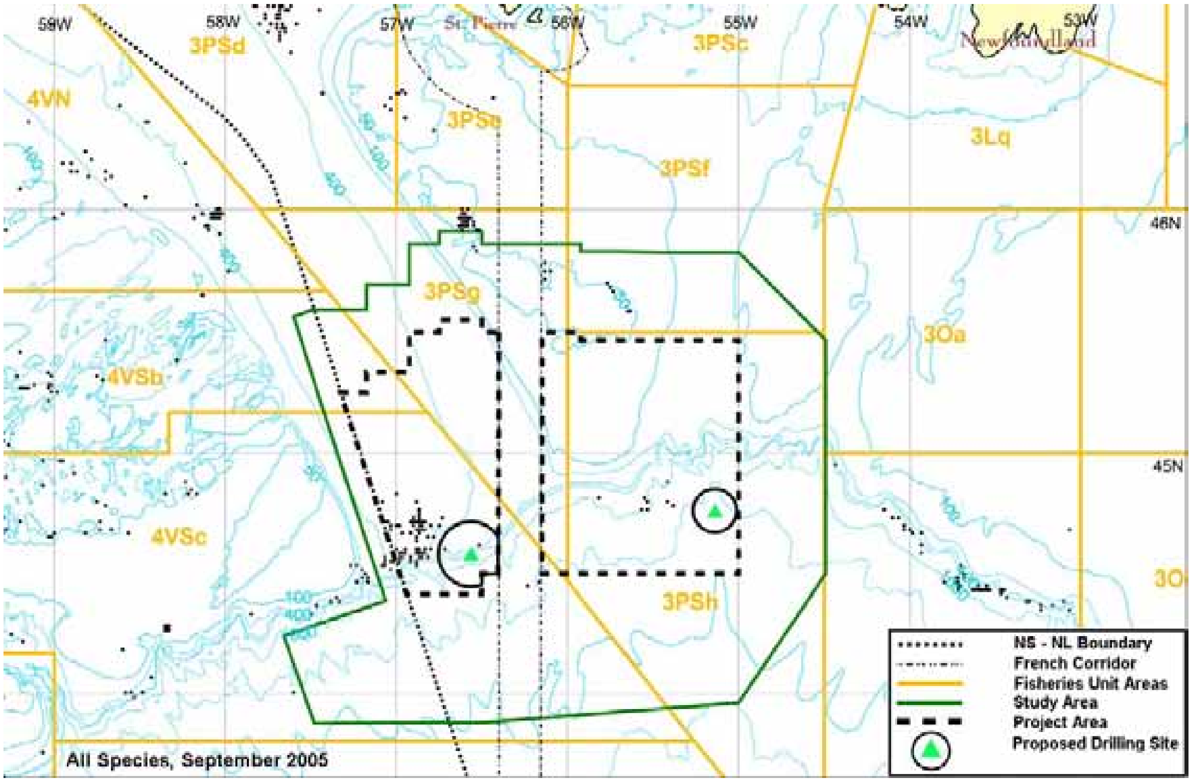

Figure 4.22. All Species Harvesting Locations, September 2005.

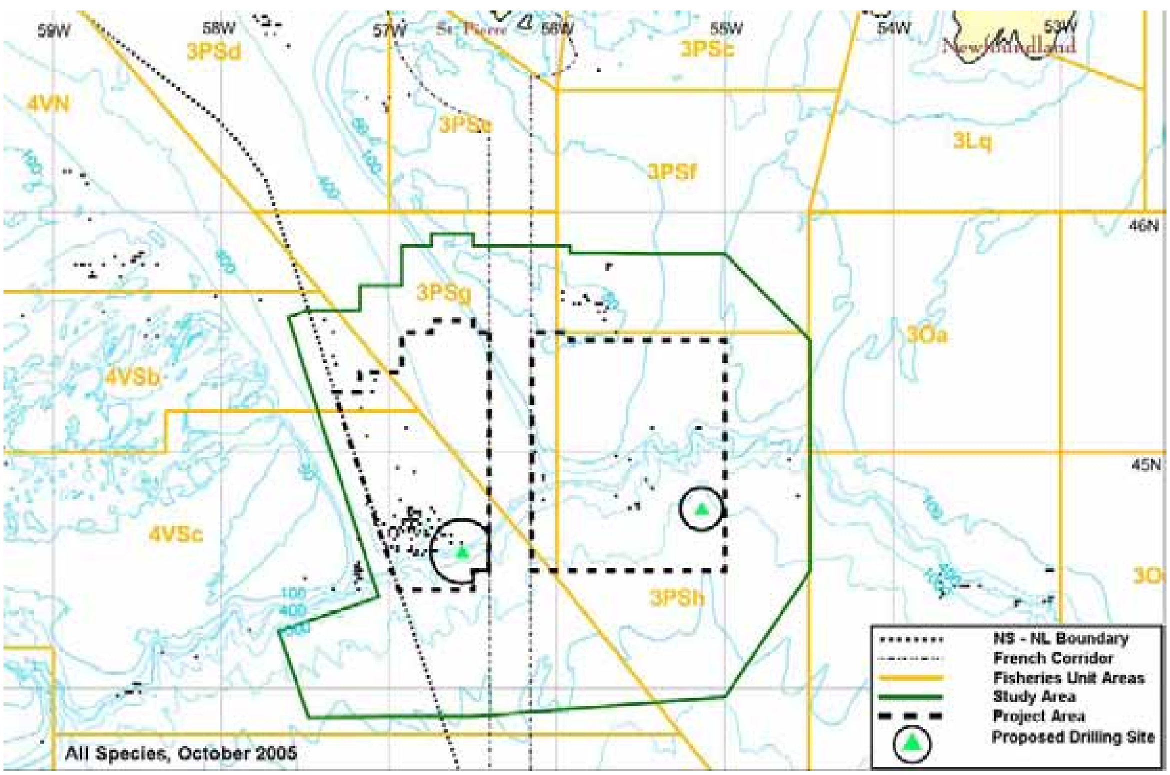

Figure 4.23. All Species Harvesting Locations, October 2005.

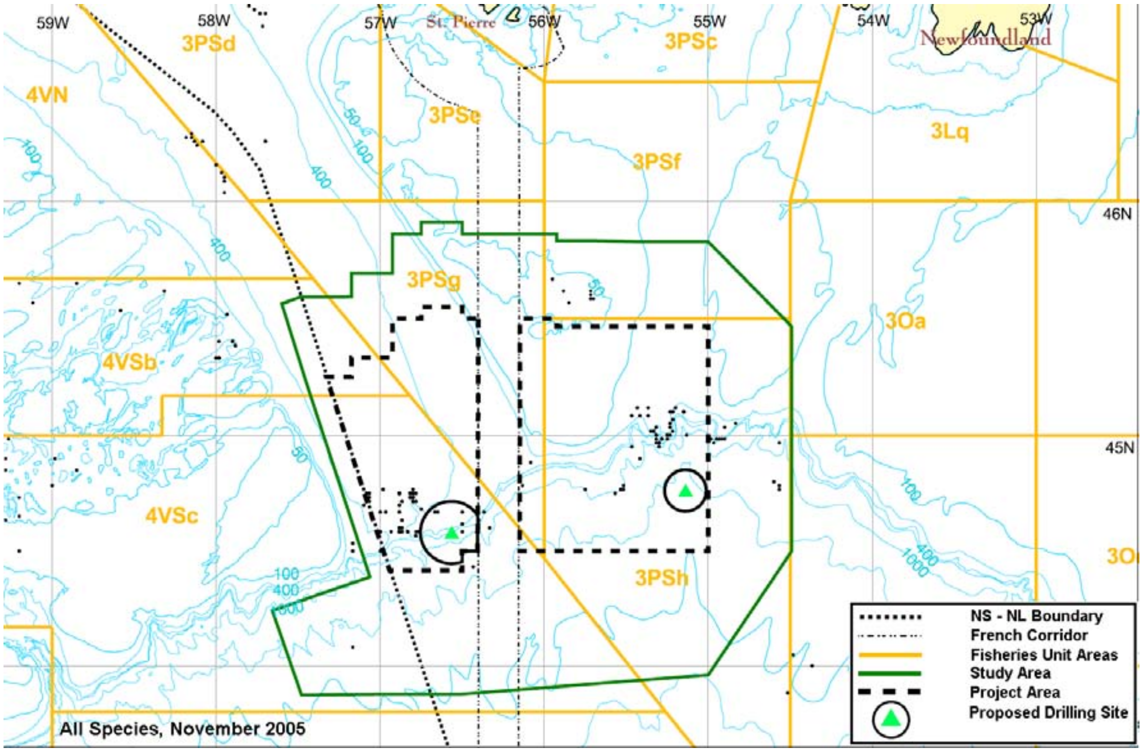

Figure 4.24. All Species Harvesting Locations, November 2005.

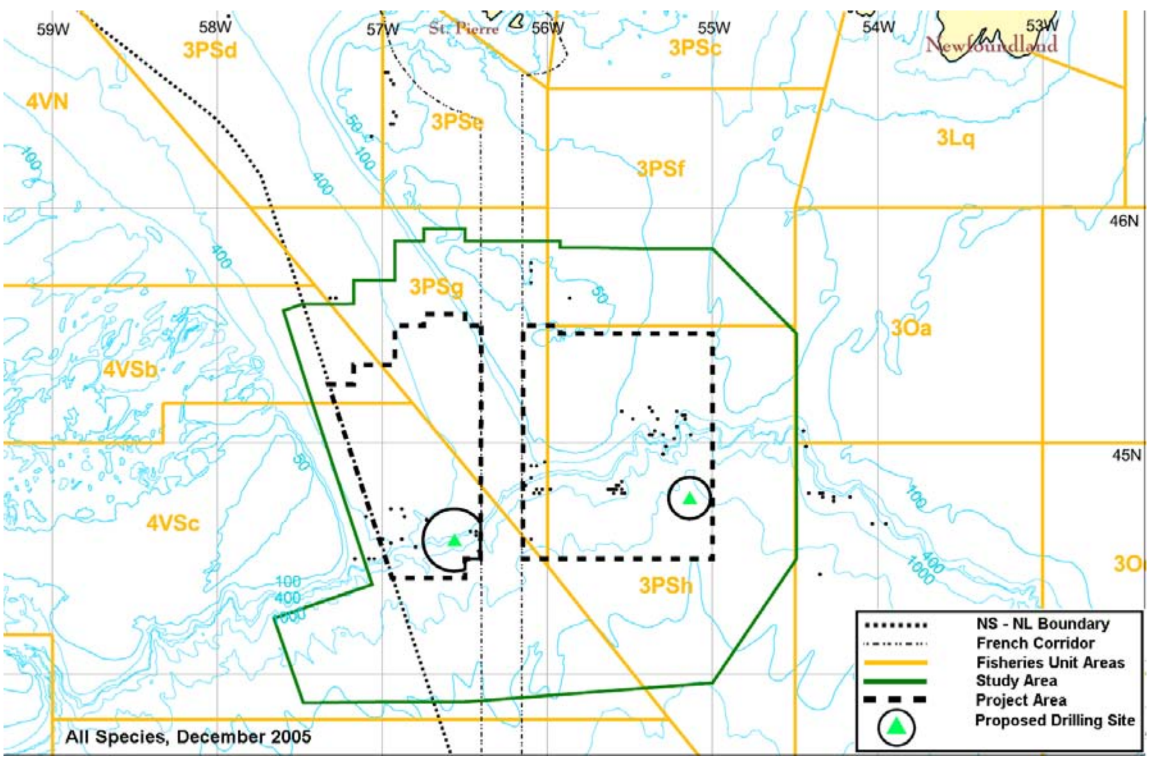

Figure 4.25. All Species Harvesting Locations, December 2005.

4.7.4.3. Principal Species Fisheries

This section describes the principal groundfish and other fisheries that are expected to be active in these areas over the next few years.

4.7.5. Groundfish

As described above, the groundfisheries within both the Study Area and the Project Area have made up the great majority of the catch by quantity for many years. The following maps (Figures 4.26 to 4.28) show the groundfishing locations (including skates) for the past three years. As these maps indicate, there is a high level of consistency in the preferred harvesting locations from year to year.

4.7.5.1. Industry Consultations (Groundfish)

Due to corporate financial difficulties FPI is currently (June 2006) experiencing a major shutdown of its normal groundfish harvesting operation. Managers did provide information about the firm's likely 2006 and 2007 activities, assuming a resolution of these matters in the next few months. They indicated that, as in previous years, FPI vessels may be expected to harvest cod (and some greysole/witch flounder) within the Project Area this year and in 2007. If so, future harvesting will likely take place in January and involve two vessels, one harvesting cod and the other greysole. These activities would still be

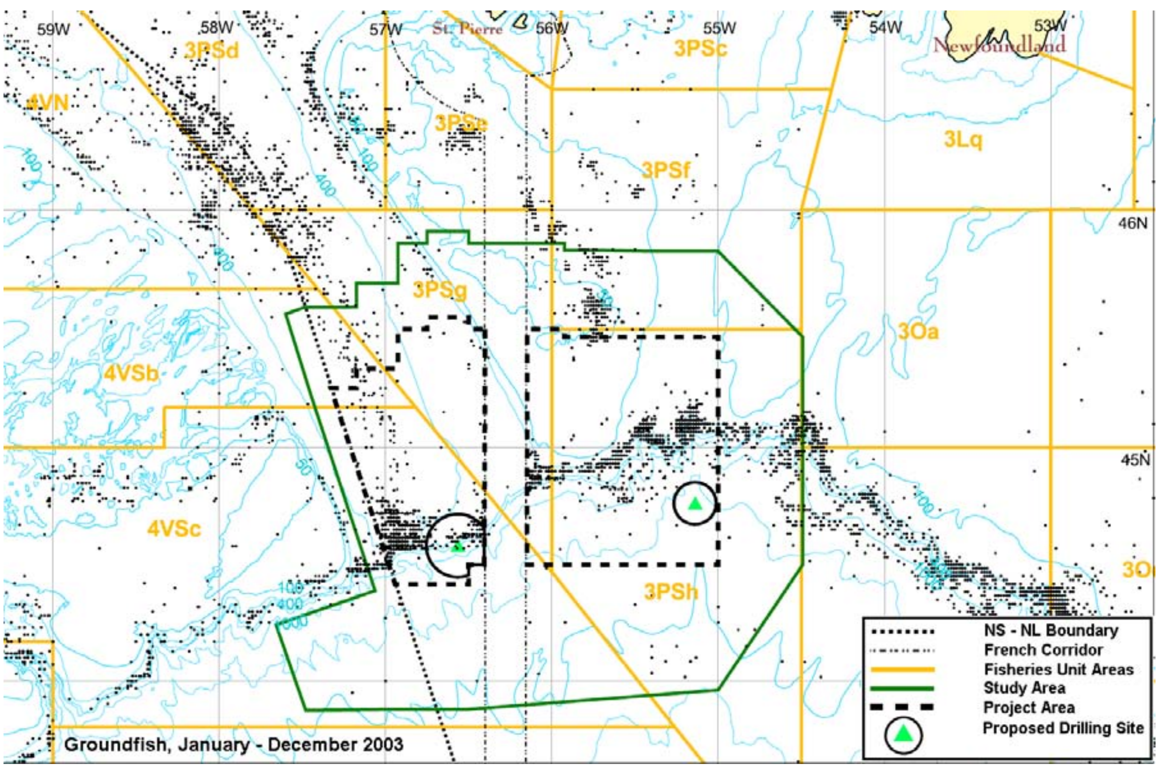

Figure 4.26. Groundfish Harvesting Locations 2003.

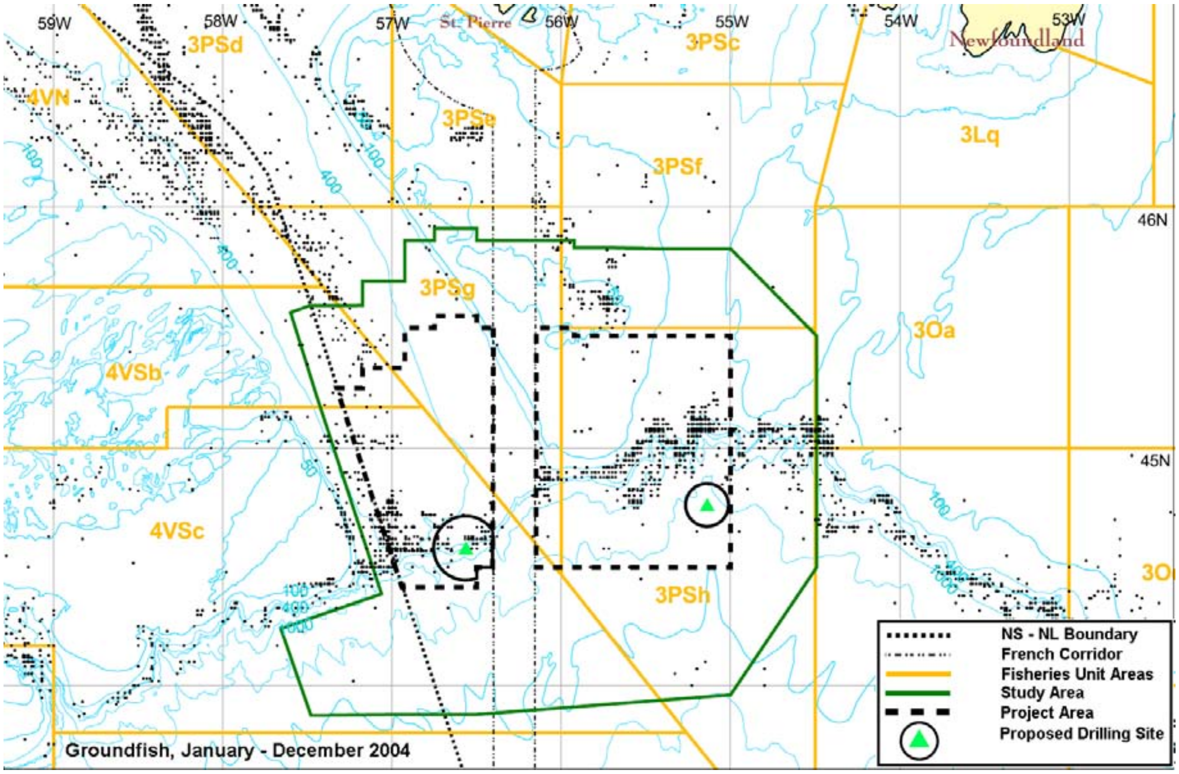

Figure 4.27. Groundfish Harvesting Locations 2004.

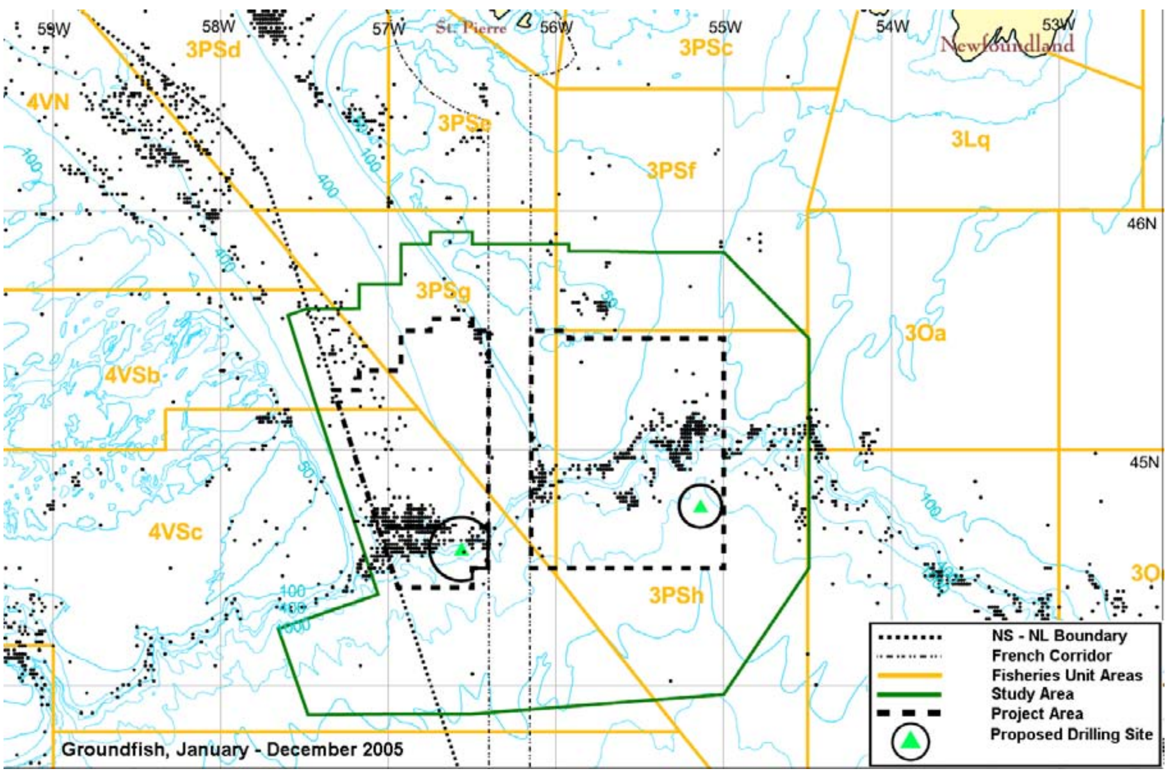

Figure 4.28. Groundfish Harvesting Locations 2005.

concentrated in two locations within the Project Area: (1) along the 200 m contour line in the vicinity of 55 00W and 45 00N, and (2) in shallower water close to the northern boundary of the Project Area, just east of the French corridor. FPI managers noted that their directed cod fishery generally takes place in January and February, while greysole activities occur from January to March. These two species are generally found in the same areas with greysole in somewhat deeper water (D. Fudge, pers comm., June 2006 and FPI meeting, June 2004). As discussed below, FPI vessels are also involved in the annual research survey for 3PS cod.

Clearwater Seafoods Limited Partnership (Clearwater) did not provide any update of its planned harvesting activities for 2006 and 2007. However, based on previous discussions with the firm, it is likely that company vessels would be operating within the Project Area at some point during the proposed drilling activities. For example, in 2004, Clearwater managers reported that the firm would have two vessels harvesting cod and halibut with longline gear during the summer and fall months at various locations within the Project Area (C. Penney, pers. comm., June 2004).

In 2004, an independent fishing enterprises harvesting greysole (flounder) in the vicinity of the Stone Fence (in the western extreme of the Project Area, Figure 4.1) reported that it expected to complete its fishing activities in this area by 1 July, and possibly earlier (W. Grover, pers. comm., June 2004). In 2005, the firm's vessel harvested this species in the same general area during the early spring – 1 April to 15 April, and expects to continue this fishery in future; however, for several reasons, the firm reports that it did not pursue this fishery in 2006. (W. Grover, pers comm. May 2006)

The following sections provide more detailed information on the main groundfish species harvested in the Study Area.

4.7.5.2. Atlantic Cod

As Table 4.8 shows, cod was one of the main species harvested in the Study Area, accounting for just over 29% of the total harvest by quantity during 2003-2005. It is also a major species within the 3PS part of the Adjacent Unit Areas. As Figure 4.4 indicates, the cod fishery in the Adjacent Unit Areas dropped from harvests of more than 45,000 tonnes in 1986 to less than 500 tonnes from 1994-1997. The harvest there has been relatively stable at about 3,500-2,500 tonnes since 2002.

At present, within the Study Area, a directed fishery for cod is permitted in the 3PS portion only. Within 4VS, the cod fishery has been closed to directed commercial fishing since 1993. Typically less than 1% of the cod harvest within 4VS and 3PS is now taken from 4VS waters.

The quota year for 3PS cod is from 1 April to 31 March of the following year, but the fishery is closed during March because it is the spawning season. In May 2006 it was announced by the federal Minister that the Total Allowable Catch (TAC) for 3PS cod would be 13,000 tonnes for 2006, which was down from 15,000 tonnes in 2005 (DFO 2006b). Table 4.9 shows how the 2006/07 quota for 3PS is distributed over the various license categories in Newfoundland and Labrador Region. It also shows the quantity of harvesting by category to 15 June 2006.

Table 4.9. 2006/07 3PS Atlantic Cod Quotas and Harvesting by License Category to 15 June 2006.

License Category / Quota Definition	Quota (tonnes)	Harvested	% Harvested
Mobile Gear < 65', based in 3PS	246	4	2
Mobile Gear < 65', based in 3KL (overlaps)	215	0	0
Mobile Gear < 65' based in 4R3PN (overlaps)	65	15	23
Fixed Gear <65', based in 3KL (overlaps)	344	0	0
Fixed Gear <65', based in 3KL (equivalents)	190	0	0
Fixed Gear <65', based in 3PN (Overlap)	190	57	30
Fixed Gear < 65', Area 9 Overlaps	160	0	0
Fixed Gear < 65', based in Branch / Point Lance	96	0	0
Fixed Gear <35', Placentia Bay - Area 10	3,010	305	10
Fixed Gear 35'-64', Placentia Bay - Area 10	1,142	45	4
Fixed Gear <35', Fortune Bay & West - Area 11	2,608	314	12
Fixed Gear 35'-64', Fortune Bay & West - Area 11	693	33	5
Sentinel Fishery	173	0	0
Fixed Gear 65'-100'	216	8	3
Mobile Gear 65'-100'	0	0	0
Vessels >100'	1,593	0	0
Total 3PS	10,941	781	7

Source: DFO Quota Reports accessed 15 June 2006 (http://www.nfl.dfo-mpo.gc.ca/publications/reports_rapports/ cod_2006.htm).

Figure 4.29 maps the locations of cod fishing activity (georeferenced dataset) for 2005. As the maps show, the harvest was focused within 3PS on and near the shelf edge and St. Pierre Bank.

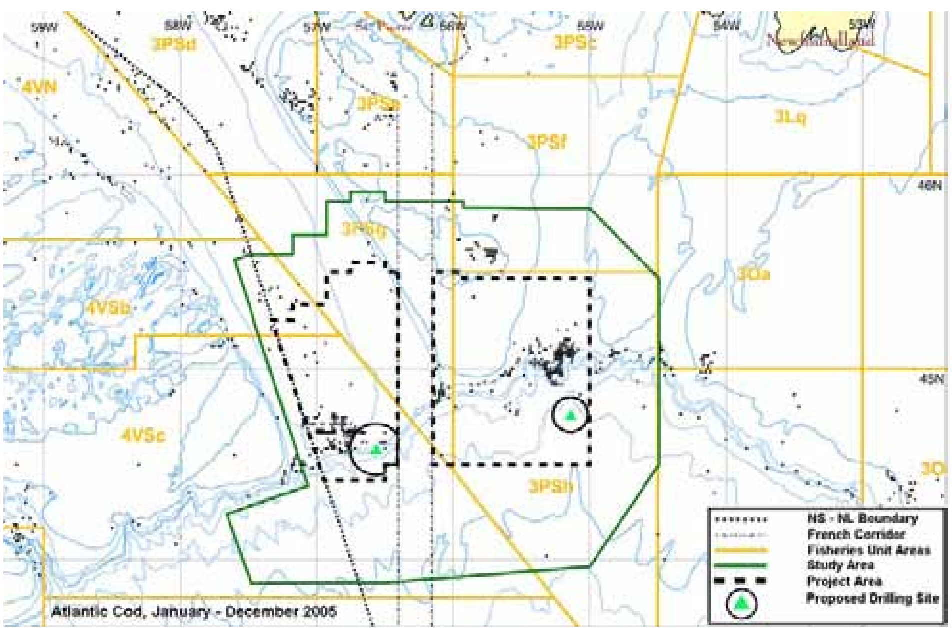

Figure 4.29. Atlantic Cod Harvesting Locations, 2005.

The timing of the fishery in the Study Area was fairly consistent during 2003 - 2005, with relatively little after February until late summer and fall (Figure 4.30).

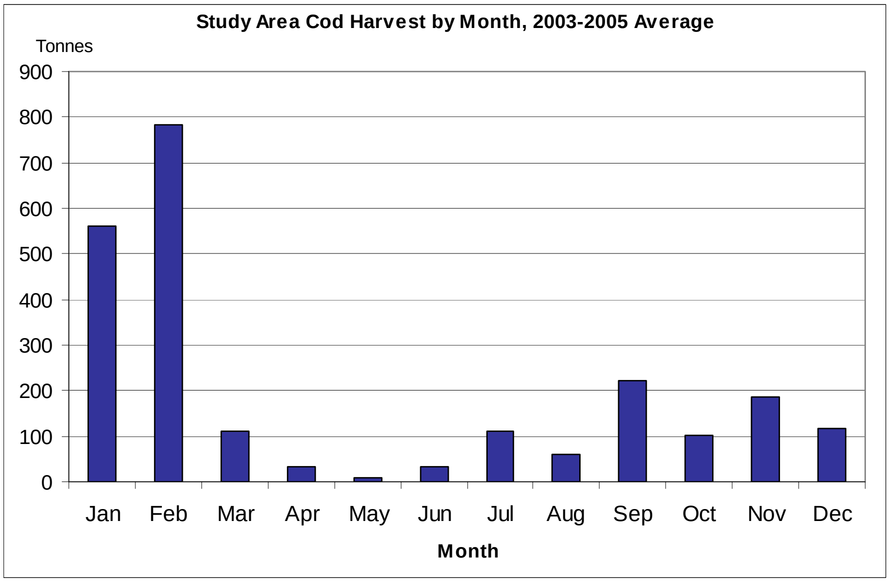

Figure 4.30. Study Area Atlantic Cod Harvest by Month, 2003-2005 Average.

The cod harvest is taken primarily by larger vessels using mobile otter trawls in the Study Area (63% on average over the past three years). The remainder was harvested with set gillnets (26%), and a lesser quantity with longlines (11%). The fixed gear harvest occurred mainly in the summer months.

4.7.5.3. Redfish (spp.) (Ocean Perch)

The redfish fisheries were also very important within the Study Area and Project Area during 2003 - 2005. In these years they made up 22% - 36% of the harvest during the year. Though the fishery involves three species of redfish (Acadian, golden and deepwater), they are harvested as one.

The following map (Figure 4.31) indicates the recorded harvesting locations during 2005.

The fisheries in the area are part of redfish management Unit 2 (3PS4VS4WFG year round, but including 3PN4VN June-December). In May 2006 (DFO 2006b) the Minister of Fisheries announced a TAC increase from 8,000 tonnes (in 2005) to 8,500t for the Unit II redfish, with the increase being used for a scientific survey by the Groundfish Enterprise Allocation Council (GEAC). The majority of the share of the TAC is allocated to offshore vessels based in both Nova Scotia and Newfoundland and Labrador.

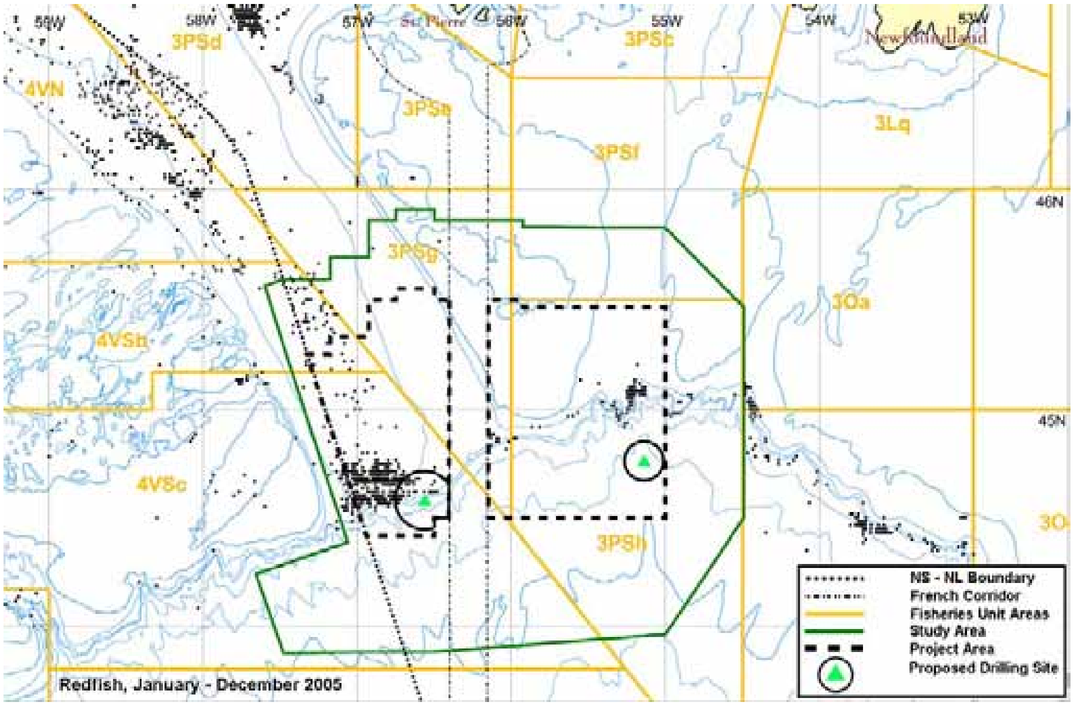

Figure 4.31. Redfish (spp.) Harvesting Locations, 2005.

The season for this species is 1 July to 31 March. There is no directed fishery for this species during the spawning (pupping) period, 1 April to 30 June, which is reflected in Figure 4.32.

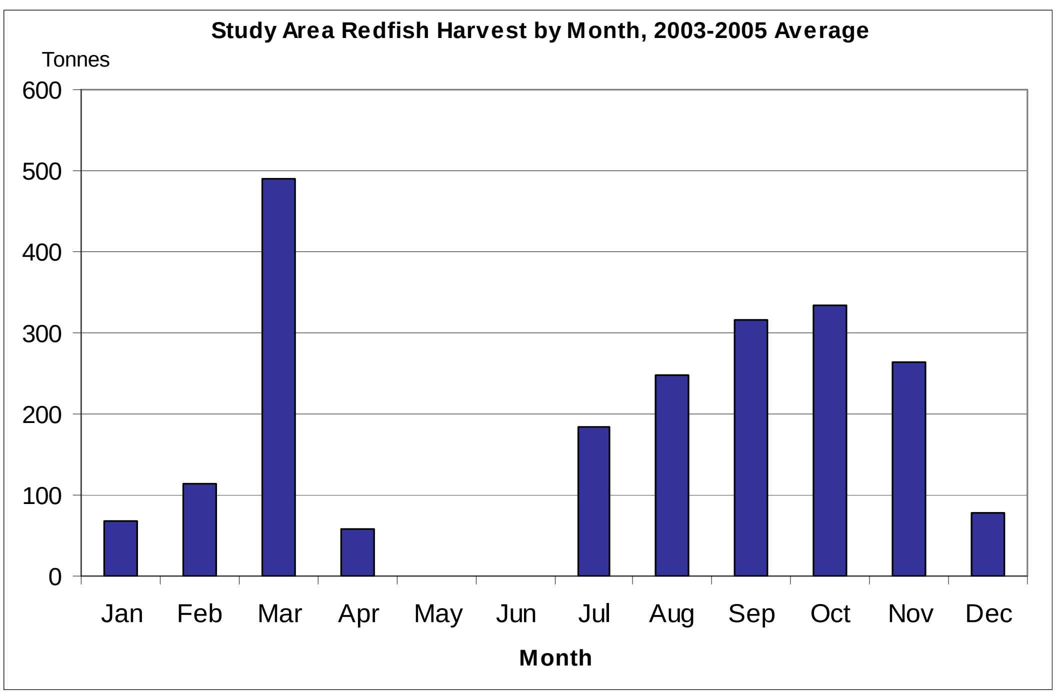

Figure 4.32. Study Area Redfish (spp.) Harvest by Month, 2003-2005 Average.

The harvest within the Project Area is taken largely by bottom (stern) otter trawls, with a smaller proportion harvested using mid-water trawls.

4.7.5.4. Skates (spp.)

Thirteen species of skate are found in Atlantic Canadian waters, but of these the thorny skate (*R. radiata*) is the most common, comprising about 80% of the skate harvested in commercial offshore catches on the Grand Banks and the Northeastern Shelf from 1981–1994, and 90% of the skates caught in groundfish research surveys from 1951 to 1994 (Kulka and Mowbray 1999; Kulka et al. 1996). During 2003 – 2005, skates made up nearly 8% of the Study Area harvest.

Figure 4.33 indicates the recorded skate harvesting locations for 2005. As Figure 4.34 indicates, the great majority of the skate harvest has occurred in April over the past three years in the Study Area.

In Newfoundland and Labrador Region, the management area for the species is NAFO 3LONPs, and in Maritimes Region 4VsW. The 2005/06 TAC is shown in Table 4.10.

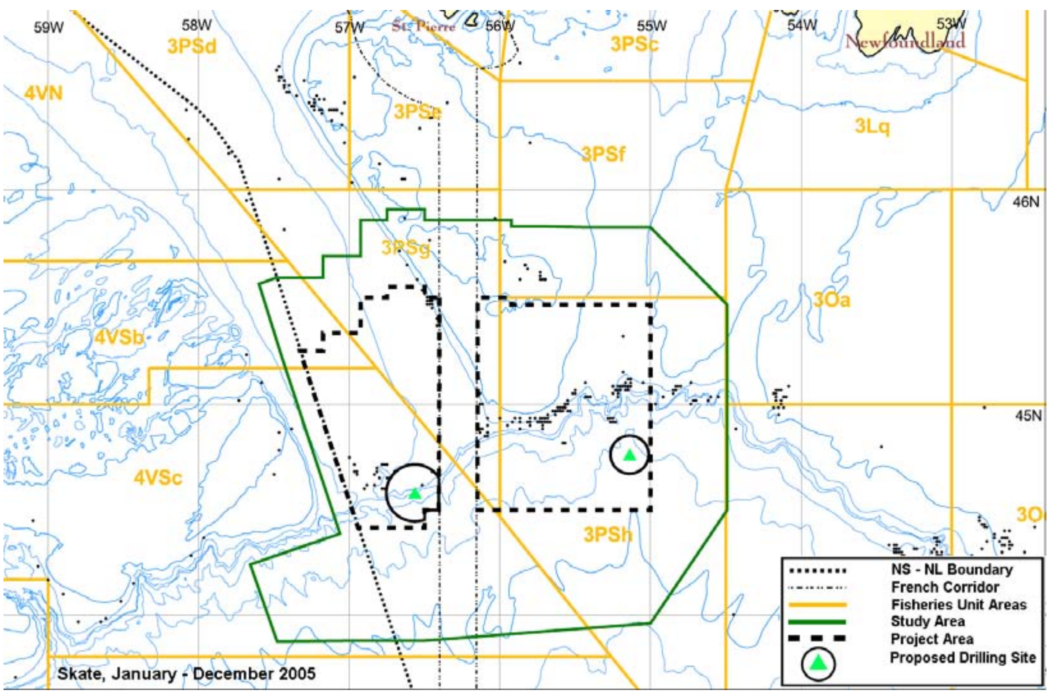

Figure 4.33. Skate (spp.) Harvesting Locations, 2005.

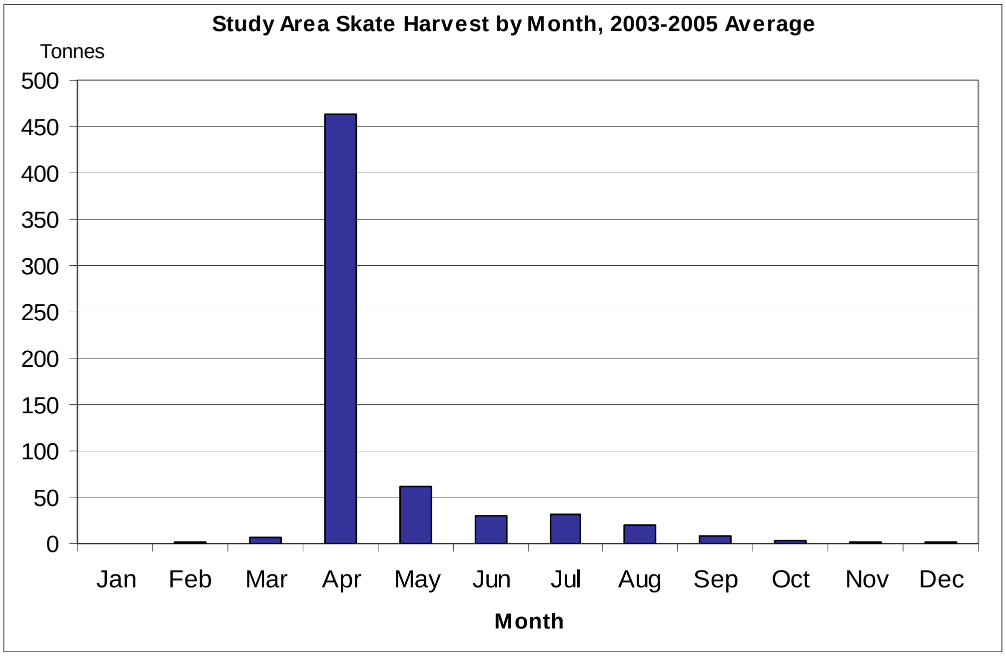

Figure 4.34. Study Area Skate (spp.) Harvest by Month, 2003 – 2005 Average.

Table 4.10. 2005/06 Skate TAC (Quotas) for 3PS and 4VsW.

Area	Gear Sector	Tonnes
3PS	Fixed <35'	250
	Fixed 35' - 64'	250
	Fixed >65'	100
	Mobile Gear	450
Total 3ps		1,050
4VsW	All Fleets Bycatch	200
	Mobile < 65'	0
	Fixed < 65'	0
	Mobile 65' - 100'	0
	Fixed 65' - 100'	0
	Vessels > 100'	0
Total 4VsW		200

Within the Study Area, the majority of the harvest has been with mobile (bottom stern otter trawl) gear, with smaller proportions taken with fixed gillnets and some with longlines. The 200 tonne quota is allocated to one Nova Scotia-based enterprise (W. T. Grover Fisheries Ltd; W. Grover, pers. comm., June 2004). This enterprise now reports that DFO has recently closed his skate fishery entirely as this species of skate has now been placed on the endangered list. Consequently, there will be no skate fishery this year, or in the foreseeable future (W. Grover, pers comm., May 2006).

DFO reports that the four populations of winter skate -- Southern Gulf of St. Lawrence (endangered), Eastern Scotian Shelf (threatened), Georges's Bank/Bay of Fundy/Western Scotian Shelf (special concern) and the Northern Gulf-Newfoundland (data deficient) -- were assessed by COSEWIC in May 2005, but are not yet legally listed as *SARA* species. The winter skates are going through an extended consultation process, so it will be likely Fall 2006 before the Minister's recommendation is acted on (S. Kuehnmund, pers comm., May 2006).

4.7.5.5. White Hake

During the 2003 – 2005 period, white hake made up 7.5% of the Study Area harvest. On the Scotian Shelf and adjacent waters, white hake is caught as a by-catch in the longline, gillnet and otter trawl fisheries targeting other groundfish (e.g., halibut, redfish, cod and pollock). Longlines typically take about 55% of the catch overall, gillnets about 29% and the rest is harvested by otter trawlers (< 65') (DFO 2002d). On the Grand Banks, white hake is not regulated by quotas, but its relatively low market value, and closures because of high by-catch of other species, limit the directed effort inside 200 miles. Beyond 200 miles, there are no constraints and the fishery appears to be expanding there (DFO 2003d).

DFO (2003d) notes that in Newfoundland waters "Landings occur both as bycatch and from a directed fishery. Reported catches in recent years have been mainly from 3Ps and 3O although significant amounts were reported from 3N in the late 1980’s. Catches declined from about 4000 t annually in the 1980's to less than 1000 t in 1994. The average catch from 1994 to 2001 was 1182 t, but increased rapidly to 5399 t in 2002-2003 (2003 preliminary) due to increased non-Canadian activity outside 200 miles. Non-Canadian catches made up 69% of the total reported catch in 2002-2003, up from 20% in 1994-2001."

Figure 4.35 maps the recorded white hake harvesting locations in 2005. Figure 4.36 shows the timing of the harvest for the past three years.

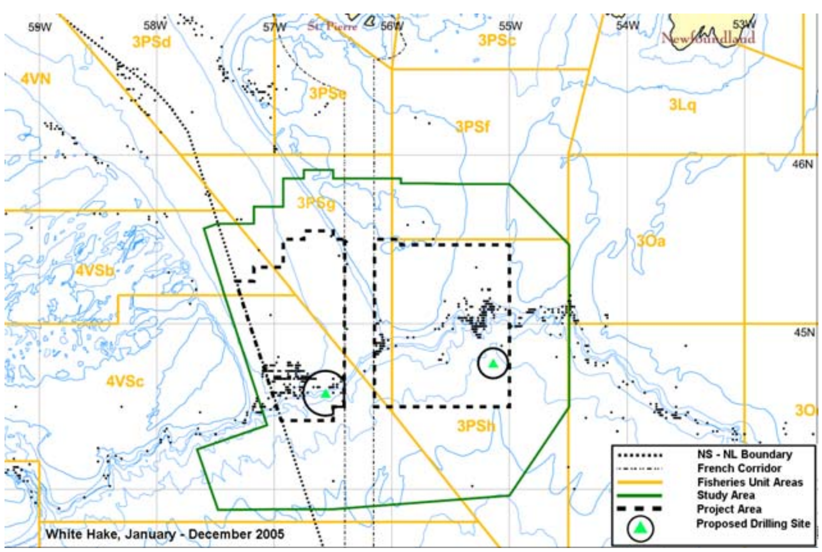

Figure 4.35. White Hake Harvesting Locations, 2005.

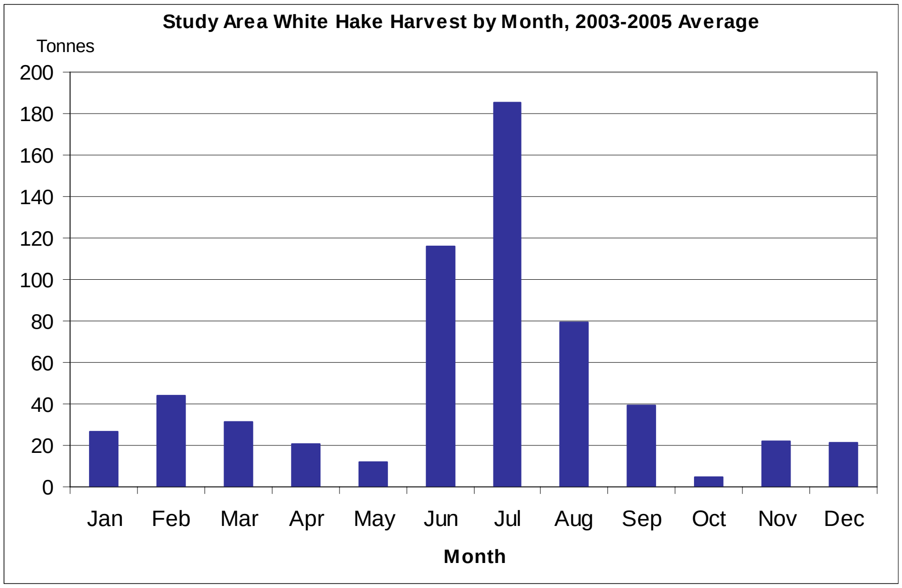

Figure 4.36. Study Area White Hake Harvest by Month, 2003-2005 Average.

4.7.5.6. Other Groundfish Species

A few other groundfish species make up most of the remainder of the groundfish harvest. These are briefly described below.

Atlantic Halibut

The harvest of Atlantic halibut makes up a relatively small proportion of the overall Study Area catch (3.3% for 2003-2005). However, it is a high-value fishery. The major concentrations tend to be along the shelf edge and upper slope, particularly in Unit Area 3PSh, and in 3Oc and 3Od to the east.

The fishery is managed within the management area 3NOPs4VWX5Zc. The TAC for this area in recent years has been about 1,300 tonnes. Most of the quota is allocated to a directed fishery by fixed gear vessels less than 100'. A small allocation is for mobile gear vessels >65'. These mobile gear fleet sectors may take halibut as a by-catch only. Within 3PS, fixed gear vessels (directed) and <65' mobile gear fleet (by-catch) have small allocations, and the bulk is allocated to fixed gear vessels based in 4VWX and 5Zc, mostly under 45'. Over the past three years in the Study Area, 85% of the harvest was taken with halibut longlines, 8% with gillnets and 7% with otter trawls.

Past consultations with a Nova Scotia fishery representative (D. Hart, pers. comm., June 2004) indicated that since the designation of the Sable Gully as a Marine Protected Area in May 2004, halibut fishers are no longer able to set gear there (within MPA Zone 1), which was a favoured fishing location. Consequently, more fishing effort is expected to be direct elsewhere, including – potentially - within the Study Area. Consultations with other Nova Scotia-based fixed-gear fishers also indicated that halibut are taken both inside and outside of 50 miles, where they are harvested along the edge of the Shelf (e.g., along the edge of the Stone Fence). Halibut are usually harvested when they come up over the edge of the Shelf in early June, and fishers report that the bulk of the halibut fisheries along the Shelf are generally completed by late June to early July.

After early June, halibut begin to move inshore where they continue to be pursued by many of the smaller vessels, though some participants in the smaller fleet sector will usually cease their fixed gear halibut fisheries and switch to the harpoon swordfish fishery. At approximately the same time (early July), many of the bigger boats (with the relevant licenses) involved in the fixed gear halibut fishery will cease fishing this species and begin their annual swordfish harvest (A. Henneberry and D. Hart, pers. comm., March 2003).

Greysole (Witch) Flounder

This species may be fished year-round. Most of the Canadian allocation (577 tonnes 2005/06) is harvested by larger (>100’) offshore vessels. Vessels under 100’ have an overall allocation of 156 tonnes: the majority of this is harvested by vessels based in 3PN using Danish seines. Harvests within the Study Area are primarily by the larger vessels using stern otter trawls.

Snow Crab

The region’s Crab Fishing Areas (CFA) locations (based on DFO 2006a,b) are shown in Figure 4.37.

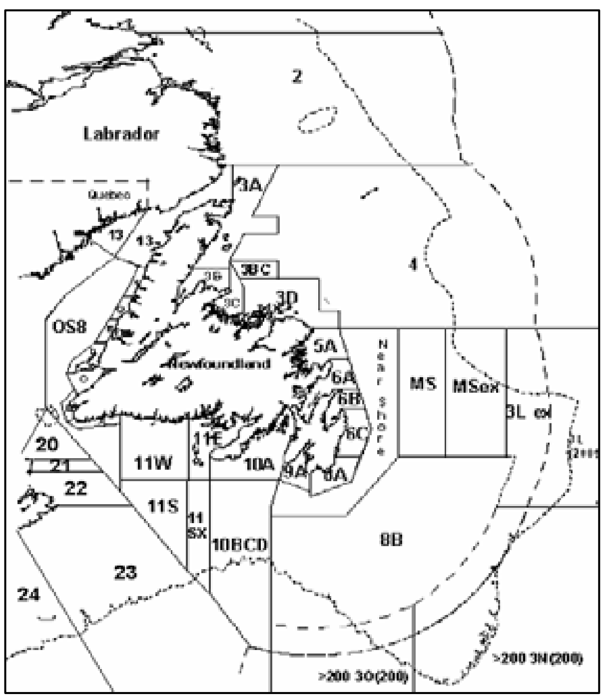

Figure 4.37. Eastern NS and NL Snow Crab Fishing Areas.

In 3P, The Study Area is in part of CFAs 10 and 11; near the Scotian Shelf, the Study Area overlaps with part of CFA 23, though not in areas where harvesting is usually conducted. The snow crab harvested within the Study Area, averaging 12% of the total harvest over the past three years, has been confined almost entirely to Unit Area 3PSf, between the northern limit of the eastern Project Area and the Study Area boundary. Recorded harvesting locations are shown in Figures 4.38 to 4.40. The snow crab fishery uses fixed gear crab pots.

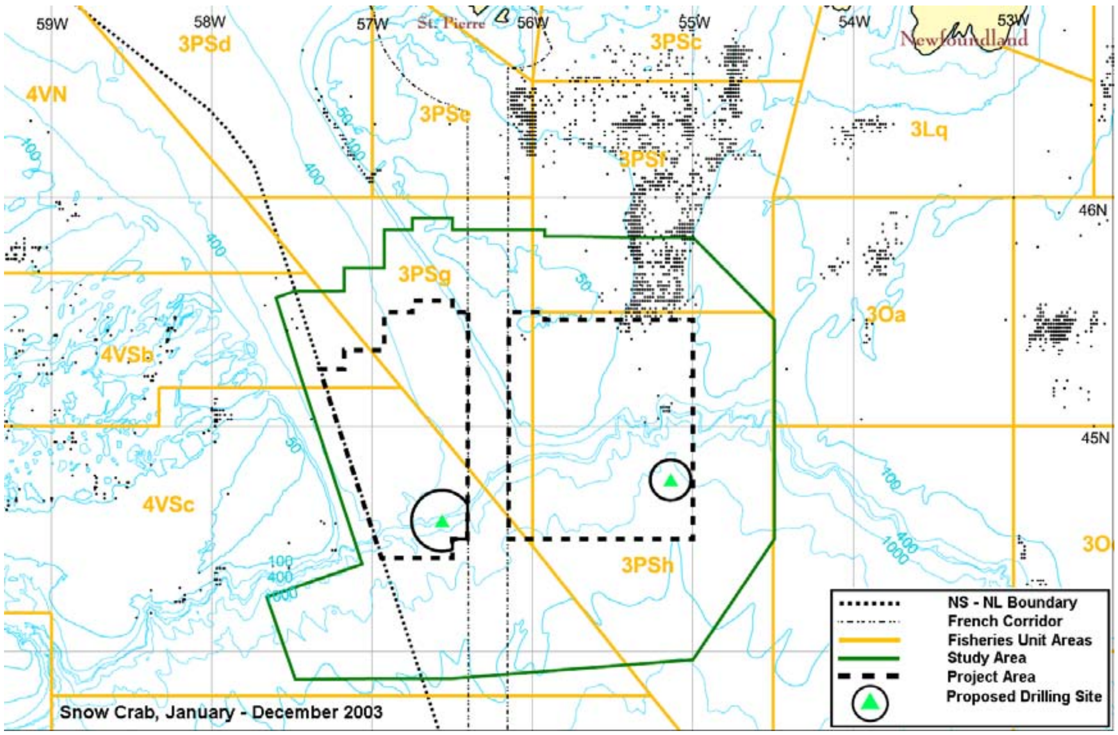

Figure 4.38. Snow Crab Harvesting Locations 2003.

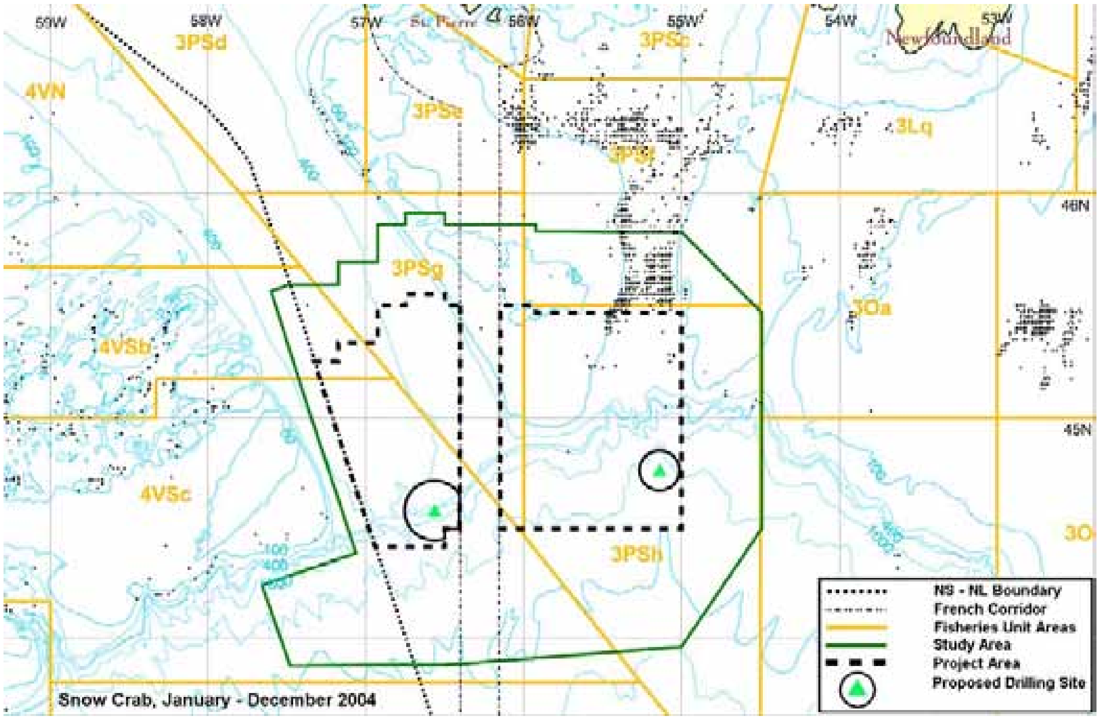

Figure 4.39. Snow Crab Harvesting Locations 2004.

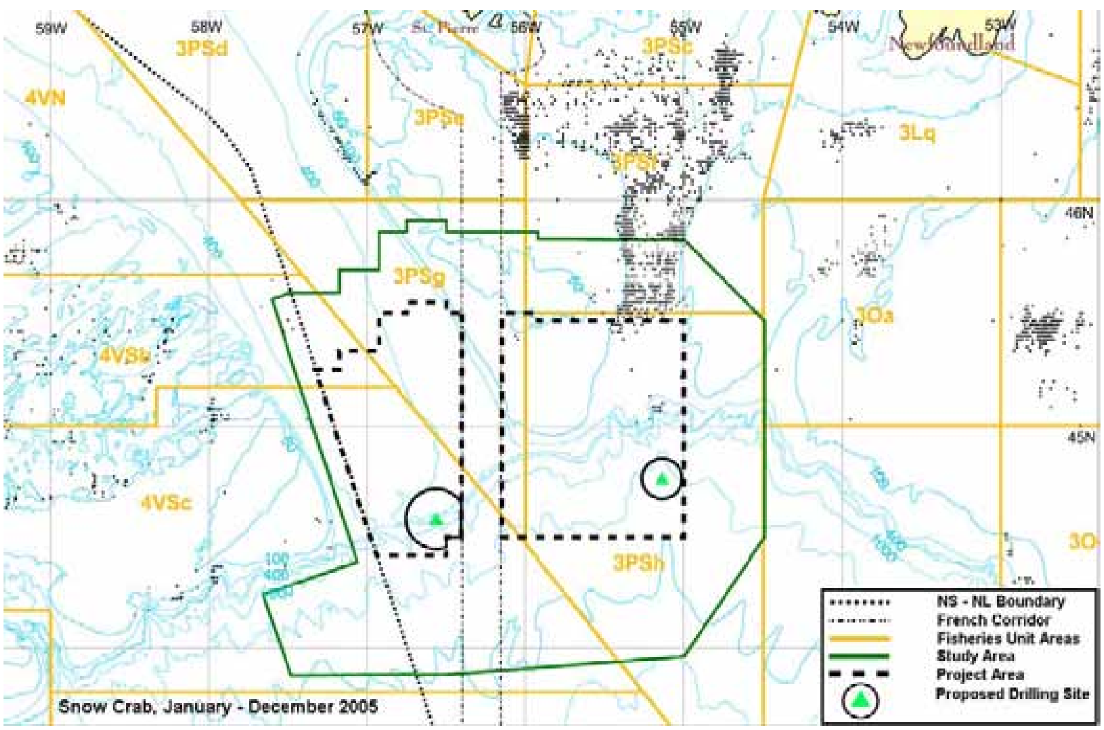

Figure 4.40. Snow Crab Harvesting Locations 2005.

Table 4.11 shows the 2006 snow crab quotas for the Study Area and adjacent licenses (3PS), and also indicates when the harvest closed in 2006. By June 10, 2006, all snow crab fishing in these areas was closed.

Table 4.11. 2006 3PS Snow Crab Quotas.

License Category / Quota Definition	Quota	Taken (t)	% Taken	Date Closed
Supplementary				
CFA 10 Between 46'30"N to 45'35"N (10BCD)	1 885	1995	106%	Jun 10, 2006
CFA 10 Exploratory South of 45'35"N (10X)	0	264	--	Jun 10, 2006
CFA 11 South of 46'30" N (11S)	160	36	22	Jun 10, 2006
Total	2 045	2294	112	
Inshore				
CFA 10 North of 46'30"N (10A)	450	260	58	Jun 10, 2006
CFA 10 North of 46'30"N Outside 12 miles (10A)	525	316	60	Jun 10, 2006
CFA 11 East of Western Head < 35' (11E)	0	202	0	May 15, 2006
CFA 11 South of 46'30"N > 35' (11S)	25	17	68	Jun 10, 2006
CFA 11 S. of 46'30N/W.of 56'30W >35 Exp 11SX	0	9	0	Jun 10, 2006
CFA 11 West of Western Head Hare Bay (11W)	0	0	0	May 15, 2006
Total	1 000	804	80	

This was shorter than the typical harvesting season in this area, as Figure 4.41 indicates. It shows that the snow crab fishery in the Project Area for the last three years has occurred predominantly in the June - August period.

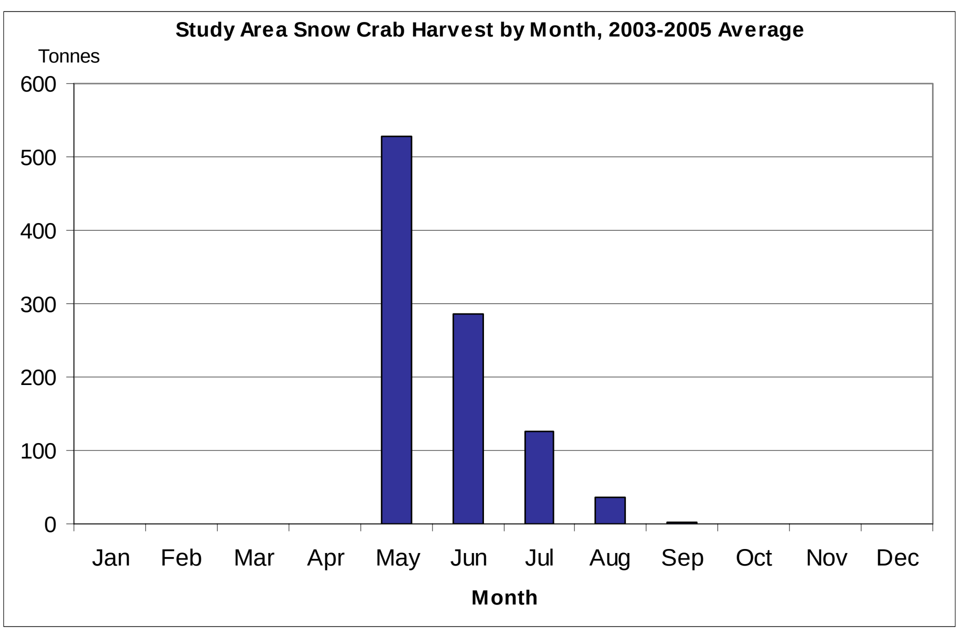

Figure 4.41. Study Area Snow Crab Harvest by Month, 2003-2005 Average.

In Nova Scotia, Snow Crab Area 23, the annual snow crab harvest typically opens on 1 June and is expected completed by about 15 September. The Study Area does not extend into crab grounds usually fished by Area 23 fishers.

Large Pelagic Species

Large pelagic species harvested within the Study Area made up less than 2% of its catch during 2003-2005. These included swordfish, sharks (porbeagle and mako) and tuna (bluefin). Although the total quantities have been very low relative to other species, these are high-value species and the gear used to harvest them is unique, and may be 50 miles long, floating near the surface. These species are harvested almost entirely by Nova Scotia vessels. As Figure 4.42 illustrates, in and near the Study Area these species tend to be harvested along the edges of the shelf, in the thermocline near the 200-m contour. Figure 4.43 indicates when the Study Area harvest occurred during 2003 - 2005, i.e., primarily in August and September in these years.

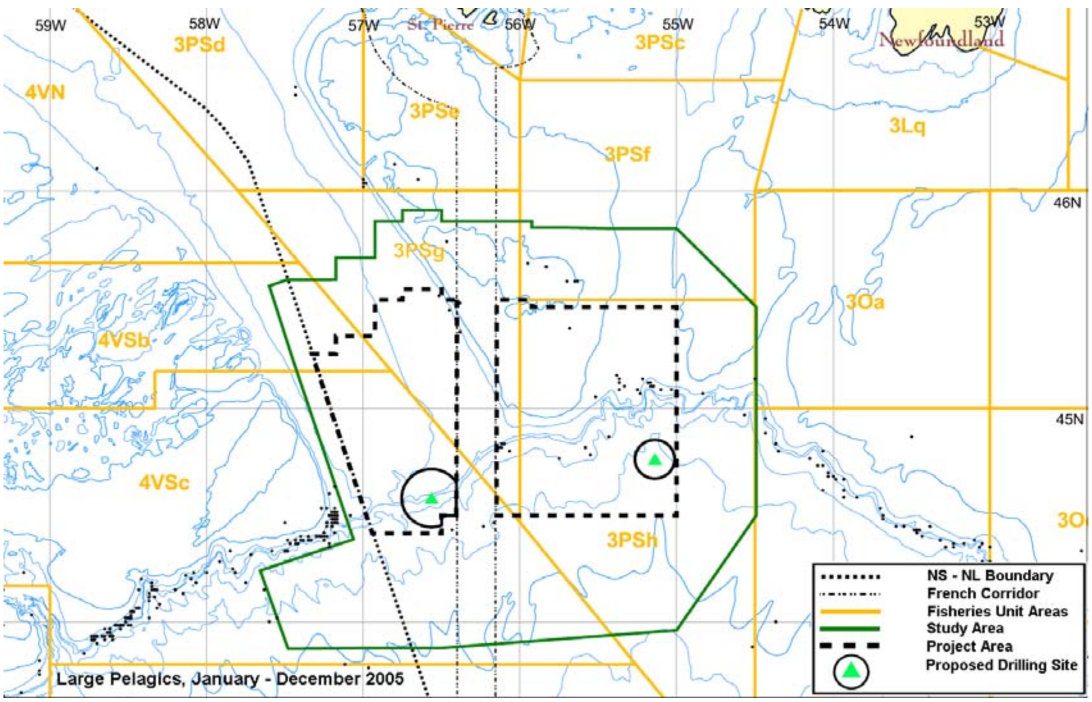

Figure 4.42. Large Pelagics Harvesting Locations, 2005.

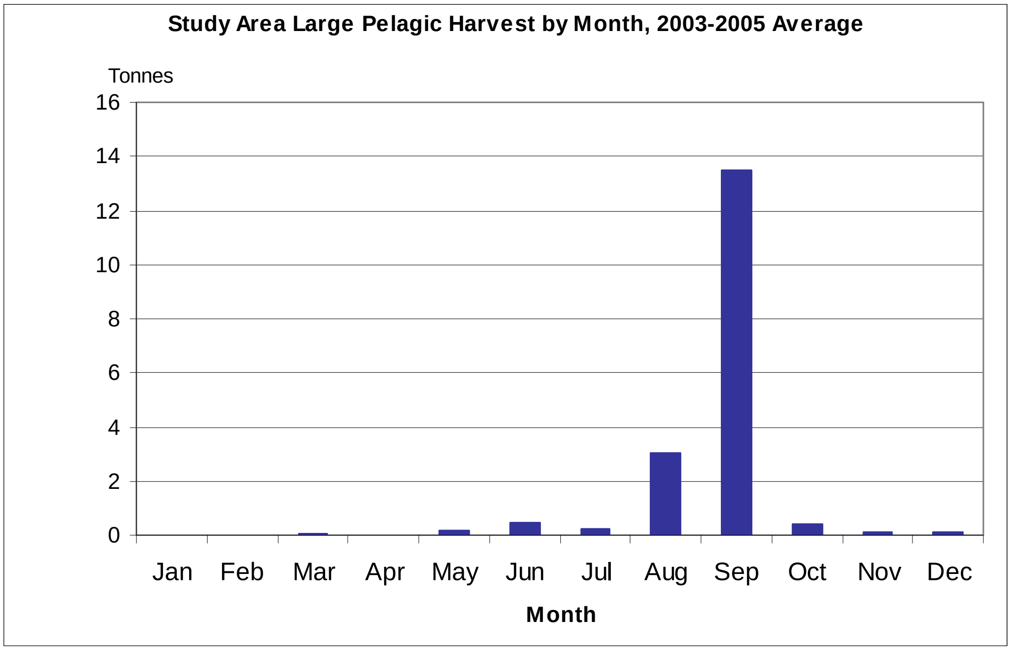

Figure 4.43. Large Pelagics Harvest by Month.

Sea Cucumber

DFO reports that the experimental fishery for sea cucumber (*Cucumaria frondosa*) that began in the St. Pierre Bank area in 2003 is continuing in 2006. The fishery is designed to obtain more scientific data on the species (e.g., population size, distribution) and investigate its potential as a commercial species. Approximately ten fishers are now involved in this experimental fishery and each enterprise has been assigned a specific grid area for harvesting and survey purposes. In previous years, vessels surveyed four grids in their area, completing ten tows per grid. Once they completed the survey portion of their fishery, they proceeded with their commercial harvest. DFO established a tentative total catch of one million pounds (454 t) in 2004, and the same TAC is available for the 2006 fishery. In previous years (e.g., in 2003) some fishers continued to fish into November. However, DFO notes that this fishery is usually completed by the end of August. By September, sea cucumbers typically get soft and are not suitable for the market and harvest is also limited by changing weather conditions (R. Smith, pers comm., June 2006).

The gear (mobile) used is a modified sea urchin drag about 6.5 feet wide to which a 15 foot bag is attached. The gear is towed along the seabed in much the same way as a scallop rake/dredge (E. Way and D. Stansbury, pers. comm., June 2004).

In 2003 and 2004, the areas set aside for this experimental fishery were located on either side of the French Corridor. Figure 4.44 shows the overall experimental fishing area and the 52 grids within this area. As this map indicates, most of the grids were not within the Project Area (the blue horizontal line on the map represents the approximate location of the Project Area's northern limit), but are in the Study Area.

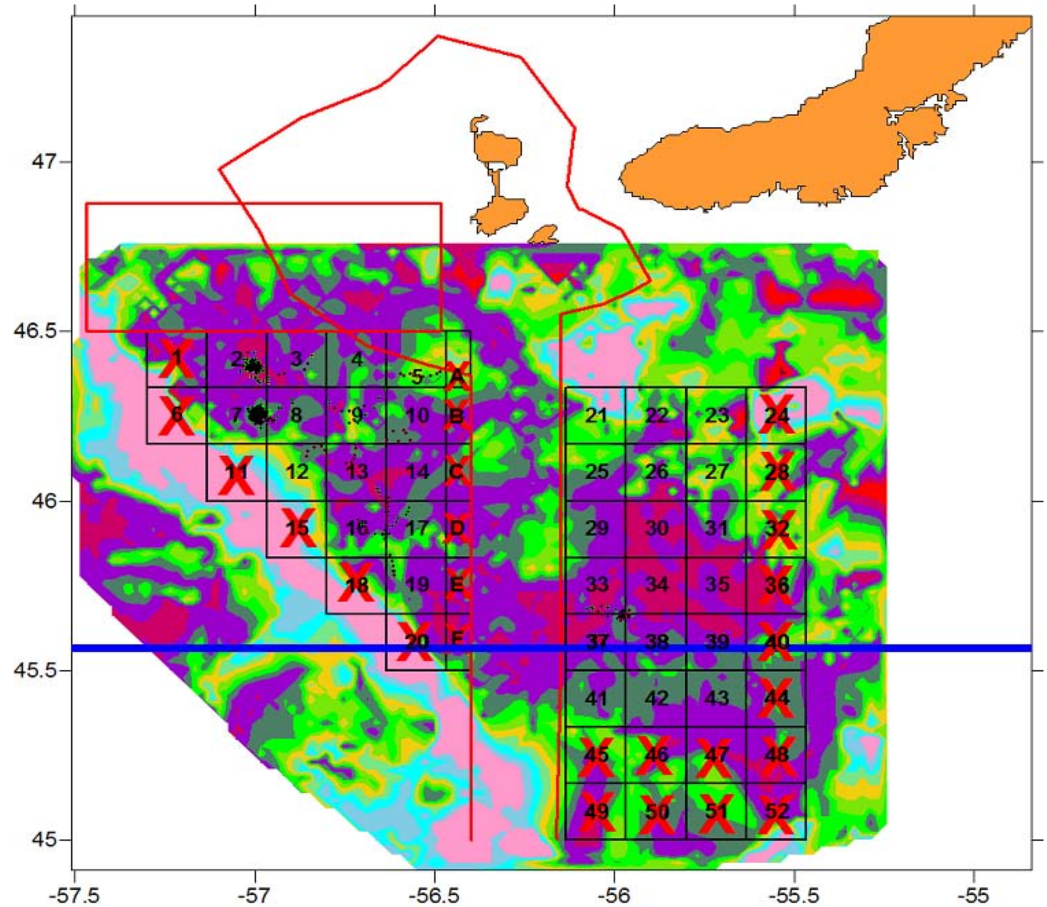

Figure 4.44. 2004 Sea Cucumber Harvesting Grid.
Source: D. Stansbury, DFO.

4.7.6. Fishing Gear

Fisheries within the Project Area are conducted using both fixed (mainly gillnets, longlines and pots) and mobile gear (mainly stern otter trawls). In general, fixed gear poses a much greater potential for conflicts with seismic surveys or other towed equipment, such as that used for vertical seismic profiling or geohazard surveys (e.g., a compressed air sound array and streamer towed behind a vessel, multi-beam sonar, side scan sonar, bottom sampling and/or ROV video equipment). This is because fixed gear is often hard to detect when there is no fishing vessel near by, and it may be set out over long distances in the water. Because mobile gears are towed behind a vessel they pose less risk of conflict because the activity can be more easily observed and located on the water. Survey ships and fishing vessels should be able to communicate with each other and exchange information about their operating areas and activities.

Table 4.12 indicates the quantities harvested by each type in 2003 - 2005.

Table 4.12. Study Area Harvest by Principal Gear Type, 2003 – 2005 Average.

Gear Type	Tonnes	% of Total
Mobile Gear		
Bottom Stern Otter Trawl	4,140.61	51.9%
Midwater Trawl	79.28	1.0%
Fixed Gear		
Gill Nets	1,237.22	15.5%
Longlines	606.14	7.6%
Pots	989.88	12.4%
Total	7,982.10	100.0%

The following maps (Figures 4.45 to 4.50) show the location of fixed gear and mobile gear fishing in 2003, 2004 and 2005.

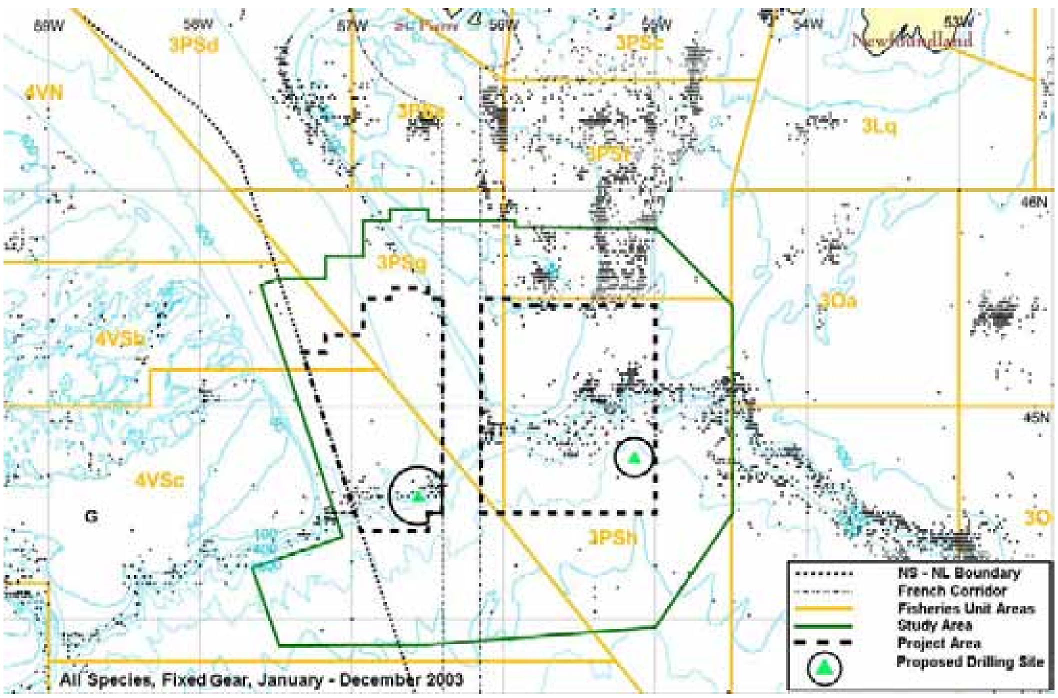

Figure 4.45. Fixed Gear Harvesting Locations, 2003.

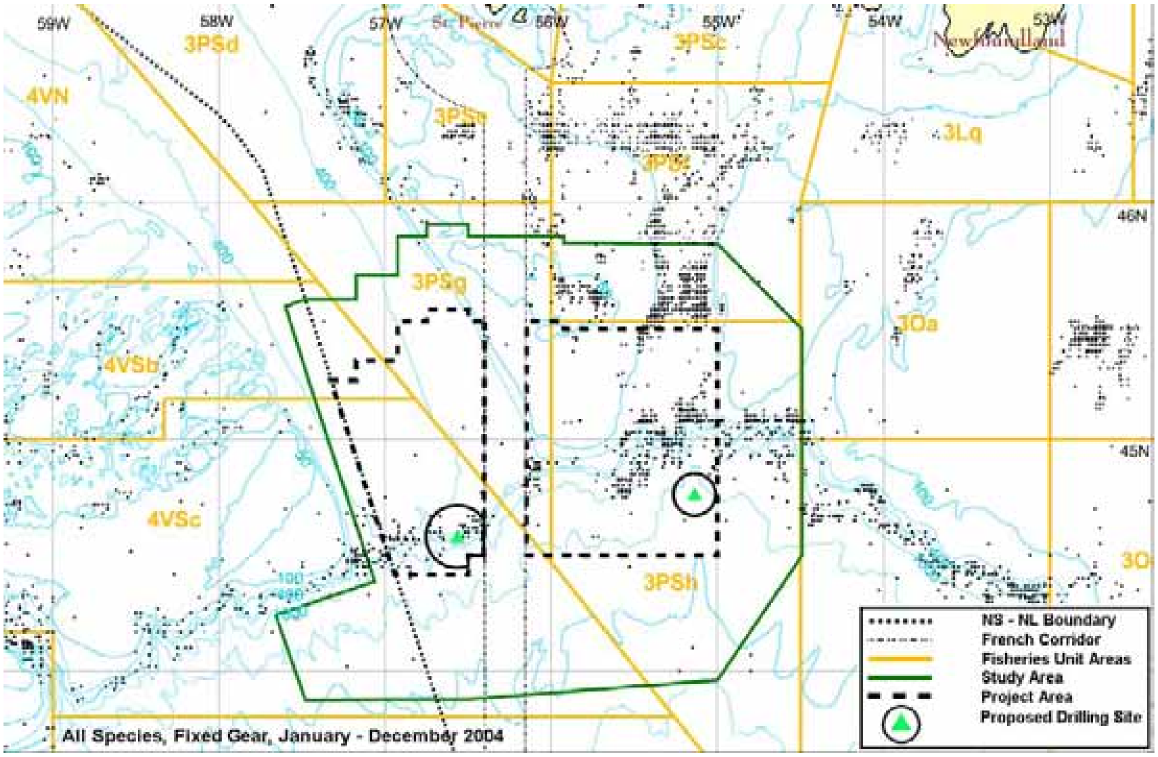

Figure 4.46. Fixed Gear Harvesting Locations, 2004.

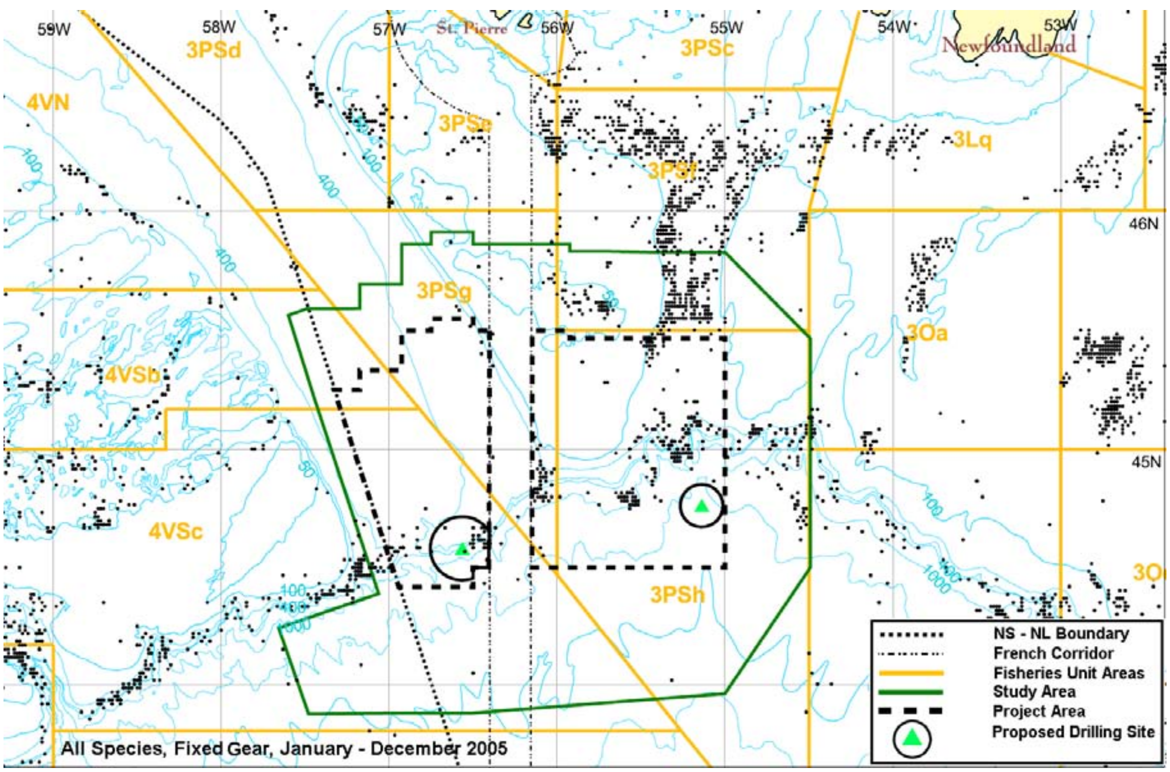

Figure 4.47. Fixed Gear Harvesting Locations, 2005.

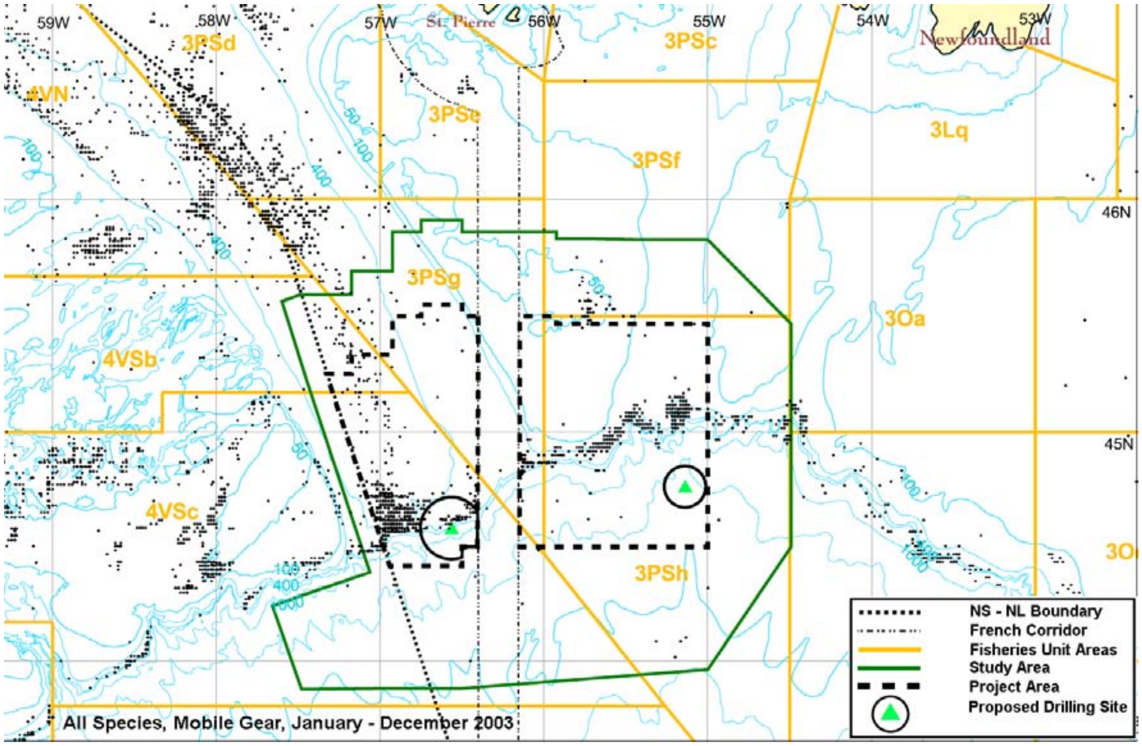

Figure 4.48. Mobile Gear Harvesting Locations, 2003.

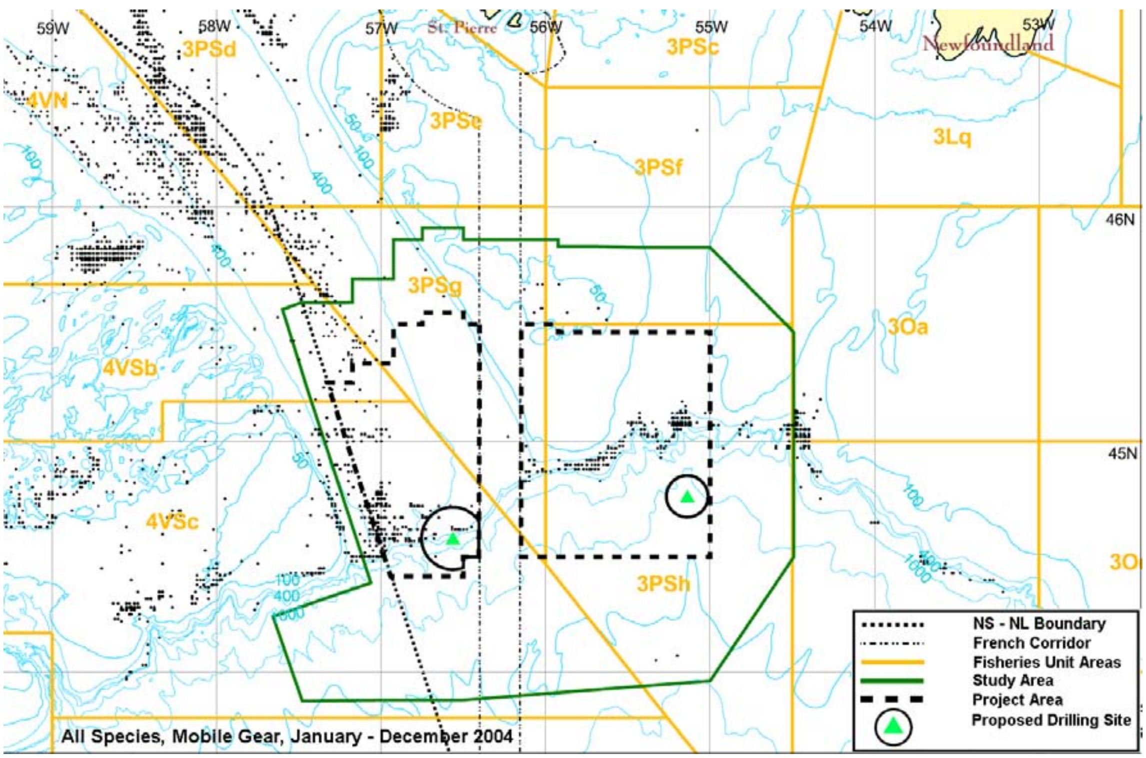

Figure 4.49. Mobile Gear Harvesting Locations, 2004.

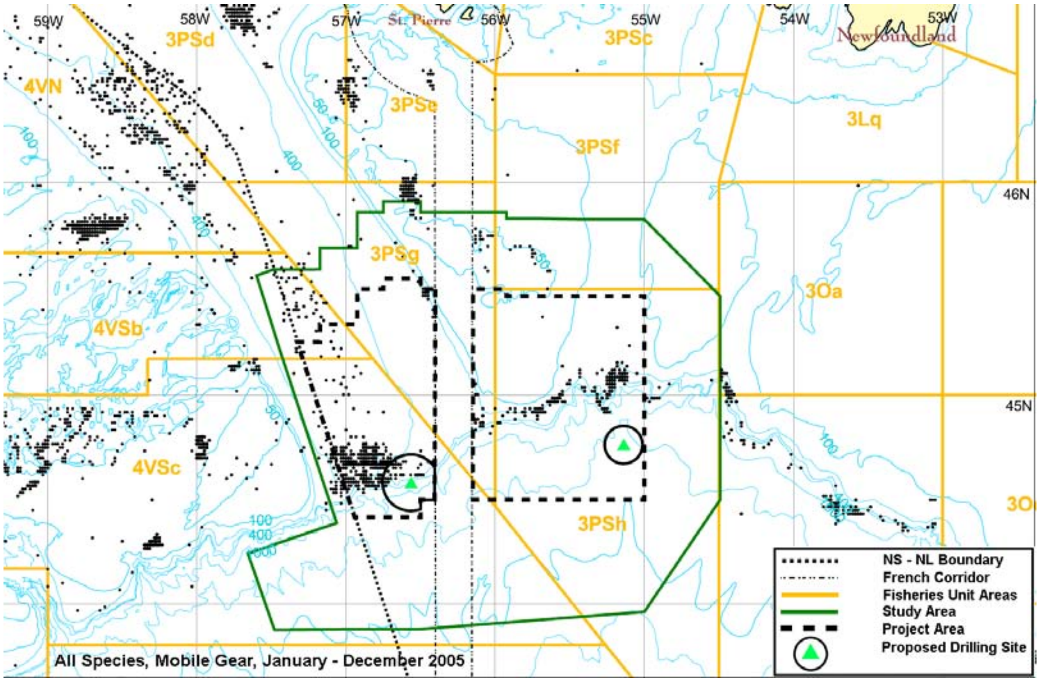

Figure 4.50. Mobile Gear Harvesting Locations, 2005.

Within the potential initial drilling site (see circles on maps), which is where any initial site surveys would likely take place, there was no recorded harvest within the eastern area during 2003-2005. Within the western area, the harvest has been taken with both fixed and mobile gears. The harvest in this area was primarily redfish (by quantity of harvest) (Figure 4.51).

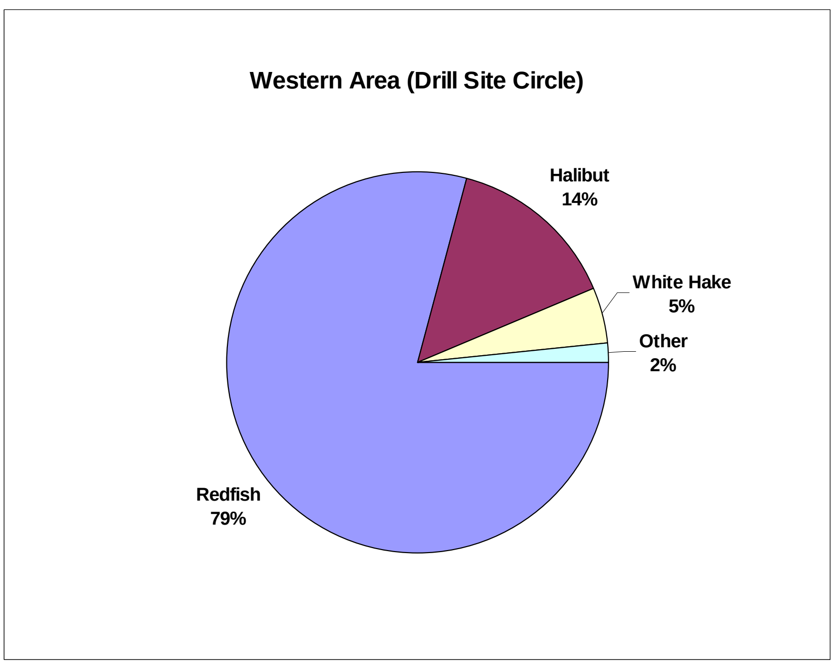

Figure 4.51. Composition of Harvest, Western Proposed Drilling Site Area.

4.7.7. Fishing Vessels

In 2003, the majority of the catch (68% by quantity) in the Project Area during June - November was taken by vessels less than 65' in length. The remainder was by vessels up to 200'. The 2003 Laurentian Channel SEA (JWEL 2003) provides the following information (Table 4.13) about fishing vessel size in the general area.

Table 4.13. Frequency of Vessel Sizes within 3PS and 4VS, 1995 – 2001.

Length	1995	1996	1997	1998	1999	2000	2001
NAFO 3PS							
1-34.9 ft	266	204	305	454	6,256	5,451	11
35-44.9 ft	527	808	1,352	3,021	5,434	5,444	99
45-64.9 ft	586	462	604	1,245	1,080	911	64
65-99.9 ft	361	103	83	357	416	288	130
100-124.9 ft	203	148	71	274	170	244	188
>124.9 ft	513	585	471	1,167	1,269	1,621	154
Missing	-	-	-	-	-	-	7,361
Total	2,886	2,044	2,038	2,358	5,009	4,084	3,960
NAFO 4VS							
1-34.9 ft	46	73	58	26	141	57	46
35-44.9 ft	876	661	674	631	730	1,279	1,329
45-64.9 ft	856	668	479	349	355	592	580
65-99.9 ft	448	234	255	173	170	161	194
100-124.9 ft	200	198	319	400	566	453	267
>124.9 ft	913	781	753	1,890	2,264	1,112	450
Missing	-	-	-	-	-	-	1,148
Total	3,339	2,615	2,538	3,469	4,226	3,654	4,014

(based on Table 6, Appendix C, JWEL 2003)

4.7.8. DFO Research Vessel and Industry Surveys

DFO and the fishing industry conduct fisheries research surveys throughout most of Atlantic Canada's offshore each year. Most recur annually; some might run for a few years, and a few are unique or one-time. The purpose of most of these surveys is to contribute information and field data to understanding the status and health of various commercial fish and invertebrate stocks, and – in some surveys – the other non-commercial species, as well. Most are conducted by collecting (catching) specimens using various types of nets or other harvesting gear.

The following table (Table 4.14) indicates the anticipated approximate timing of DFO research vessel (RV) surveys that could overlap parts of the Study Area or areas nearby. (It should be noted that some surveys cover very large areas outside the Study Area – e.g., the 4VWX survey, which includes all Scotian Shelf NAFO Divisions.) These schedules may vary from year to year, but tend to occur about the same time. In any given year, the relevant DFO planners and scientists will be contacted in order to avoid any potential conflicts. The following table indicates timing in recent years.

Table 4.14. DFO Research Surveys, Scotian Shelf, Southern Laurentian Channel and Eastern Grand Banks.

Survey	NAFO Division location	Approx. Timing
4VsW RV survey	4VsW	March
Summer RV survey	4VWX	July
Multispecies survey	3PS	April - May

DFO RV survey data collected in the vicinity of the Study Area during 2003-2005 were requested in early April 2006 but have not yet been delivered.

GEAC has also been involved in conducting fisheries research in the general area of the Project in recent years. FPI vessels have typically been involved in GEAC's annual redfish and multispecies research surveys in the area. While GEAC will not be conducting surveys in 2006, (D. Power, DFO, pers. comm.), company managers expect they, or other GEAC member companies, will be undertaking these activities again in 2007.

FPI expects GEAC to complete its next redfish index fisheries research survey in the vicinity of the Project Area in 2007. FPI managers noted that the Unit 2 redfish survey generally takes about 12 days to complete, and there are many survey locations (stations) within the proposed Study Area (Figure 4.52). The vessel proceeds to a particular station, tows its gear for about two hours and then proceeds on to the next station.

In previous years, the FPI vessel MV *Penny Smart* has been involved in the 3PS GEAC multi-species grid survey and in 3PS cod tagging (cod, American plaice, witch flounder and yellow tail flounder). These survey activities involve approximately 100 sets (tows) as well as tagging of individual fish.

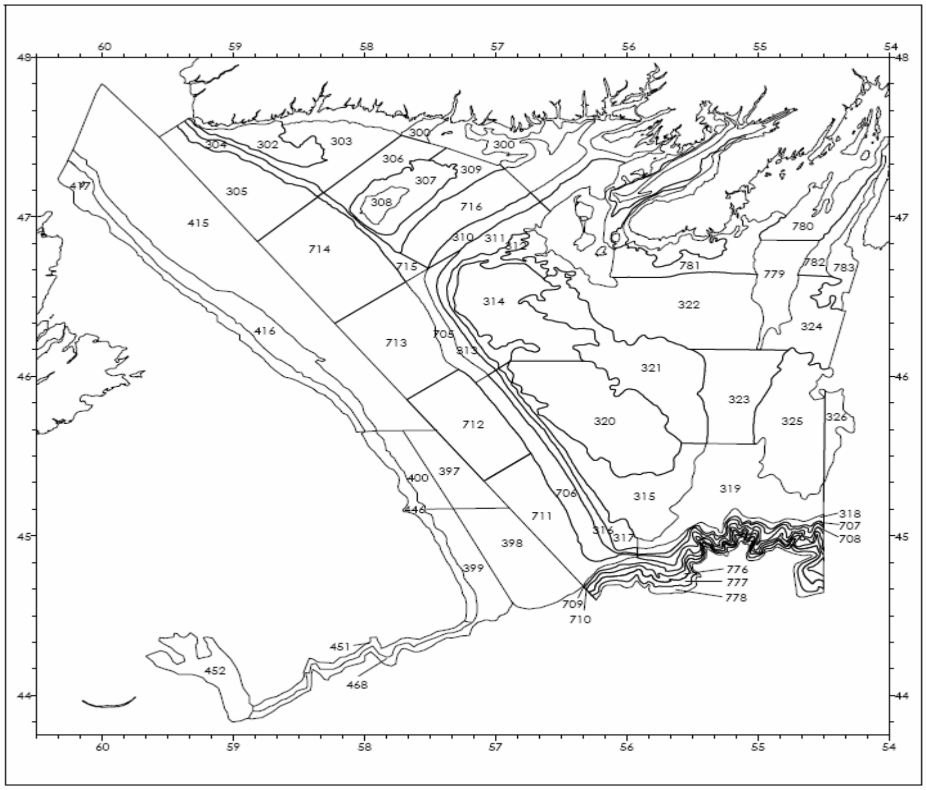

Figure 4.52. Unit 2 Redfish Survey Strata.

Research stations are located throughout the entire 3PS zone, but FPI indicated that most of the stations are located within the Study Area. The 3PS GEAC multi-species survey usually takes place during late November and early December and generally takes about 12 days to complete. (D. Fudge, pers comm., June 2006 and FPI meeting, June 2004).

In the past, FPI has noted its concern that noise (i.e., seismic survey activities) might affect the results of its research survey work, especially the September redfish survey. The concern is that noise might influence fish behaviour such that the data collected might vary from previous research surveys.

The 4VsW Sentinel Fisheries Program is another annual survey. It is a partnership between DFO and the Fishermen's and Scientists Research Society (FSRS). The FSRS arranges various aspects of the survey, such as contracting fishing vessels and other issues associated with this research.

The 4VsW Sentinel Program involves a random survey, as well as a commercial index fishery. The random survey takes place between 1 September and 3 October and involves data collection at approximately 200 stations from the shore of Nova Scotia out to the edge of the Scotian Shelf; the commercial index component takes place during the regular season for groundfish species, usually between 1 June to 31 March (of the following year) but in previous consultations the FSRS has noted that the bulk of these survey activities generally occur in August and September.

Because of financial constraints, the survey was modified in 2004/05, and the current (2006/07) program focuses on surveying six strata in 4VsW. The modified Commercial Index permits a limited amount of commercial fishing effort following fishermen's customary fishing patterns, with up to 20 vessels fishing 12 days each.

Both survey components utilize bottom (baited) longline gear. The following maps showing the locations of research stations in 2003 and 2005 (Figures 4.53 and 4.54).

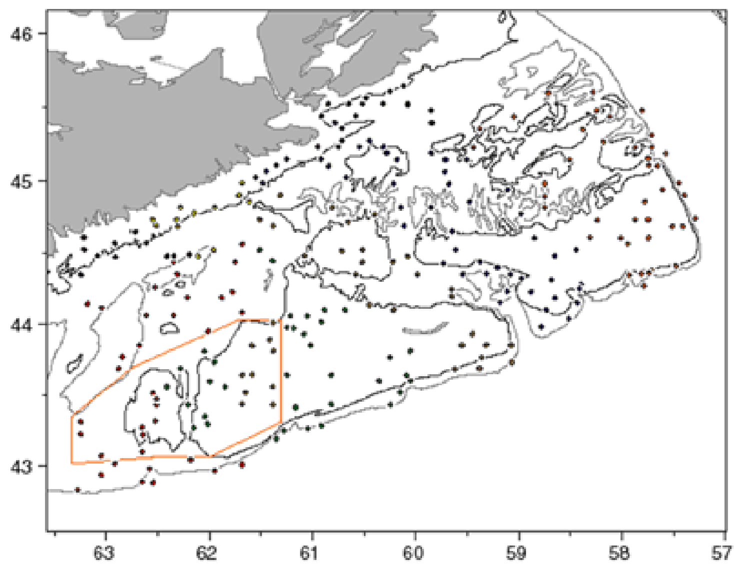

Figure 4.53. 2003 Sentinel Survey Stations.

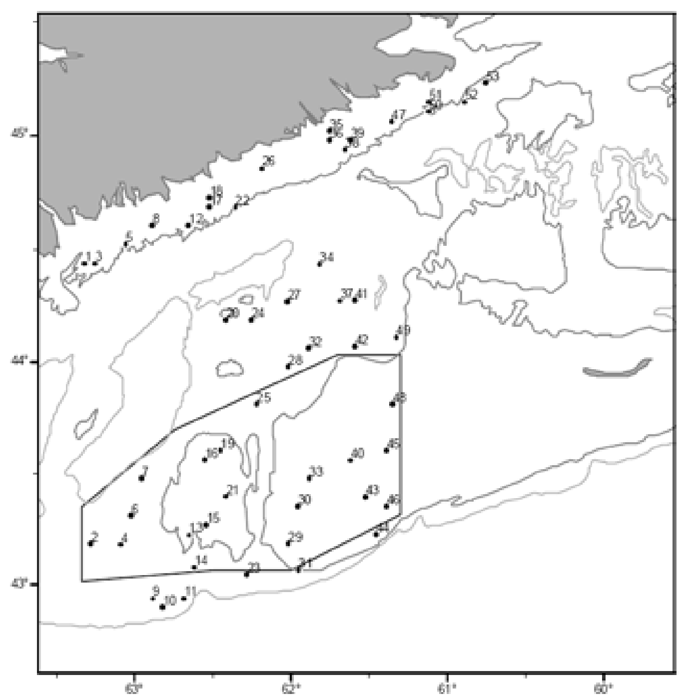

Figure 4.54. 2005 Sentinel Survey Stations.

The Scotian Shelf Atlantic Halibut Survey is also conducted annually by fishers and DFO. Fishers of the Nova Scotia fixed gear 45-65' fleet sector undertake these surveys on halibut grounds on the Scotian Shelf (Figure 4.55). During the regular halibut fishery, each participant fishes just one string of gear (longlines) at a prescribed location. Survey locations are at the exact same co-ordinates each year, and are sampled at the same time each year. DFO scientists have precise co-ordinates of all survey sites.

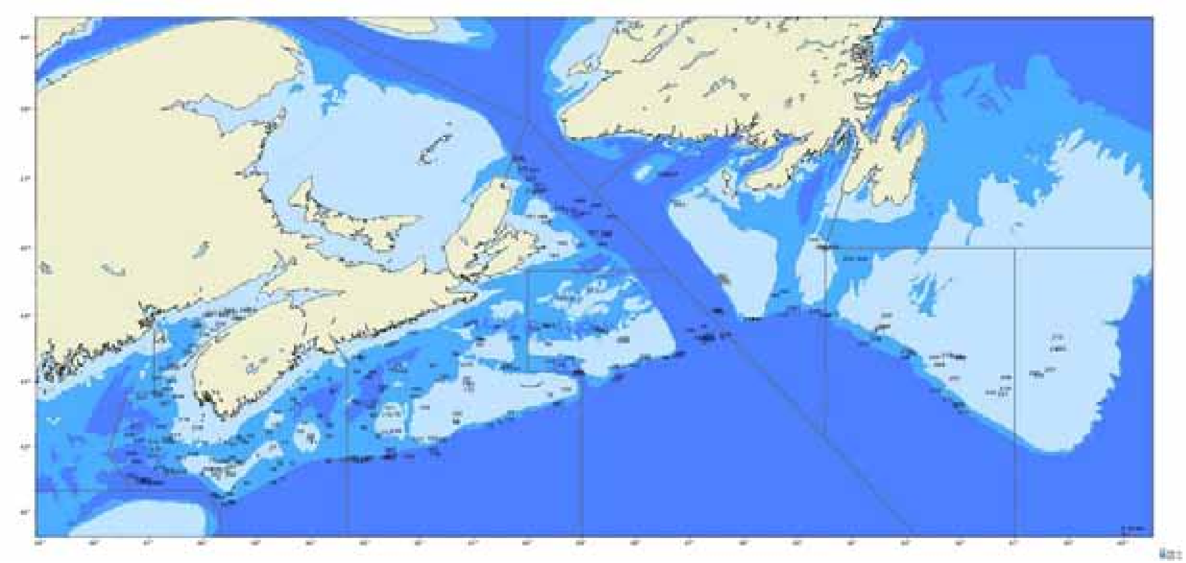

Figure 4.55. Halibut Survey Set Locations, 2003.

The survey starts when the halibut season opens, and is generally completed within 2-3 weeks between late May and late June, according to fishers. The survey halibut are kept separate from the catch made under the fisher's quota, and both catches are recorded in the vessel's logbook as well as by DFO personnel onshore. The exact co-ordinates of all the sites can be obtained from the relevant DFO manager.

In 2005, only one Eastern Shore Fisherman's Protective Association boat (F. Reyno in the *Short & Sassy*) was involved in that survey, and this Southwest Nova (western NS) expected to complete their survey work by the last week in July (N. Baker Stevens, Eastern Shore Fisherman's Protective Assoc, pers. com. June 2005). Based on information provided by the Association in 2005 concerning 2004 research activities, this survey consisted of some 270 locations on the Scotian Shelf and southern Grand Banks (ranging from NAFO 4X to 3N), of which 22 were in 3PS and 3 in 4VS.

4.7.8.1. DFO Research Vessel Survey Data

The DFO survey data for 2002-2005 were analyzed for species and catch numbers and weights (see Appendix 1 for detailed analyses and distribution maps). There were at least 22 species involved (see Appendix 1, Table 1). The main species are summarized below by depth. It should be noted that virtually all of the catches are on the slope and shelf, but this is likely at least partly due to the fact that the RV vessels do not typically sample deeper than slope waters.

Average Water Depth <100 m

Survey catches on areas of the 3Ps Shelf where average depths were less than 100 m were dominated by sea cucumbers, yellowtail flounder and sand lance in terms of both catch weight and number of individuals. Mailed sculpins were also caught in relatively large numbers.

Average Water Depth 100 to 200 m

Survey catches in areas of the 3Ps Shelf where average depths ranged between 100 m and 200 m were dominated by Atlantic cod, thorny skate and American plaice in terms of catch weight. The survey catch number in these areas was dominated by capelin, mailed sculpin and American plaice.

Average Water Depth >200 to 300 m

Survey catches in areas of the 3Ps Slope where average depths ranged between >200 m and 300 m were dominated by thorny skate, deepwater redfish and Atlantic cod in terms of catch weight. The survey catch number in these areas was dominated by deepwater redfish, witch flounder and longfin hake.

Average Water Depth >300 to 400 m

Survey catches in areas of the 3Ps Slope and the Laurentian Channel where average depths ranged between >300 m and 400 m were dominated by deepwater redfish, Atlantic cod, thorny skate and white hake in terms of catch weight. The survey catch number in these areas was dominated by deepwater redfish, witch flounder and longfin hake.

Average Water Depth >400 to 500 m

Survey catches in areas of the 3Ps Slope and Laurentian Channel where average depths ranged between >400 m and 500 m were dominated by deepwater redfish, unspecified invertebrates, thorny skate and white hake in terms of catch weight. The survey catch number in these areas was dominated by deepwater redfish, longfin hake, witch flounder and marlin spike.

Average Water Depth >500 m

Survey catches in areas of the 3Ps Slope where average depths exceeded 500 m were dominated by white hake, deepwater redfish, unspecified invertebrates, and longfin hake in terms of catch weight. The survey catch number in areas with average depths exceeding 500 m was dominated by longnose eels, marlin spikes, longfin hake, shrimp and lanternfishes.

Monkfish

The largest catches of monkfish during the 2002-2005 DFO RV surveys in the area of 3Ps occurring in the Study Area were made in strata where the average water depth ranged between 300 and 500 m (Appendix 1, Figure 6). However, even in these areas, monkfish catches represented a very small proportion of the total catches.

4.8. Seabirds

The Study Area includes the shallow shelf waters of St. Pierre Bank and the Laurentian Channel, the continental slope and deep water (2,500 m) beyond the shelf edge. The dynamic zone of water mixing at continental shelf breaks often creates a relative abundance of food that may concentrate seabirds (Brown 1986; Lock et al. 1994).

The Canadian Wildlife Service has collected shipboard observations conducted in a systematic method (PIROP) for Atlantic Canada. The 1969-1983 results are mapped in the Revised Atlas of Eastern Canadian Seabirds (Brown 1986). There is little coverage in the Laurentian Sub-basin Study Area (*in* Brown 1986). However, information from areas more frequently surveyed in southern and eastern Newfoundland and eastern Nova Scotia can be used to extrapolate the abundance and timing of seabirds in the Laurentian Sub-basin Study Area. Extensive seabird surveys were also conducted during a seabird monitoring of ConocoPhillips seismic exploration of the Laurentian Sub-basin Study Area 16 June to 29 September 2005 (Moulton et al. 2006a). A total of 837 ten-minute seabird counts using the Tasker Method were conducted in this time period. For methods see Moulton et al. (2006a). These studies form the basis for information on seabirds in the Laurentian Sub-basin Study Area. In addition, recent seabird surveys were conducted in the Laurentian Sub-basin Study Area by a LGL ornithologist aboard the Canadian Coast Guard Ship *Hudson* which was working in the area 18-20 June 2004 (Lang and Moulton 2004).

Seabirds expected to occur regularly in the Laurentian Sub-basin Study Area are listed in Table 4.15. A relative abundance is presented by month. Predicting the abundance of birds during the fall, winter and spring months was achieved mostly by extrapolating information from other parts of Newfoundland and Nova Scotia. Italics were used for abundance predictions where confidence was low. Four categories of abundance were used: Common, Uncommon, Scarce and Very Scarce. *Common* = observed daily in moderate to high numbers, *Uncommon* = observed regularly in small numbers, *Scarce* = a few individuals observed and *Very Scarce* = very few individuals. Overall world populations of species is taken into consideration. For example, Greater Shearwater are far more numerous on a world wide scale compared to a predator like the Long-tailed Jaeger. Therefore, 20 Greater Shearwaters per day of observation would be considered Uncommon whereas the same number of Long-tailed Jaeger might be considered Common.

Table 4.15. Seabirds Occurring in the Laurentian Sub-basin Study Area and Predicted Monthly Abundances.

Common Name	**Scientific Name**	**Monthly Abundance**											
		Jan	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**
Procellariidae													
Northern Fulmar	*Fulmarus glacialis*	C	C	C	C	C	U	S	S	S	C	C	C
Cory's Shearwater	*Calonectris diomedea*						S	S-U	S-U	S-U			
Greater Shearwater	*Puffinus gravis*					*U-C*	C	C	C	C	*C*	*S*	
Sooty Shearwater	*Puffinus griseus*					S	S	S	S	S	S		
Manx Shearwater	*Puffinus puffinus*					S	S	S	S	VS	VS		
Hydrobatidae													
Wilson's Storm-Petrel	*Oceanites oceanicus*						S	S	S	S			
Leach's Storm-Petrel	*Oceanodroma leucorhoa*				C	C	C	C	C	C	*C*	*S*	
Sulidae													
Northern Gannet	*Sula bassanus*				*VS*	*VS*	VS	VS	VS	S	*S*		
Phalaropodinae													
Red Phalarope	*Phalaropus fulicaria*					*VS*	*VS*	S	S	S	*S*		
Red-necked Phalarope	*Phalaropus lobatus*					*VS-S*	VS-S	VS-S	VS-S	VS-S			
Laridae													
Great Skua	*Catharacta skua*					*VS*	VS	VS	VS	VS	*VS*		
South Polar Skua	*Catharacta maccormicki*					*VS*	VS	VS	VS	VS	*VS*		
Pomarine Jaeger	*Stercorarius pomarinus*				*S*	*S*	S	S	S	S	*S*		
Parasitic Jaeger	*Stercorarius parasiticus*					*S*	S	S	S	S	*S*		
Long-tailed Jaeger	*Stercorarius longicaudus*					*S*	S	U-C	U-C	S			
Herring Gull	*Larus argentatus*	*S-U*	*S-U*	*S-U*	*S*	*VS*	VS	VS	VS	S	*S-U*	*S-U*	*S-U*
Iceland Gull	*Larus glaucoides*	*S*	*S*	*S*	*S*						*VS*	*S*	*S*
Glaucous Gull	*Larus hyperboreus*	*S*	*S*	*S*	*S*							*S*	*S*
Great Black-backed Gull	*Larus marinus*	*S*	*S*	*S*	*S*	*S*	VS	VS	VS	S	*S*	*S*	*S*
Ivory Gull	*Pagophila eburnea*		*VS*	*VS*									
Sabine's Gull	*Xema sabini*					*VS*	VS	VS	VS	VS			
Black-legged Kittiwake	*Rissa tridactyla*	*S-U*	*S-U*	*S-U*	*S*	*VS*	VS	VS	VS	VS	*S*	*S-U*	*S-U*
Arctic Tern	*Sterna paradisaea*					*S*	S	S	S	S			
Alcidae													
Dovekie	*Alle alle*	*S-U*	*S-U*	*S-U*	*S-U*	*VS*				VS	*S-U*	*S-U*	*S-U*
Common Murre	*Uria aalge*	*VS-S*	*VS-S*	*VS-S*	*VS-S*	*VS-S*	S	VS	VS	VS	*VS-S*	*VS-S*	*VS-S*
Thick-billed Murre	*Uria lomvia*	*S-U*	*S-U*	*S-U*	*S-U*	*VS*	VS				*S-U*	*S-U*	*S-U*
Razorbill	*Alca torda*	*VS*	*VS*	*VS*	*VS*	*VS*	VS				*VS*	*VS*	*VS*
Atlantic Puffin	*Fratercula arctica*	*VS*	*VS*	*VS*	*VS*	*VS*	VS				*VS*	*VS*	*VS*

Sources: Brown (1986), Lock et al. (1994) and Moulton et al. (2006a).

C = Common, U = Uncommon, S = Scarce and VS = Very Scarce. Abundance codes in italic based on limited information and may not be accurate.

4.8.1. Procellariidae (Fulmars and Shearwaters)

One fulmar (Northern Fulmar) and four species of shearwater (Greater, Cory's, Sooty and Manx Shearwater) occur in the Laurentian Sub-basin Study Area. Northern Fulmar is the only species present throughout the year. It is most numerous during the colder months. The four species of shearwater occur in warmer months of the year. Generally shearwaters occur in low numbers in the Laurentian Sub-basin Study Area compared to the Grand Banks, Orphan Basin and other locations in eastern Newfoundland (Brown 1986; Lock et al. 1994; Moulton et al. 2006b).

Greater Shearwater is the most numerous of the four shearwater species occurring in the Laurentian Sub-basin Study Area. Cory's and Sooty Shearwater occur regularly in small numbers. Manx Shearwater is scarce. Cory's Shearwater is a warm water species reaching the northern limit of its range in southern Newfoundland. The numbers of Cory's Shearwaters recorded during the seismic monitoring season of summer 2005 are the highest recorded for Newfoundland waters (Moulton et al. 2006a).

4.8.1.1. Northern Fulmar

Northern Fulmar has a circumpolar distribution breeding in the north Pacific, Arctic and the north Atlantic Ocean. The center of breeding abundance in the north Atlantic is the Canadian Arctic, Greenland, Iceland and northeast Europe and Scandinavia. It is a common year around resident in eastern Newfoundland waters south of the pack ice. It is thought that 50-100 pairs breed in eastern Newfoundland (Lock et al. 1994). The summer populations off eastern Newfoundland are thought to be composed of sub-adults from northern breeding colonies. Banding records show that Northern Fulmars from breeding colonies in the Canadian Arctic, Greenland and the British Isles regularly occur in Newfoundland waters (Brown 1986; Lock et al. 1994).

Northern Fulmar was scarce during the seismic exploration seabird monitoring study period 16 June to 29 September 2005. Highest one day totals derived from a combination of ten-minute counts and incidental observations were 64 on 24 June and 600 on 28 June. Sightings were less than a daily occurrence from mid July to mid September. It was not recorded during ten-minute surveys during a three week period in August. A slight increase in numbers was detected in late September. The species is expected to be common during the colder months of the year (October to April) when Northern Fulmars from the Canadian Arctic, Greenland and possibly Icelandic breeding colonies come south to winter in Newfoundland waters (Brown 1986). It is scarce from July to September (Moulton et al. 2006a).

4.8.1.2. Cory's Shearwater

Cory's Shearwater is a bird of cool sub-tropical waters occurring in the Atlantic Ocean and western Indian Ocean. In the Atlantic, it breeds on eastern islands including The Azores, Madeira and Canary Islands. About 50,000 pairs or half the Atlantic population breeds on The Azores. Cory's Shearwater reaches Canadian waters in southern Nova Scotia and southern Newfoundland where ocean temperatures are the warmest in Atlantic Canada (Brown et al. 1975). During the seismic exploration seabird monitoring study period 16 June to 29 September 2005, Cory's Shearwater was observed nearly daily from early July until the end of August. It was most numerous from July to mid August with numbers decreasing gradually from mid August to mid September. Maximum daily totals for each month, derived from ten-minute counts and incidental sightings, were 20 on 11 July, 25 on 16 July, 30 on 24 July, 12 on 15 August, 30 on 17 August, 12 on August 25, four on 6 September, nine on 10 September and seven on 18 September. The last Cory's Shearwater sighting occurred on 22 September. The results of these surveys establish Cory's Shearwater as a regular bird in Laurentian Sub-basin Study Area. Previous knowledge of Cory's Shearwater in Newfoundland waters is based on sporadic observations from the Laurentian Channel, St. Pierre Bank and the southern Grand Banks (Brown et al. 1975; P. Linegar, January 2006, pers. comm.). Cory's Shearwater is expected to be scarce to uncommon from late June to early October in the Laurentian Sub-basin Study Area (Moulton et al. 2006a).

4.8.1.3. Greater Shearwater

Greater Shearwater breeds in the south Atlantic Ocean, mainly on the Tristan da Cunha Island group and Gough Island. The adults are present at the breeding sites from October to April. They spend the non-breeding season (April to October) in the North Atlantic. A significant percentage of the total world population (five million) migrates to eastern Newfoundland, particularly the Grand Banks for the annual moult in June and July (Lock et al. 1994). During the seismic exploration seabird monitoring study period 16 June to 29 September 2005, Greater Shearwater was the second most abundant species after Leach's Storm-Petrel. Monthly average densities peaked in June at 2.11 birds per km^2. Daily totals of combined ten-minute counts and incidental observations typically ranged from 25-300. A significant southward movement of 3,000-4,000 Greater Shearwaters was observed in a one hour period on 28 June. The observers noticed more Greater Shearwaters at the shelf edge (Moulton et al. 2006a). Densities were relatively low for Newfoundland waters even on the shelf edge (see Brown et al. 1975; Brown 1986). Along the shelf edge densities ranged from 2.0-9.9 birds per km^2 in June, 1.0-1.9 birds per km^2 in July, 0.1-4.9 birds per km^2 in August and 0.1-0.9 birds per km^2 in August (Moulton et al. 2006a). Greater Shearwater showing signs of heavy wing moult were noted in June and the first half of July by Moulton et al. (2006a) but no large concentrations were present on the water as is often the case with moulting shearwaters in Newfoundland (Brown 1986; Lock et al. 1994). Greater Shearwater is expected to be uncommon to common from May to October in the Laurentian Sub-basin Study Area (Moulton et al. 2006a).

4.8.1.4. Sooty Shearwater

Sooty Shearwater breeds on islands in the Southern Hemisphere from November to March. A large percentage of the population migrates to the Northern Hemisphere and is present from April to October. It is a common bird during the summer months off Atlantic Canada north to Labrador (Brown 1986). During the seismic exploration seabird monitoring study period 16 June to 29 September 2005 Sooty Shearwater was present in small numbers throughout the survey period. It was less numerous than Greater and Cory's Shearwater but more numerous than Manx Shearwater. It was most numerous in late June-early July with daily maximum counts, derived from combined totals of ten-minute counts and incidental sightings, of 25 on 24 June and 140 on 28 June. The total number of Sooty Shearwaters observed in July was 32 with daily maximums of 11 on 1 July and four on 17 July. The total number of Sooty Shearwaters observed in August was 33 with a daily maximum of eight on 5 August. Only seven Sooty Shearwaters were observed in September with a maximum daily count of two on 12 September. Because of its scarcity it was not often detected on ten-minute bird counts Sooty Shearwater is expected to be scarce from May to October in the Laurentian Sub-basin Study Area (Moulton et al. 2006a).

4.8.1.5. Manx Shearwater

Most of the world population of Manx Shearwater breeds on islands in northwest Europe (Iceland, Scotland, Ireland, England, France) and The Azores and Canary Islands. It winters in the southwest Atlantic off eastern South America (Lee and Haney 1996). The only known established colony in the northwest Atlantic is at Middle Lawn Island, Burin Peninsula, Newfoundland where an estimated 100 pairs breed (Lock et al. 1994). The small population of Manx Shearwater present in Atlantic Canada during the summer months is probably a combination of Newfoundland breeders, non-breeding sub-adults and migrants from European breeding colonies (Lee and Haney 1996). During the seismic exploration seabird monitoring study period 16 June to 29 September 2005 a total of 35 Manx Shearwaters were recorded during ten-minute counts and through incidental observations (Moulton et al. 2006a). Most sightings were of single birds. Total individuals by month were: five in June, 11 in July, 17 in August and one in September. Manx Shearwater is expected to be regular in small numbers from May to October in the Laurentian Sub-basin Study Area.

4.8.2. Hydrobatidae (Storm-Petrels)

Two species of storm-petrel occur in Atlantic Canada. They are the Leach's and Wilson's Storm-Petrel. Leach's Storm-Petrel is an abundant breeder in eastern Newfoundland. It was the most numerous species in the Laurentian Sub-basin Study Area during the seismic exploration seabird monitoring study period 16 June to 29 September 2005 (Moulton et al. 2006a). Wilson's Storm-Petrel visits the Northern Hemisphere from May to October after breeding in the Southern Hemisphere. Southern Newfoundland is the northern limit of its range.

4.8.2.1. Leach's Storm-Petrel

Leach's Storm-Petrel is a widespread and abundant species occurring in both the Atlantic and Pacific Oceans. In the Atlantic it breeds in northwest Europe (Iceland, Scotland and Norway) and in North America from southeast Labrador to Massachusetts (Huntington et al. 1996). Newfoundland is the center of breeding abundance in the North Atlantic. There are several large colonies on the east coast of Newfoundland including the largest colony in the world at Baccalieu Island where 3.3 million pairs breed (Table 4.15). In the Atlantic, Leach's Storm-Petrel winter mainly south of the equator off both South America and Africa. During the seismic exploration seabird monitoring study period 16 June to 29 September 2005, Leach's Storm-Petrel was the most numerous species (Moulton et al. 2006a).

Densities were highest in July and August ranging from 2.0-99.9 birds per km². Densities were distinctly lower in September with most of the surveyed area showing 0.1-0.9 birds per km². The observers noted higher numbers of Leach's Storm-Petrels at the shelf edge. Three significant Leach's Storm-Petrels breeding colonies are located on the southern Burin Peninsula which is located approximately 250 km north of the closest point to the Study Area. They are Middle Lawn Island with 26,313 pairs, Corbin Island with 100,000 pairs and Green Island with 72,000 pairs (Table 4.16). Leach's Storm-Petrels are thought to fly considerable distances from breeding colonies in search of food. Steele and Montevecchi (1994 *in* Huntington et al. 1996) calculated that adult Leach's Storm-Petrels fed >200 km from some colonies in eastern Newfoundland. The average time adult Leach's Storm-Petrels spend away from incubating duties was determined to range from 2.9 days (Watanuki 1985a *in* Huntington et al. 1996) and up to six days by Gross (1935 *in* Huntington et al. 1996). A trans-Atlantic homing experiment determined a traveling rate of almost 500 km per day (M. Constantine-Paton, unpubl. data *in* Huntington et al. 1996). This indicates maximum distances between breeding colonies and feeding areas could be as high as 1,500 km. While it is unlikely most Leach's Storm-Petrels travel this far, it puts much of the Laurentian Sub-basin Study Area within the potential feeding range of adult Leach's Storm-Petrels from the Burin Peninsula colonies. Leach's Storm-Petrels usually breed at five years of age (Huntington et al. 1996). The range of birds during the first five years of life is poorly understood. It is quite likely many non-breeders return north in the spring and spend the summer at sea near the same latitude where they were hatched. It is unknown if the Leach's Storm-Petrels present in the Laurentian Sub-basin Study Area are adults from Newfoundland breeding colonies or non-breeding adults or combination of both. Leach's Storm-Petrel is expected to be common in the Laurentian Sub-basin Study Area from April to October.

4.8.2.2. Wilson's Storm-Petrel

Wilson's Storm-Petrel breeds on islands in the South Atlantic Ocean including the Antarctic and Sub Antarctic. The breeding season is December to March. In the non-breeding season, the south Atlantic population migrates to the Northern Hemisphere. The northern limit of their range is Nova Scotia and southern Newfoundland (Brown 1986; Godfrey 1986). During the seismic exploration seabird monitoring study period 16 June to 29 September 2005, a total of 43 Wilson's Storm-Petrels were observed during ten-minute counts and incidentally during marine mammals surveys. The numbers of Wilson's Storm-Petrel peaked early in the summer with 13 in June and 18 in July. The latest date was one on 18 September. Wilson's Storm-Petrel is probably scarce from June to September on the Laurentian Sub-basin Study Area (Moulton et al. 2006a).

4.8.3. Sulidae (Gannets)

Northern Gannet breeds in the north Atlantic in Quebec, Newfoundland, Iceland, Faeroe Islands and British Isles. It winters along the coast from New Jersey to Florida and British Isles to the Azores. Three of the five major Northern Gannet colonies in North America are located in Newfoundland at

Table 4.16. Number of Pairs of Seabirds Nesting at Significant Seabird Colonies in Eastern Newfoundland

Species	Wadham Islands	Funk Island	Cape Freels and Cabot Island	Baccalieu Island	Witless Bay Islands	Cape St. Mary's	Middle Lawn Island	Corbin Island	Green Island
Procellariidae									
Northern Fulmar	-	13[a]	-	20[a]	40[a,f]	Present[a]	-	-	-
Manx Shearwater	-	-	-	-	-	-	100[a]	-	-
Hydrobatidae									
Leach's Storm-Petrel	1,038[d]	-	250[a]	3,336,000[a]	621,651[a,f]	-	26,313[a]	100,000[a]	72,000[a]
Sulidae									
Northern Gannet		9,837[b]		1,712[b]	-	6,726[b]	-	-	-
Laridae									
Herring Gull	-	500[a]	-	Presenta	4,638[a,e]	Present[a]	20[a]	5,000[a]	-
Great Black-backed Gull	Present[d]	100[a]	-	Present[1]	166[a,e]	Presenta	6[a]	25[a]	-
Black-legged Kittiwake	-	810[a]	-	12,975[a]	23,606[a,f]	10,000[a]	-	50[a]	-
Arctic and Common Terns	376[a]	-	250[a]	-	-	-	-	-	-
Alcidae									
Common Murre	-	412,524[c]	2,600[a]	4,000[a]	83,001[a,f]	10,000[a]	-	-	-
Thick-billed Murre		250[a]	-	181[a]	600[a]	1,000[a]	-	-	-
Razorbill	273[d]	200[a]	25[a]	100[a]	676[a,f]	100[a]	-	-	-
Black Guillemot	25[a]	1[a]	-	100[a]	20+[a]	Present[a]	-	-	-
Atlantic Puffin	6,190[d]	2,000[a]	20[a]	30,000[a]	272,729[a,f,g]	-	-	-	-
TOTALS	**7,902**	**426,235**	**3,145**	**3,385,088**	**1,007,107**	**27,826**	**26,413**	**105,075**	**72,000**

Sources:
[a] Cairns et al. (1989)
[b] Chardine (2000)
[c] Chardine et al. (2003)
[d] Robertson and Elliot (2002)
[e] Robertson et al. (2001) *in* Robertson et al. (2004)
[f] Robertson et al. (2004)
[g] Rodway et al. (2003) *in* Robertson et al. (2004)

Cape St. Mary's, Baccalieu Island and Funk Island (Table 4.16). Gannets feed on small to medium size fish and squid over shelf waters avoiding deep water beyond the continental slope. During the seismic exploration seabird monitoring study period 16 June to 29 September 2005, only 14 Northern Gannets were observed in the Laurentian Sub-basin Study Area. There were two individuals in June, three in August and nine in September. Northern Gannets arrive in Newfoundland waters in late March and depart by early November. The entire population of Newfoundland Northern Gannets probably migrates over shelf waters to and from wintering areas off southeastern United States. Northern Gannet is probably always very scarce from April to August and scarce September to October in the Laurentian Sub-basin Study Area.

4.8.3.1. Phalaropodinae (Phalaropes)

Both Red and Red-necked Phalaropes migrate through Newfoundland offshore waters en route between wintering areas in the south Atlantic and Arctic and sub-Arctic breeding grounds. Phalaropes are known to congregate in areas of upwelling and convergence particularly along the continental slope (Brown 1986, Lock et al. 1994)

4.8.3.2. Red-necked Phalarope

During the seismic exploration seabird monitoring study period 16 June to 29 September 2005, the only observation of Red-necked Phalarope on the Laurentian Sub-basin Study Area was a flock of five on the water on 1 August (Moulton et al. 2006a). Red-necked Phalarope is not often recorded at sea off Atlantic Canada (Brown 1986). This is partly attributed to the difficulty in distinguishing Red-necked Phalaropes from Red Phalaropes at sea. Red-necked Phalarope is probably a very scarce to scarce migrant from late May to mid June and July to August in the Laurentian Sub-basin Study Area.

4.8.3.3. Red Phalarope

Red Phalarope is locally common during migration at upwellings along shelf edges of Newfoundland and Labrador (Brown 1986). Only 17 Red Phalaropes were observed in the Laurentian Sub-basin Study Area during the seismic exploration seabird monitoring study period 16 June to 29 September 2005 (Moulton et al. 2006a). Ten individuals were in July, three in August and five in September. The time period of this study covered the main fall migration season for both Red-necked and Red Phalaropes. The low numbers observed indicate Red Phalarope is probably never common in the Laurentian Sub-basin Study Area. No concentrations were noted at the continental shelf. Red Phalarope is probably very scarce to scarce from late May to mid June and scarce July to September in the Laurentian Sub-basin Study Area.

4.8.4. Stercorariidae (Skuas and Jaegers)

There are two species of skua in the northwest Atlantic, the Great Skua and South Polar Skua. Great Skua breeds on the northeast Atlantic. South Polar Skua breeds in the Antarctic. The two species occur together in the North Atlantic during the summer. Skuas as a family group are distinctive but they are difficult to identify to the species level. There are three species of jaeger; the Pomarine, Parasitic and Long-tailed Jaeger. They breed in the Arctic and winter generally south of 35ºN.

4.8.4.1. Great Skua

Great Skua breeds in the northeast Atlantic Ocean in Iceland, Faeroe and Iceland and winters farther south but remains north of the equator. In Atlantic Canada it is a summer visitor and spring and fall migrant. During the seismic exploration seabird monitoring study period 16 June to 29 September 2005 only four of the 16 skuas identified to species were Great Skua (Moulton et al. 2006a). The sightings are one on 25 July, two on 29 August and one on 10 September. The bird seen in July could have been a non-breeding sub-adult. The other three individuals occurred during migration period and could have been birds migrating from breeding sites in the northeast Atlantic. Great Skua is probably very scarce in the Laurentian Sub-basin Study Area and in very low numbers from May to November.

4.8.4.2. South Polar Skua

South Polar Skua breeds in the Southern Hemisphere on Antarctic islands from December to March. Part of the population migrates to the north Atlantic during May to October. Twelve of the 16 skuas identified to species during the seismic exploration seabird monitoring study period 16 June to 29 September 2005 were South Polar Skua. South Polar Skua is probably very scarce from late May to October on the Laurentian Sub-basin Study Area (Moulton et al. 2006a).

4.8.4.3. Pomarine Jaeger

Pomarine Jaeger is circumpolar, breeding in the low Arctic and Arctic. In the Atlantic Ocean it winters at sea from North Carolina to West Africa. It is a common migrant through Atlantic Canada. During the seismic exploration seabird monitoring study period 16 June to 29 September 2005, only six Pomarine Jaeger were observed in the Laurentian Sub-basin Study Area. Monthly totals were one individual in July, two in August and three in September. The low numbers probably indicate that prey was scarce. Pomarine Jaegers are kleptoparasites, meaning they harass other birds to force them to give up their food. Black-legged Kittiwake the main target of Pomarine Jaeger in Newfoundland waters was very scarce in the Laurentian Sub-basin Study Area in this time period. Pomarine Jaeger is probably scarce from May to October in the Laurentian Sub-basin Study Area (Moulton et al. 2006a).

4.8.4.4. Parasitic Jaeger

Parasitic Jaeger is circumpolar, breeding in the low Arctic and Arctic. In the Atlantic Ocean it winters at sea south of 35°N. It is a common migrant through Atlantic Canada. It was recorded in the Laurentian Sub-basin Study Area during the seismic exploration seabird monitoring study period 16 June to 29 September 2005. Due to difficulties identifying it from the more numerous Long-tailed Jaeger, precise numbers were unknown. Parasitic Jaeger was probably very scarce to scarce in the Laurentian

Sub-basin Study Area during the survey period. Like Pomarine Jaeger, the favourite target for kleptoparasitic feeding behaviour is Black-legged Kittiwake. Kittiwakes were very scarce during the study period. It is possible kittiwakes would be more numerous in October when Parasitic Jaegers would still be in migration through Newfoundland waters. It is probably scarce in the Laurentian Sub-basin Study Area from May to October (Moulton et al. 2006a).

4.8.4.5. Long-tailed Jaeger

Long-tailed Jaeger is circumpolar, breeding in the low Arctic and Arctic. The winter range is poorly known but in the Atlantic Ocean it is generally south of 35ºS (Wiley and Lee 1998). Long-tailed Jaeger is considered the least numerous of the three jaeger species in Atlantic Canada. This is partly because of its habit of migrating far offshore at the continental shelf edge or beyond (Wiley and Lee 1998). During the seismic exploration seabird monitoring study period 16 June to 29 September 2005 it was by far the most numerous jaeger species (Moulton et al. 2006a). It was observed nearly daily from late June to late August with the last individual being on 6 September. During the peak period 10 July to 15 August daily totals derived from ten-minute counts and incidental sightings were typically 15-50 but occasionally as high as 100+. All the birds were sub-adults, none were observed in adult plumage. It was thought that the majority were one year old birds based on the plumage resembling that of the juvenile. The Laurentian Sub-basin Study Area appears to be a significant summering area for sub-adult Long-tailed Jaegers. Almost nothing is known about the summering range of sub-adult Long-tailed Jaegers (Wiley and Lee 1998). No adult Long-tailed Jaegers were observed during the southbound migration period of August and September. This suggests that the Laurentian Sub-basin Study Area is not part of the migration route of Arctic breeding adults. Long-tailed Jaeger is probably scarce during spring migration from mid May to mid June, uncommon to common from mid June to mid August and scarce from mid August to late September in the Laurentian Sub-basin Study Area.

4.8.5. Laridae (Gulls)

Eight species of gull are expected to occur annually in the Laurentian Sub-basin Study Area. Four species are expected to occur regularly in small numbers. They are Great Black-backed Gull, Herring Gull, Iceland Gull and Black-legged Kittiwake. Four species expected to occur annually and be very scarce to scarce are Ring-billed Gull, Glaucous Gull, Lesser Black-backed Gull and Sabine’s Gull. There are no records of Ivory Gull from the Laurentian Sub-basin Study Area. It could possibly occur in a heavy ice year. See the Ivory Gull species account for more details.

4.8.5.1. Ring-billed Gull

The Ring-billed Gull is a widespread and abundant North American species. It is a locally common breeder in Newfoundland and Labrador. It winters south of the province from Nova Scotia south to Gulf of Mexico. Ring-billed Gulls feed inland and in coastal areas. They would not be expected at sea except during migration. During the seismic exploration seabird monitoring study period 16 June to 29 September 2005 there was only one observation of Ring-billed Gull: four juveniles on 15 September

(Moulton et al. 2006a). Ring-billed Gull is probably a very scarce transient through the Laurentian Sub-basin Study Area from April to October.

4.8.5.2. Herring Gull

Herring Gull is a widespread and abundant breeder in North America and western Europe. It is a common breeder and year round resident in Newfoundland. It is typically a species of coastal and inland locations but small numbers are present offshore in fall and winter (Brown 1986). During the seismic exploration seabird monitoring study period 16 June to 29 September 2005 of the Laurentian Sub-basin Study Area about 50 Herring Gull were observed from 19 August to 29 September (Moulton et al. 2006a). Most of these were juveniles; birds of the year. Herring Gull is probably scarce to uncommon in the fall and winter months and very scarce from June to August in the Laurentian Sub-basin Study Area.

4.8.5.3. Iceland Gull

Iceland Gull breeds in the eastern Canadian Arctic and Greenland. It winters south of the breeding range in the northeast United States and northwest Europe. It is a common winter bird in coastal Newfoundland. It ranges freely offshore where there is sea ice but less so in ice free areas. Iceland Gull is expected to be a scarce bird on the Laurentian Sub-basin Study Area November to March.

4.8.5.4. Lesser Black-backed Gull

Lesser Black-backed Gull breeds in Europe. It is a regular visitor to North America, including Newfoundland, throughout the year but mostly during the non-breeding months from August to May. During the seismic exploration seabird monitoring study period 16 June to 29 September 2005 four individuals (three juveniles, one sub-adult) were recorded in the Laurentian Sub-basin Study Area; all were observed in late August. Lesser Black-backed Gull is probably a very scarce spring and fall migrant through the Laurentian Sub-basin Study Area (Moulton et al. 2006a).

4.8.5.5. Glaucous Gull

Glaucous Gull breeds in Arctic and sub-Arctic regions of North America and Eurasia. In the western Atlantic it winters from breeding range south to the New England States. It is a common winter bird in Newfoundland. It is a coastal bird and goes offshore where there is pack ice. Small numbers probably winter in the offshore even without ice. On the Laurentian Sub-basin Study Area it is probably a scarce winter bird.

4.8.5.6. Great Black-backed Gull

Great Black-backed Gull breeds in Atlantic Canada, Greenland and northwest Europe. In Newfoundland it is a common widespread breeder. In winter it is common from the edge of the pack ice and southward to the mid Atlantic States. Great Black-backed Gull is a coastal species generally living within sight of land. However a proportion of the population of Great Black-backed Gull winters at sea (Good 1998). During the seismic exploration seabird monitoring study period 16 June to 29 September 2005 a total of 24 individuals were recorded during ten-minute surveys and incidental sightings in the Laurentian Sub-basin Study Area (Moulton et al. 2006a). Most of these were juveniles occurring late August to late September. Great Black-backed Gull is probably scarce to uncommon in fall, winter and early spring and very scarce late spring to mid summer on the Laurentian Sub-basin Study Area.

4.8.5.7. Sabine's Gull

Sabine's Gull is circumpolar, breeding in the low Arctic and Arctic. It winters at sea in the south Atlantic and south Pacific. The majority of the eastern Canadian Arctic breeding population migrates through the eastern Atlantic Ocean when transiting between Arctic breeding grounds and south Atlantic wintering areas. In Newfoundland it is a scarce migrant and visitor to offshore waters. During the seismic exploration seabird monitoring study period 16 June to 29 September 2005 there was only one sighting of the species; 2 birds in adult plumage on 28 June (Moulton et al. 2006a). This date falls between migration periods for the species. Therefore, they may have been non-breeding sub-adults. The species is probably very scarce from mid May to September in the Laurentian Sub-basin Study Area.

4.8.5.8. Black-legged Kittiwake

Black-legged Kittiwake is an abundant seabird of the North Pacific and North Atlantic Oceans. In the Atlantic it breeds on islands in northern Europe, Arctic, sub-Arctic south to Nova Scotia. In Newfoundland it breeds in large colonies, mainly on the Avalon Peninsula (Table 4.16). It is a common resident in Newfoundland waters remaining south of the main pack ice in winter. Large numbers of birds from Canadian Arctic and Greenland breeding colonies winter on the Grand Banks and southern Newfoundland waters (Lock et al. 1994). Kittiwakes are considered birds of shelf waters (Brown 1986) and are possibly always very scarce to scarce in the >1,000 m water of the Laurentian Sub-basin Study Area. During the seismic exploration seabird monitoring study period 16 June to 29 September 2005 only 14 Black-legged Kittiwakes were observed. Brown (1986) shows >1 to <10 Black-legged Kittiwakes per linear km near the shelf edge in the period October to March. Black-legged Kittiwake is probably very scarce to scarce from April to September and scarce to uncommon from October to March in the Laurentian Sub-basin Study Area.

4.8.6. Sterninae (Terns)

The only species of tern expected in offshore Newfoundland is the Arctic Tern. Common Tern probably migrate across the Laurentian Sub-basin Study Area between the littoral waters of Newfoundland and Nova Scotia.

4.8.6.1. Arctic Tern

Arctic Tern is circumpolar, breeding in the low Arctic and Arctic. Its breeding range extends south along the Atlantic coast to Newfoundland and sporadically farther south to Massachusetts. It migrates at sea between wintering grounds in the south Atlantic and north Atlantic breeding areas. Arctic Tern is present in Newfoundland waters late May to September. During the seismic exploration seabird monitoring study period 16 June to 29 September 2005 just 19 Arctic Terns were observed during ten-minute seabird surveys and incidentally (Moulton et al. 2006a). This time period covers three of the four months in which Arctic Tern is present in Newfoundland waters. Twelve of these were in August during the peak of southward migration in Newfoundland. Arctic Tern is probably a scarce migrant during spring and late summer Laurentian Sub-basin Study Area.

4.8.6.2. Common Tern

Common Tern breeds in North America and Eurasia. In eastern North America it winters from South Carolina and southward. It is a common breeder both inland and in littoral waters of Newfoundland and Labrador. It migrates over open sea but does not linger at sea as does the Arctic Tern. During the seismic exploration seabird monitoring study period 16 June to 29 September 2005 there were just two sightings of Common Tern, one on 4 July and one on 4 August (Moulton et al. 2006a). These were presumably migrants heading south. Common Tern is probably a very scarce migrant from May to early September in the Laurentian Sub-basin Study Area.

4.8.7. Alcidae (Auks, Murres and Puffins)

Five of the six species of alcidae breeding in the North Atlantic are expected on the Laurentian Sub-basin Study Area. They are Dovekie, Common Murre, Thick-billed Murre, Razorbill and Atlantic Puffin. Black Guillemot is a coastal species not likely to occur offshore in the Laurentian Sub-basin. Numbers are expected to be lowest during the summer months when they are at breeding colonies and higher in winter. The Laurentian Sub-basin Study Area is a minimum of 230 km from the closest major seabird colony containing large numbers of alcids at Cape St. Mary’s (Table 4.16).

4.8.7.1. Dovekie

Dovekie breeds mainly in Greenland, Iceland and northern Norway and winters at sea in the north Atlantic Ocean south to New Jersey and France. In Newfoundland it is a common winter bird. During the seismic exploration seabird monitoring study period 16 June to 29 September 2005 one Dovekie was observed on 16 September (Moulton et al. 2006a). This was probably an early fall migrant. The limited shipboard winter surveys of the Laurentian Sub-basin Study Area shows that Dovekie is found in the Laurentian Sub-basin Study Area in low numbers (Brown 1986). Dovekie is probably scarce to uncommon (possibly locally common) from October to April and very scarce from May to September in the Laurentian Sub-basin Study Area.

4.8.7.2. Common Murre

Common Murre breeds in North Pacific and North Atlantic Oceans. In the Atlantic it breeds in northern Europe including Iceland and Greenland and in the western Atlantic from Labrador to Nova Scotia. Large colonies exist in eastern Newfoundland (Table 4.16). Common Murres winter in southern Newfoundland and southern Nova Scotia. During the seismic exploration seabird monitoring study period 16 June to 29 September 2005 ten Common Murre were identified in the Laurentian Sub-basin Study Area, all from 16 June to 25 July (Moulton et al. 2006a). There were also 12 unidentified murres observed in June and July that could have been Common Murre. The Laurentian Sub-basin Study Area is too far from the closest breeding colony at Cape St. Mary's for breeding murres to access during the breeding season. Information is lacking on the distribution and abundance of winter murres in the Laurentian Sub-basin Study Area. Common Murre is very scarce from June to September and probably very scarce to scarce in the winter months in the Laurentian Sub-basin Study Area.

4.8.7.3. Thick-billed Murre

Thick-billed Murre breeds in the Arctic, North Atlantic and North Pacific Ocean. In eastern North America it breeds mainly in the Arctic. Smaller numbers breed south to Newfoundland. It is estimated that four million Thick-billed Murres winter in eastern Newfoundland, largely on the Grand Banks (Lock et al. 1994). Band returns show that the Newfoundland wintering population originates from breeding colonies in the Canadian Arctic (Hudson Strait and Lancaster Sound), west Greenland and Iceland (Lock et al. 1994). During the seismic exploration seabird monitoring study period 16 June to 29 September 2005 there was one sighting of Thick-billed Murre and that was of two birds on 16 June (Moulton et al. 2006a). Thick-billed Murres are more likely to occur in this area from October to April. Information is lacking on winter distribution of murres beyond the continental shelf off southern Newfoundland but this species may be scarce to uncommon in winter in the Laurentian Sub-basin Study Area.

4.8.7.4. Razorbill

Razorbill breeds in the North Atlantic from northern Europe including Iceland and Greenland to the mid Labrador coast and south to Maine. It breeds at several sites in eastern Newfoundland (Table 4.16). This alcid stays closer to shore than the murres so is less likely to be seen over the deep water beyond the continental shelf. There was only one sighting of a Razorbill (28 June) during the seismic exploration seabird monitoring study period 16 June to 29 September 2005 (Moulton et al. 2006a). It is expected to be absent or a very scarce bird in the Laurentian Sub-basin Study Area.

4.8.7.5. Atlantic Puffin

Atlantic Puffin breeds in the North Atlantic British Isles, Norway, Iceland, Greenland, Newfoundland and Labrador and south to Maine. In Canada, the centre of breeding abundance is in southeast Newfoundland (Table 4.16). In North America Atlantic Puffins winter mainly off southern

Newfoundland and Nova Scotia. During the seismic exploration seabird monitoring study period 16 June to 29 September 2005 only two Atlantic Puffins (16 June) were recorded in the Laurentian Sub-basin Study Area (Moulton et al. 2006a). Atlantic Puffin is probably very scarce throughout the year in the Laurentian Sub-basin Study Area.

4.8.8. Bird Species at Risk

Ivory Gull is classified as a species of 'Special Concern' under *SARA* (www.speciesatrisk.gc.ca). This is likely to change to 'Endangered' since COSEWIC upgraded the status to 'Endangered' in April 2006 (Peter Thomas, CWS, pers. comm.) It is rare on global scale with fewer than 14,000 pairs. The Canadian Arctic supports a significant but declining population of Ivory Gull. The Canadian breeding population was estimated at 2,400 individuals in the early 1980s (Thomas and MacDonald 1987). Extensive surveys of historic breeding sites and adjacent breeding habitat in 2002 and 2003 and interviews with Inuit residents indicate the breeding population in Canada has declined by 80% (Gilchrist and Mallory 2005). Reasons for the apparent decline of the Canadian breeding population are uncertain.

The winter range of the Ivory Gull in the Northwest Atlantic is among sea ice from the Davis Strait south to about 50º to the Labrador Sea (Orr and Parsons 1982 *in* Haney and MacDonald 1995). Small numbers may winter on the north shore of the Gulf of St. Lawrence (Godfrey 1986). It is considered very rare, being less then annually reported, from the south coast of Newfoundland, New Brunswick and Nova Scotia. (Tufts 1986; Godfrey 1986). The occurrence of Ivory Gull is nearly always directly related to sea ice.

Sea ice does not reach the Laurentian Sub-basin every year. Thirty years of ice data from Canadian Ice Services (1972-2001) and US National Ice Center (1972-1994) shows that ice was present eight out of the 30 years (see Section 3.7, Figures 3.49-3.52). The duration of ice coverage in years when ice was present ranged from one to three weeks with a mean duration of one week. All ice observations fall within the period 22 February to 5 April with the peak influx occurring in March. Ice coverage ranged from 30-100% with a mean concentration of 60%. The Gulf of St. Lawrence ice is made up entirely of first-year ice. In extreme ice years, ice may reach the Laurentian Sub-basin from the east after coming around the Avalon Peninsula.

Considering the known range of Ivory Gull, the overall low numbers of individuals in the Northwest Atlantic and the paucity of sea ice on the Laurentian Sub-basin, Ivory Gull is likely a very rare occurrence on the Laurentian Sub-basin.

4.9. Marine Mammals and Sea Turtles

4.9.1. Whales and Dolphins

Nineteen species of cetacean, including dolphins, small and large toothed whales, and baleen whales, are likely to occur in the Project Area for the proposed drilling program. These species are presented in Table 4.17 with temporal and spatial indications of occurrence and relevant designations under *SARA* (Government of Canada 2005). All large species of whale in the North Atlantic have been commercially hunted, and most stocks have been substantially depleted. Some, including northwest Atlantic humpback whales, seem to be showing signs of recovery (Best 1993).

In addition to the cetacean species listed in Table 4.17, five other toothed whale species are known to occur on the adjacent Scotian Shelf. These are: pygmy (*Kogia breviceps*) and dwarf (*Kogia simus*) sperm whales, Cuvier's (*Ziphius cavirostris*), Blainville's (*Mesoplodon densirostris*), and True's (*Mesoplodon mirus*) beaked whales. Their use of these waters in not well known or it is thought to be infrequent (Breeze et al. 2002), so while they could potentially occur in the Project Area, their presence is likely to be rare.

Four species of pinniped are also likely to occur in the Project Area (see Table 4.18). The ringed seal (*Phoca hispida*) and bearded seal (*Erignathus barbatus*) are considered rare visitors in the area (JWEL 2003), and so they are not considered further in this EA.

Waring et al. (2004) provide information on the distribution, abundance, seasonality and conservation status of individual cetacean species in the Northwest Atlantic. Whitehead et al. (1998) and Breeze et al. (2002) are also sources of information on marine mammals on the Scotian Shelf. However, prior to ConocoPhillips' monitoring program in 2005, there has been virtually no published information on the presence of cetaceans specifically within the Laurentian Sub-basin area, apart from the following plotted sightings: (1) two humpbacks reported by Sergeant (1966); (2) several sei whales reported by Mitchell and Chapman (1977); and (3) a few common dolphins and white-sided dolphins reported by Palka (2001 *in* JWEL 2003). A large database of cetacean sightings, including some data for the Laurentian Sub-basin, is currently being developed by DFO but is not yet available. Mitchell (1977) gives tagging positions of 672 whales off Nova Scotia and Newfoundland and Labrador. Apparently, none of these animals were tagged within the Laurentian Sub-basin area. Historical records of whaling in the region provide only limited insight into the occurrence of large whales in the Project Area. Therefore, the most comprehensive data set for the area is the 1,483 h of observations along 13,484 km of ship trackline made from the seismic vessel MV *Western Neptune* from 14 June to 29 September 2005 (Moulton et al. 2006a). These data provide valuable information on marine mammal occurrence and distribution in the area but results may be biased by the noise from the airgun arrays; in addition, the data represent only one season of observations.

Despite limited area-specific information on cetacean populations in the Laurentian Sub-basin area, the presence of a deep channel running to the shelf break with its flanking banks suggests a mix of

Table 4.17. Cetaceans with Known or Expected Occurrences in the Project Area.

Species		Occurrence	Season	Habitat	COSEWIC Status (date of most recent status report)	*SARA* Status[a]
Common Name	**Scientific Name**					
Baleen Whales	***Mysticeti***					
North Atlantic right whale	*Eubalaena glacialis*	Rare	Summer	Coastal and shelf	Endangered (May 2003)	Schedule 1: Endangered
Humpback whale	*Megaptera novaeangliae*	Uncommon	Spring to fall	Primarily nearshore and banks	Not At Risk (May 2003)	No status
Minke whale	*Balaenoptera acutorostrata*	Common	Year-round but primarily spring to fall	Continental shelf and coastal	Not At Risk (April 2006)	No status
Sei whale	*Balaenoptera borealis*	Uncommon	Summer	Primarily offshore and pelagic	Data Deficient (May 2003)	No status
Fin whale	*Balaenoptera physalus*	Common	Spring to fall	Continental slope and pelagic	Special Concern (May 2005)	*No status; under consideration for addition to Schedule 1*
Blue whale	*Balaenoptera musculus*	Uncommon? Common?	Year-round but primarily spring and fall	Coastal and pelagic	Endangered (May 2002)	Schedule 1: Endangered
Toothed Whales	***Odontoceti***					
Sperm whale	*Physeter macrocephalus*	Common	Year-round but primarily summer	Usually pelagic and deep seas	Not At Risk (April 1996)	No status
Northern bottlenose whale [b]	*Hyperoodon ampullatus*	Uncommon	Year-round	Pelagic	Endangered (November 2002)	Schedule 1: Endangered
Sowerby's beaked whale	*Mesoplodon bidens*	Rare	Year-round	Pelagic	Special Concern (April 1989)	Schedule 3: Special Concern
Beluga whale	*Delphinapterus leucas*	Very rare	Year-round	Coastal estuaries, bays and rivers	Threatened (May 2004)[c]	Schedule 1: Threatened[c]
Killer whale	*Orcinus orca*	Rare	Year-round	Widely distributed	Data Deficient (November 2001)	No status
Long-finned pilot whale	*Globicephala melas*	Common	Year-round	Mostly pelagic	Not assessed	No status
Bottlenose dolphin	*Tursiops truncatus*	Uncommon	Summer	Coastal and oceanic	Not assessed	No status
Striped dolphin	*Stenella coeruleoalba*	Uncommon	Summer	Continental shelf and pelagic	Not assessed	No status
Short-beaked common dolphin	*Delphinus delphis*	Common	Summer	Continental shelf and pelagic	Not assessed	No status
Atlantic white-sided dolphin	*Lagenorhynchus acutus*	Common	Year-round but primarily spring and fall	Continental shelf and slope	Not assessed	No status
White-beaked dolphin	*Lagenorhynchus albirostris*	Uncommon	Year-round	Continental shelf	Not assessed	No status
Risso's dolphin	*Grampus griseus*	Rare - Uncommon	Year-round?	Continental slope	Not At Risk (April 1990)	No status
Harbour porpoise	*Phocoena phocoena*	Uncommon	Year-round?	Continental shelf	Special Concern (April 2006)	*No schedule or status; refered back to COSEWIC*

Note: ? indicate uncertainty

[a] Species designation under the *Species at Risk Act* (Government of Canada 2005).

[b] Scotian Shelf population.

[c] St. Lawrence Estuary population. COSEWIC (2004) considers the Eastern Hudson Bay and Ungava Bay populations Endangered; the Cumberland Sound population Threatened; and the Eastern High Arctic and Western Hudson Bay populations Special Concern. These populations are currently pending public consultation for addition to Schedule 1 of *SARA*.

environmental conditions known to be important for cetacean populations elsewhere in the western North Atlantic. Hamazaki (2002) developed "habitat prediction models" for cetaceans occurring in the region between North Carolina and southern Nova Scotia. These models indicated the preferences of different cetaceans for various habitat types including nearshore, shelf and offshore. A more regionally relevant indication of the importance of shelf break deeper water to cetaceans is provided by Whitehead et al. (1998), who concluded that relative abundances of numerous cetaceans were substantially higher in The Gully than in other areas of the eastern Scotian Shelf. Sutcliffe and Brodie (1977 *in* JWEL 2003) noted that high productivity may support the concentration of baleen whales along the Scotian Shelf slope. Some larger toothed whales are known to dive to great depths to feed on squids and fishes.

The Project Area appears to offer a range of suitable habitats for a variety of cetacean species. It should be noted that most of the "best estimates" (Waring et al. 2004) of cetacean population sizes are based on aerial survey data that are uncorrected for dive times. Detailed information on cetacean presence and movements within the Project Area is not available.

The following sections provide an overview of the whales and dolphins that are known or expected to occur within the Project Area. The overview is based largely on information for other regions plus the information gathered during ConocoPhillips' 2005 monitoring program.

4.9.1.1. Baleen Whales

North Atlantic Right Whale

The North Atlantic right whale is the most endangered large whale in the world. In spite of being the first whale to receive total protection from hunting over 60 years ago, its population size remains low. The western North Atlantic population is estimated to be on the order of 300 individuals (IWC 2001a; Kraus et al. 2001) and appears to be declining (Caswell et al. 1999). The North Atlantic right whale is presently listed under Schedule 1 of *SARA* as Endangered. Right whales are also listed as Endangered under the US *Endangered Species Act* of 1973 (http://www.nmfs.noaa.gov/pr/species/esa_species.htm) and are protected in US waters and from US citizens on the high seas under the *Marine Mammal Protection Act* of 1972 (http://www.nmfs.noaa.gov/pr/laws/mmpa.htm).

Within the western North Atlantic, right whales are known to aggregate in five seasonal habitat areas (IWC 2001b). From December to March, adult female right whales and their newborn calves, as well as some juvenile animals, can be found in coastal waters of the southeastern United States, with the peak of the calving season occurring in January. In January, right whales begin arriving in Cape Cod Bay, and their abundance peaks there from March to May. Right whales are present in the Great South Channel, off Cape Cod, from April through July, with a peak in May and June. Right whales can be found in the Bay of Fundy from June to November, with a peak of abundance in August to early October. Finally, right whales can be found in Roseway Basin, south of Nova Scotia, from July to November, with a peak in abundance in August and September, but their use of this area seems to be declining in recent years (IWC 2001b). Although there has been a great deal of effort put into identifying their distribution, on average, only about 25% of the known right whale population can be accounted for in any month except August (IWC 2001b).

Right whales are generally found in waters with surface temperatures ranging from 8°C to 15°C in areas that are 100- to 200-m deep (Winn et al. 1986). In the Great South Channel, the average right whale dive depth was found to be only 7.3 m, and few dives were deeper than 30 m (Winn et al. 1994). In the lower Bay of Fundy, right whales are generally distributed in an area where the bottom topography is relatively flat and the water column is stratified (Woodley and Gaskin 1996). Right whales tagged with satellite-monitored radiotags in the Bay of Fundy were found to range widely (Mate et al. 1997) and were most often located along bank edges, in basins, or along the continental shelf in water <182 m deep. Tagged whales were also noted to spend extended periods of time at the edge of a warm core ring and in upwellings. The primary prey item of the North Atlantic right whale is the copepod *Calanus finmarchicus*, and shifts in the distribution and abundance of this species can dramatically affect right whale distribution (Kenney 2001). Zakardjian et al. (2003) suggested that North Atlantic right whales might occasionally feed on the large concentrations of copepods known to occur in the Laurentian Channel.

Historically, whalers took right whales off the coast of Newfoundland, but recent sightings in these waters have been rare despite systematic surveys; however, it is possible that at least some right whales pass through the proposed Project Area during their north-south migrations (Knowlton et al. 1992). Scattered sightings of right whales off Newfoundland and in the Gulf of St. Lawrence have been made in recent years, but these are not important summering areas for these whales (Gaskin 1991). There have been rare sightings of this whale species in the Laurentian Sub-basin (Sergeant 1966) and speculation of some movement of these whales to and from the Gulf of St. Lawrence and western Newfoundland waters. No right whales were seen during fairly intensive aerial surveys of the Gulf of St. Lawrence in 1995 and 1996 (Kingsley and Reeves 1998) or during a shipboard survey east of the Scotian shelf out to the Laurentian Channel in 2002 (Clapham and Wenzel 2002). None were sighted during ConocoPhillips' 3-D seismic survey in the Project Area from mid-June to the end of September 2005 (Moulton et al. 2006a). Hence, while it is possible that right whales could occur in the Project Area between late spring and early fall, their presence is likely to be rare.

Humpback Whale

The humpback whale has a cosmopolitan distribution. Although considered to be mainly a coastal species, it often traverses deep pelagic areas while migrating. Its migrations between high-latitude summering grounds and low-latitude wintering grounds are reasonably well known (Winn and Reichley 1985). The size of the western North Atlantic humpback whale population is considered to be increasing (COSEWIC 2003a), and this population is no longer listed under *SARA*. In the United States, the humpback continues to be listed as Endangered under the *Endangered Species Act* of 1973 (http://www.nmfs.noaa.gov/pr/species/esa_species.htm) and is protected in US waters and from US citizens on the high seas under the *Marine Mammal Protection Act* of 1972 (http://www.nmfs.noaa.gov/pr/laws/mmpa.htm).

The worldwide population of humpback whales is divided into northern and southern ocean populations (Mackintosh 1965), although genetic analyses suggest a small amount of gene flow between the North Atlantic and the southern oceans (Baker et al. 1993). In the North Atlantic, there are five areas where humpback whales aggregate in the summer to feed—Iceland-Denmark Strait, western Greenland, Newfoundland (including Labrador), the Gulf of St. Lawrence, and the Gulf of Maine-Scotian Shelf—and three winter breeding regions in the West Indies—Virgin Bank, Puerto Rico, and the Dominican Republic (Katona and Beard 1990). Feeding aggregations are thought to be distinct, while individuals from these different feeding areas mix on the breeding grounds (Mattila et al. 1984; Katona and Beard 1990). Genetic studies have revealed matrilineally determined distinctiveness between feeding aggregations of humpback whales in the North Atlantic and that the humpback whales from the western North Atlantic are distinct from those off Iceland (Palsbøll et al. 1995). Valsecchi et al. (1997) provided further evidence that humpback whales in the western North Atlantic were genetically distinct from those off Iceland using nuclear genetic markers.

Humpback whales are often sighted singly or in groups of two or three; however, while in their breeding and feeding ranges, they may occur in groups of up to 15 individuals (Leatherwood and Reeves 1983).

Kingsley and Reeves (1998) reported a mean group size of 1.5 for humpbacks sighted in the Gulf of St. Lawrence, and Whitehead et al. (1998) reported a mean group size of 1.47 for humpback whales seen in The Gully. Groups of humpback whales sighted off Banquereau Bank on the eastern Scotian Shelf included up to 10 individuals (Clapham and Wenzel 2002). Humpback whales produce sounds in the frequency range of 20 Hz to 8.2 kHz, although songs have dominant frequencies of 120-4,000 Hz (reviewed by Thomson and Richardson 1995). The hearing range of humpback whales was mathematically modeled to range from 700 Hz to 10 kHz (Houser et al. 2001).

The humpback whale is common in Newfoundland waters. About 900 humpbacks are thought to use the southeast shoal of the Grand Bank as a summer feeding area, where their primary prey species is capelin, *Mallotus villosus* (Whitehead and Glass 1985). An aerial survey of the Gulf of St. Lawrence found humpback whales located predominantly northwest of Newfoundland and in the Strait of Belle Isle (Kingsley and Reeves 1998), but the overall density of humpback whales (0.0005/km^2, CV = 0.42) was low in that study. Whitehead et al. (1998) reported that humpback whales were sighted regularly during the summer months in The Gully on the eastern Scotian Shelf, and a shipboard survey in August of 2002 found the humpback whale to be the most common baleen whale on the eastern Scotian Shelf, with major concentrations on the northern edge of Banquereau Bank and on Stone Fence (Clapham and Wenzel 2002). A density of 0.0074 (CV = 0.74) humpbacks per km^2 was reported from aerial surveys on the eastern Scotian Shelf in 1995 (Palka 2001 *in* JWEL 2003). During ConocoPhillips' seismic survey of the Laurentian Sub-basin in 2005 there were five humpback sightings (six individuals) (Moulton et al. 2006a). They were seen in both the Eastern and Western Blocks of the seismic survey area, mostly in depths of less than 1,000 m (Figure 4.56). The entire North Atlantic population of humpback whales was estimated to be approximately 10,600 individuals (95% CI = 9,300-12,100) using photoidentification data from the feeding and breeding areas (Smith et al. 1999). Hence, humpback whales are likely regular visitors to the Project Area, although their presence there is likely to be uncommon.

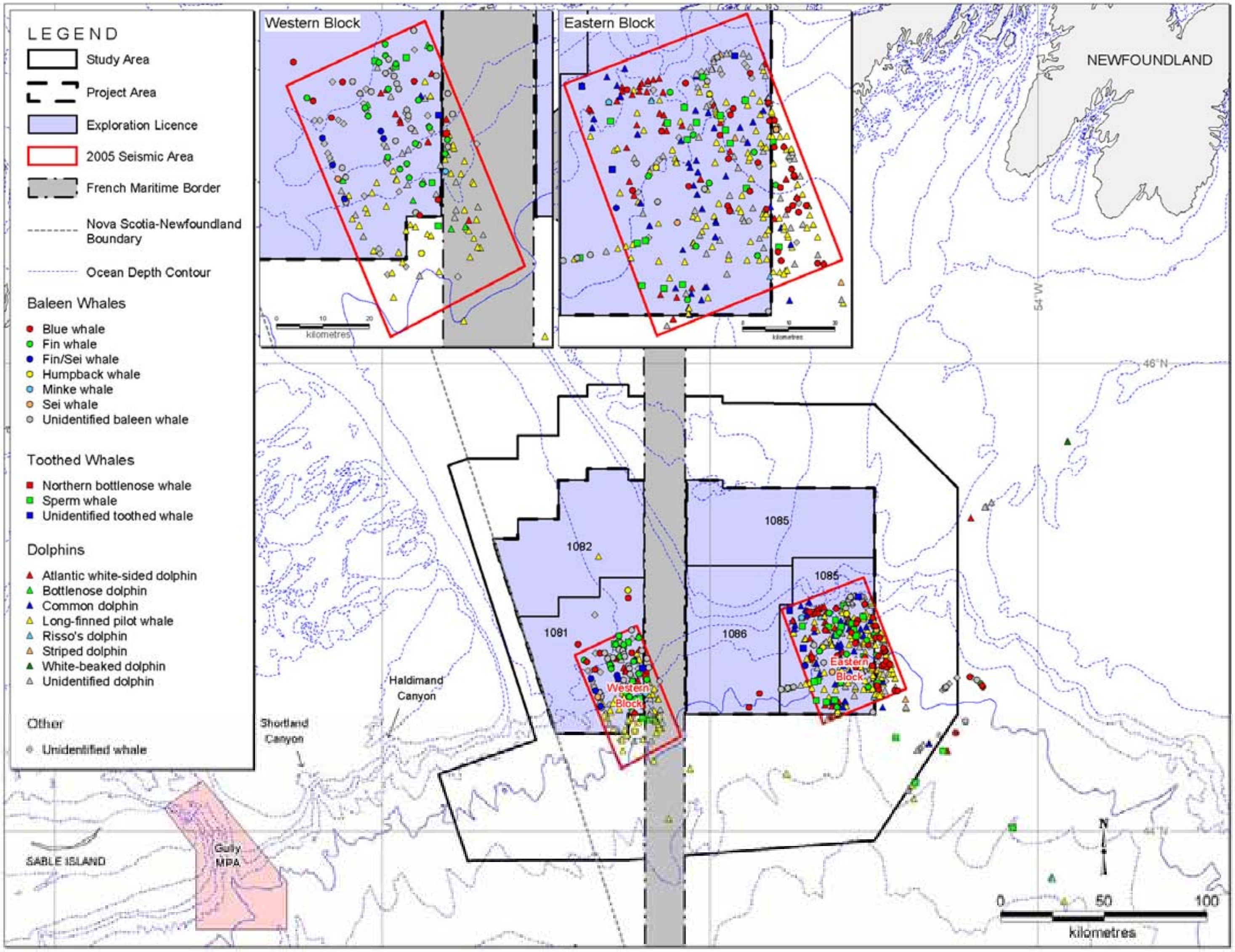

Figure 4.56. Marine Mammal Sightings made from the MV *Western Neptune* during ConocoPhillips' Seismic Monitoring Program from June to September 2005 (adapted from Moulton et al. 2006a).

Minke Whale

Minke whales are the smallest of the baleen whales found in the Study Area. They have a cosmopolitan distribution that spans ice-free latitudes (Stewart and Leatherwood 1985). Like other baleen whales, minkes undergo seasonal migrations from high-latitude feeding grounds in the summer to low-latitude breeding grounds in the winter. Some minke whales, however, are seen at high latitudes in the winter, including off Newfoundland (Lynch 1987).

Minke whales are relatively solitary, usually seen individually or in groups of two or three, but they can occur in large aggregations of up to 100 animals at high latitudes where food resources are concentrated (Perrin and Brownell 2002). Kingsley and Reeves (1998) reported a mean group size of 1.07 for minke whales sighted in the Gulf of St. Lawrence, and Whitehead et al. (1998) reported a mean group size of 1.25 for minke whales seen in The Gully. Females give birth every year and calving typically occurs between November and March (Sergeant 1963). A large variety of sounds, ranging in frequency from 60 Hz to 12 kHz, have been attributed to minke whales (Stewart and Leatherwood 1985; Mellinger et al. 2000).

Minke whales are common off Newfoundland from May to August, where they feed principally on capelin (Sergeant 1963). Minke whale sightings in the Gulf of St. Lawrence during aerial surveys in 1995 and 1996 occurred throughout the Gulf in waters of 200-m depth or less (Kingsley and Reeves 1998). The density of minke whales found in that study was $0.0046/km^2$ (CV = 0.27) for the entire Gulf of St. Lawrence. A density of 0.0023 (CV = 0.47) minke whales per km^2 was reported from aerial surveys on the eastern Scotian Shelf in 1995 (Palka 2001 cited *in* JWEL 2003). The best estimate available for the size of the Canadian east coast stock of minke whales is 4,018 (CV = 0.16) (Waring et al. 2004). Only two minke sightings (two individuals) were recorded during ConocoPhillips' seismic survey of the Laurentian Sub-basin (Moulton et al. 2006a). One was seen in each of the two Blocks of the seismic survey area. There are no other published observations of minkes in the Laurentian Sub-basin area, but they likely occur there regularly during their spring and fall migration between the Scotian Shelf and Gulf of St. Lawrence.

Sei Whale

The sei whale has a cosmopolitan distribution, with a marked preference for temperate oceanic waters (Gambell 1985a). Sei whales migrate from temperate zones, which they occupy in the winter, to higher latitudes in the summer, where most feeding takes place (Gambell 1985a). Northern and southern hemisphere sei whales are thought to be distinct because their migration schedules are six months out of phase (Mizroch et al. 1984). Sei whale populations were depleted by whaling, and their current status is generally uncertain (Horwood 1987). The global population is thought to be low. The Atlantic population of sei whales was assessed by COSEWIC in 2003 and was considered to be Data Deficient (COSEWIC 2003b). In the United States, sei whales are listed as Endangered under the *Endangered Species Act* of 1973 (http://www.nmfs.noaa.gov/pr/species/esa_species.htm) and are protected in US waters and from US citizens on the high seas under the *Marine Mammal Protection Act* of 1972 (http://www.nmfs.noaa.gov/pr/laws/mmpa.htm).

Sei whales are a mainly pelagic species and usually occur alone or in small groups. Whitehead et al. (1998) reported an average group size of 1.0 in three sightings of sei whales off the Nova Scotian shelf. Sei whales show sexual dimorphism, with females being larger than males (Horwood 2002). They become sexually mature at about 10 years of age (Horwood 2002). Sei whales produce sounds in the range of 1.5-3.5 kHz (reviewed by Thomson and Richardson 1995).

In the western North Atlantic, sei whales found on the Scotian Shelf are thought to be from a distinct stock from those that summer in the Labrador Sea (Mitchell and Chapman 1977). Sei whales of the Nova Scotia stock migrate northward in June and July and southward in September to November (Mitchell and Chapman 1977). From mark-recapture data in the late 1960s and early 1970s, the Nova Scotia stock of sei whales was estimated to contain from 1,393 to 2,248 individuals; based on census data, a minimum stock size of 870 was calculated (Mitchell and Chapman 1977). There are no recent estimates of the sei whale population size in the western North Atlantic. No sei whales were sighted during a shipboard survey of the eastern Scotian Shelf in 2002 (Clapham and Wenzel 2002). Sei whales were sighted on three occasions during 623 km of search effort off Georges Bank (Griffin 1999). Those whale sightings corresponded with the front of a Gulf Stream warm-core ring. Sei whales are thought to occur sporadically in the proposed Project Area during their migration into the Laurentian Channel (COSEWIC 2003b). There were only three sightings (three individuals) of sei whales during ConocoPhillips' seismic program in the Project Area (Moulton et al. 2006a); confirmed sightings of sei whales were made in June and September. They were sighted in both the East and West Blocks of the survey area.

Fin Whale

Fin whales are widely distributed in all the world's oceans (Gambell 1985b), but typically occur in temperate and polar regions. They appear to have complex seasonal movements and are likely seasonal migrants (Gambell 1985b). Fin whales mate and calve in temperate waters during the winter, but migrate to northern latitudes during the summer to feed (Mackintosh 1965). Whales from the northern and southern populations do not occur at the equator at the same time because the seasons are opposite (Gambell 1985b). Genetic analyses suggest several different populations of fin whales in the North Atlantic (Berubé et al. 1998). In that study, fin whales from the western North Atlantic (Gulf of Maine and Gulf of St. Lawrence) were found to be distinct from those off West Greenland, off Iceland, and in the eastern North Atlantic. The fin whale is presently being considered for addition to Schedule 1 of *SARA* as a 'Special Concern' species. In the United States, fin whales are listed as Endangered under the *Endangered Species Act* of 1973 (http://www.nmfs.noaa.gov/pr/species/esa_species.htm) and are protected in US waters and from US citizens on the high seas under the *Marine Mammal Protection Act* of 1972 (http://www.nmfs.noaa.gov/pr/laws/mmpa.htm).

Fin whales occur in coastal and shelf waters, as well as in oceanic waters. Fin whales in the Bay of Fundy, Canada, were distributed in shallow areas with high topographic variation (Woodley and Gaskin 1996). Fin whales are sometimes observed alone or in pairs, but on feeding grounds, groups of up to 20 individuals are more common (Gambell 1985b). Kingsley and Reeves (1998) reported a mean group size of 1.89 for fin whales sighted in the Gulf of St. Lawrence, Whitehead et al. (1998) reported a mean group size of 1.31 for fin whales sighted in The Gully, and Whitehead and Carlson (1988) reported feeding groups of 1-10 animals off Newfoundland and Labrador, which depended on the horizontal size of the prey schools upon which they were feeding. The distinctive 20-Hz pulses of fin whales, with source levels as high as 180 dB re 1 μPa, can be heard reliably to distances of several tens of kilometres (Watkins 1981; Watkins et al. 1987). These sounds are presumably used for communication while swimming slowly near the surface or traveling rapidly (Watkins 1981).

Sergeant (1977) suggested that fin whales from the Gulf of St. Lawrence migrated to the Laurentian Channel and probably to northern Nova Scotia in the winter. Aerial surveys of the Gulf of St. Lawrence in late-August and early September found fin whales located predominantly along the margins of the Laurentian Channel (Kingsley and Reeves 1998). The overall density of fin whales in that study was 0.0017/km^2 (CV = 0.79) for the entire Gulf of St. Lawrence. Whitehead et al. (1998) reported that fin whales were sighted consistently in The Gully on the eastern Scotian Shelf in July and August. A density of 0.0071 (CV = 0.76) fin whales per km^2 was reported from aerial surveys on the eastern Scotian Shelf in 1995 (Palka 2001 cited *in* JWEL 2003). Few fin whales were sighted during a shipboard survey of the eastern Scotian Shelf out to the Laurentian Channel in 2002 (Clapham and Wenzel 2002). Waring et al. (2004) provide an estimate of the western North Atlantic fin whale population size of 2,814 (CV = 0.21), based on shipboard and aerial surveys from Georges Bank to the mouth of the Gulf of St. Lawrence in the summer of 1999. A total of 30 fin whale sightings (37 individuals) were recorded during the 2005 ConocoPhillips seismic survey of the Project Area (Moulton et al. 2006a). Sighting rates were highest during July (0.044 sightings/h) and August (0.035 sightings/h) and in water less than 1,000 m deep. However, twelve sightings occurred in water more than 1,500 m deep. There were about twice as many sightings in the Western Block of the survey area than in the Eastern Block. Together, these studies suggest that fin whales are regular visitors to the proposed Project Area, and their presence there is likely to be common during the spring to fall period.

Blue Whale

The blue whale is widely distributed throughout the world's oceans and occurs in coastal, shelf, and oceanic waters. The worldwide population has been estimated to be 15,000 whales, with 10,000 animals in the Southern Hemisphere (Gambell 1976), 3,500 in the North Pacific, and up to 1,400 in the North Atlantic (NMFS 1998). Waring et al. (2002) provided a minimum estimate of 308 for the western North Atlantic population of blue whales, which was the number of blue whales that had been individually identified in the Gulf of St. Lawrence. All populations of blue whales have been exploited commercially, and many have been severely depleted as a result. The blue whale is presently listed under Schedule 1 of *SARA* as Endangered. In the United States, blue whales are listed as Endangered under the *Endangered Species Act* of 1973 (http://www.nmfs.noaa.gov/pr/species/esa_species.htm) and are protected in US waters and from US citizens on the high seas under the *Marine Mammal Protection Act* of 1972 (http://www.nmfs.noaa.gov/pr/laws/mmpa.htm).

Blue whales usually occur alone or in small groups (Leatherwood and Reeves 1983). Kingsley and Reeves (1998) reported a mean group size of 1.0 for blue whales sighted in the Gulf of St. Lawrence, and Whitehead et al. (1998) noted an average group size of 1.38 for blue whales sighted in The Gully. Blue whales calve and mate in the late fall and winter (Yochem and Leatherwood 1985) and females give birth in the winter to a single calf every 2-3 years (Sears 2002). Blue whales have a tall and conspicuous blow and may lift their flukes clear of the surface before a deep dive. Dives can last from 10-30 minutes and are usually separated by a series of 10-20 shallow dives. The best-known sounds of blue whales consist of low-frequency moans and long pulses that range from 12.5 Hz to 200 Hz and can have source levels up to 188 dB re 1 μPa (Cummings and Thompson 1971).

The distribution of blue whales, at least during the times of year when feeding is a major activity, is specific to areas that provide large seasonal concentrations of euphausiids, which are the whale's main prey (Yochem and Leatherwood 1985). Generally, blue whales are seasonal migrants between high latitudes in the summer, where they feed, and low latitudes in the winter, where they mate and give birth (Lockyer and Brown 1981). In the western North Atlantic, blue whales occur in the Gulf of St. Lawrence and east of Nova Scotia in spring, summer, and fall, in the Davis Strait in summer, and off southern Newfoundland in winter; movement between the Gulf of St. Lawrence and western Greenland has been demonstrated (summarized by Waring et al. 2002). There were five sightings of blue whales during aerial surveys in the Gulf of St. Lawrence in the summers of 1995 and 1996 (Kingsley and Reeves 1998), and only one very small blue whale was sighted during a shipboard survey of the eastern Scotian Shelf (Clapham and Wenzel 2002). Whitehead et al. (1998) reported that blue whales are consistently found in The Gully on the eastern Scotian Shelf during mid and late August. Blue whale sightings made up more than half of the baleen whale sightings in the Laurentian Sub-basin during ConocoPhillips' seismic survey (Moulton et al. 2006a). In total, 49 sightings comprised of 53 individuals were seen in and near the Project Area. Sighting rates were highest during August (0.09 sightings/h) and in water depths of 2,000-2,500 m (also 0.09 sightings/h). Most sightings were in the Eastern Block of the seismic survey area. These relatively large number of blue whale sightings in the Laurentian Sub-basin area in 2005 were unexpected (J. Lawson, DFO, pers. comm.). Based on available information, blue whales are likely to occur in the Project Area during summer, and perhaps may occur there on a regular basis. The Study Area has not previously been identified as a known area of concentration for blue whales in the North Atlantic (COSEWIC 2002).

4.9.1.2. Toothed Whales

Sperm Whale

Sperm whales are the largest of the toothed whales, with an extensive worldwide distribution (Rice 1989). They range as far north and south as the edges of the polar pack ice, although they are most abundant in tropical and temperate waters where temperatures are higher than 59ºF or 15ºC (Rice 1989). In the North Atlantic, female sperm whales range only as far as about 45-50°N (Rice 1989), so most sperm whales encountered in the Laurentian Sub-basin Project Area are likely to be males. The status of the sperm whale has not been assessed by COSEWIC. Sperm whales are listed as Endangered under the

Endangered Species Act of 1973 (http://www.nmfs.noaa.gov/pr/species/esa_species.htm) and are protected in US waters and from US citizens on the high seas under the *Marine Mammal Protection Act* of 1972 (http://www.nmfs.noaa.gov/pr/laws/mmpa.htm).

Sperm whales are generally distributed over large areas that have high secondary productivity and steep underwater topography (Jaquet and Whitehead 1996); their distribution and relative abundance can vary in response to prey availability (Jaquet and Gendron 2002). Sperm whale distribution has been correlated with the Gulf Stream warm-core rings off the northeastern US shelf edge (Waring et al. 1993; Griffin 1999). Sperm whale sightings by Griffin (1999) east of George's Bank occurred in waters with depths ranging from 1,539 to 4,740 metres, with only two sightings in depths less than 2,000 m. Off Nova Scotia, Whitehead et al. (1992) noted that sperm whales were generally found in waters 200 to 1,500 m deep, with sightings in waters as shallow as 63 m and as deep as 2,000 m. Sperm whales routinely dive to depths of hundreds of metres and may occasionally dive as deep as 3,000 m (Rice 1989). Presumed feeding events have been shown to occur at depths >1,200 m (Wahlberg 2002).

Sperm whales are capable of remaining submerged for longer than two hours, but most dives probably last a half hour or less (Rice 1989).

Sperm whales occur singly (older males) or in groups, with a mean group size of 20-30 animals (Whitehead 2003). Sperm whale distribution is thought to be linked to their social structure; adult females and juveniles generally occur in tropical and subtropical waters, whereas adult males are commonly found alone or in same-sex aggregations, often occurring in higher latitudes outside the breeding season (Best 1979; Watkins and Moore 1982; Arnbom and Whitehead 1989; Whitehead and Waters 1990). Whitehead et al. (1998) reported an average group size of 1.09 for 92 sightings of sperm whales off Nova Scotia, reflective of the fact that predominantly solitary, older males are found at higher latitudes. However, while Whitehead et al. (1992) reported that the sperm whales they encountered in The Gully were almost always sexually mature males, they also reported sighting a group of 13 adult female and immature whales in that area. In addition, Lettevall et al. (2002) reported on aggregations of 10-30 mature males spread out over several kilometres of ocean at higher latitudes, including in The Gully.

Sperm whales produce acoustic clicks that are used for both echolocation and communication (Backus and Schevill 1966; Møhl et al. 2000; Madsen et al. 2002a, 2002b; Wahlberg 2002; Whitehead 2003). During foraging dives, sperm whales produce "usual clicks" in the frequency range of 5 kHz to 24 kHz (Madsen et al. 2002a). Patterns of clicks known as "codas" are used by socializing groups of female sperm whales (Weilgart and Whitehead 1992; Rendell and Whitehead 2003; Whitehead 2003). On their breeding grounds in the Galápagos Islands, mature males produce "slow clicks" that are likely related to mating (Whitehead 1993, 2003).

Whitehead et al. (1992) noted that sperms whales were often found along the edge of the eastern Scotian Shelf, especially in The Gully and Shortland Canyon, and rarely in shallower regions on the shelf. Clapham and Wenzel (2002), in a shipboard survey of the eastern Scotian Shelf, found a single sperm whale in The Gully and other sperm whales in the Laurentian Channel east of the Stone Fence. Sperm whales have been seen sporadically in the Gulf of St. Lawrence (Reeves and Whitehead 1997), although none were seen during aerial surveys in 1995 and 1996 (Kingsley and Reeves 1998). A density of 0.0006 (CV = 1.06) sperm whales per km^2 was reported from aerial surveys on the eastern Scotian Shelf in 1995 (Palka 2001 cited *in* JWEL 2003). During ConocoPhillips' seismic program in the Project Area in 2005 there were 29 sightings (33 individuals) of sperm whales in June to August (Moulton et al. 2006a). They were observed in water depths ranging from 387 to 2,815 m, with the highest sighting rate in water 1,000 to 1,500 m deep followed by 2,500 to 3,000 m. Most were sighted in or near the Eastern Block of the seismic survey area and highest sighting rate was observed in August. Based on the available data, sperm whales are likely to be common in the proposed Project Area, particularly in deep waters over the slope. Most sperm whales seen are likely to be older mature males, either singly or in pairs, but mixed groups of females and young of both sexes as well as aggregations of adult males could also be present.

Northern Bottlenose Whale

Northern bottlenose whales live in deep water areas of the North Atlantic and are rarely found in waters less than 500 m deep (Gowans 2002). They range as far south as Nova Scotia and as far north and east as Spitzbergen, at about 80°N, 20°E. In the western North Atlantic, there are two areas of abundance of northern bottlenose whales, one off northern Labrador and the other in The Gully on the Scotian Shelf. These animals seem to form distinct stocks (Whitehead et al. 1997). The northern bottlenose whale population that inhabits the Scotian Shelf has recently been listed as endangered on Schedule 1 of *SARA*; this population is currently estimated to contain about 163 animals (95% confidence interval 119–214; Whitehead and Wimmer 2005). The Davis Strait population of this species is considered 'Not at Risk' (COSEWIC 2006).

Northern bottlenose whales routinely dive to depths greater than 800 m and are capable of remaining submerged for over an hour. Their primary prey is deep water squid (Gowans 2002). Northern bottlenose whales can be found in groups ranging in size from one to 20 individuals (Gowans 2002). Whitehead et al. (1998) reported a mean group size of 3.29 northern bottlenose whales in The Gully. There is evidence that males form long-term bonds with other males that last for years, while females have a loose network of associates (Gowans 2002). Northern bottlenose whales produce whistles with a frequency range of 3 kHz to 16 kHz and clicks that range in frequency from 0.5 kHz to >26 kHz (reviewed by Thomson and Richardson 1995).

The Scotian Shelf northern bottlenose population are known to spend most of their time in the Gully (one third the whales may be present at any one time in The Gully; Gowans et al. 2000), Haldimand and Shortland canyons on the Scotian Slope and their home ranges are thought to be a few hundred kilometres or less (COSEWIC 2002; Wimmer and Whitehead 2004). Only two individuals of this species were sighted during the ConocoPhillips seismic survey of the Laurentian Sub-basin (Moulton et al. 2006a). One was sighted in 849 m of water in the Western Block, and the other in 1,450 m of water in the Eastern Block (Figure 4.56). Northern bottlenose whales are likely to be uncommon in the Project Area.

Sowerby's Beaked Whale

Sowerby's beaked whale is distributed throughout the cold temperate waters of the North Atlantic, where it is the most abundant *Mesoplodon* species (Mead 1989). This species has been seen as far north as 71°N in the Norwegian Sea (Carlström et al. 1997) and seems to be more common in the eastern North Atlantic than in the western North Atlantic (Mead 1989). As with all Mesoplodonts, little is known about Sowerby's beaked whales and what is known comes mostly from stranding records (Lien and Barry 1990). Strandings of these animals in Canada have occurred in northern Newfoundland (Lien and Barry 1990). The Sowerby's beaked whale is presently listed under Schedule 3 of *SARA* as a 'Special Concern' species.

Recently, Hooker and Baird (1999) reported four sightings of Sowerby's beaked whales in The Gully. Those animals were sighted in water depths of 550 to 1,500 metres and in groups ranging from three to 8-10 individuals. One mixed group included two female-calf pairs and 2-4 adult males. Those whales were noted to dive for 12-28 minutes. Sowerby's beaked whales were not identified during the recent ConocoPhillips' monitoring program.

There are no abundance estimates available for Sowerby's beaked whales in the Project Area, but sightings of this animal in the area are likely to be rare as there are no known concentrations of these animals in Canadian waters.

Beluga Whale

The beluga whale is a medium-sized whale that inhabits Arctic and sub-Arctic waters (O'Corry-Crowe 2002). A population of approximately 600-700 beluga whales occurs in the St. Lawrence River (Lesage and Kingsley 1997). Of the seven beluga populations reviewed by COSEWIC (2004), two are considered Endangered, two are considered Threatened, two are considered Special Concern, and one population is considered Not at Risk. Currently, only the St. Lawrence River Estuary population is listed under Schedule 1 ('Threatened'). The other populations considered at risk, are being considered for addition to Schedule 1 pending public consultation (Table 4.1).

Beluga whales sometimes are seen alone but, more often, they are found in groups of 2-10 individuals, and they often aggregate to form herds of several hundred to greater than a thousand individuals (O'Corry-Crowe 2002). They are highly vocal, using whistles and pulsed calls that range in frequency from 0.1 kHz to 12 kHz (O'Corry-Crowe 2002). The hearing ability of beluga whales is rather well known due to our ability to study well-trained captive animals. A female beluga whale was found to have a hearing threshold of 140 ± 3 dB re 1 μPa at a frequency of 40 kHz. At 125 kHz, her hearing threshold was 99 ± 4 dB re 1 μPa (Johnson et al. 1989). Using electrophysiological methods, the maximum hearing sensitivity (54.6 dB) of an adult male beluga whale was reported to be at a frequency of 54 kHz. Its best hearing range was from 32 kHz to 108 kHz (Klishin et al. 2000). Awbrey et al. (1988) found a young male beluga whale to be more sensitive to low-frequency sounds than the two adults with which it was compared. Hearing thresholds recorded for two beluga whales at depths of

100, 200, and 300 m in open ocean did not differ significantly from those recorded at a depth of 5 m (Ridgway et al. 2001).

Beluga whales are occasionally sighted outside their usual habitat, off Newfoundland or Nova Scotia, for example (Curren and Lien 1998). One whale off Nova Scotia was genetically identified as likely belonging to the St. Lawrence Estuary population (Brown Gladden et al. 1999). However, as sightings off Nova Scotia and Newfoundland appear to be extralimital, beluga whales are likely to be very rare in the Project Area, if they occur at all.

Killer Whale

Killer whales are cosmopolitan and globally fairly abundant; they have been observed in all oceans of the world (Ford 2002). Although they prefer cold waters, they have been reported from tropical waters (Heyning and Dahlheim 1988). High densities of this species occur at high latitudes, especially in areas where prey is abundant. The greatest abundance of killer whales is found within 800 kilometres of major continents (Mitchell 1975), although they also have been reported in offshore waters (Heyning and Dahlheim 1988). While resident in some parts of their range, killer whales also can be transient. Killer whale movements generally appear to follow the distribution of prey. Killer whales prey on a diverse variety of items, including marine mammals, fish, and squid. Killer whales have been known to prey upon 20 different species of cetacean, including sperm whales and the large baleen whales, and 14 different species of pinniped (Jefferson et al. 1991).

Killer whales are capable of hearing high-frequency sounds, which is related to their use of these sound frequencies for echolocation (Richardson 1995). They produce whistles and calls in the frequency range of 0.5 kHz to 25 kHz (reviewed by Thomson and Richardson 1995), and their hearing ranges from below 500 Hz to 120 kHz (Hall and Johnson 1972; Bain et al. 1993). Two adult females had their mean most sensitive hearing at a frequency of 20 kHz (Szymanski et al. 1999). The displacement of killer whales from one location to another as a result of the introduction of noise into their environment has been documented (Morton and Symonds 2002). Killer whale occurrence was re-established when the noise source was removed.

The Project Area lies within the range of killer whales, as they are widely distributed in the North Atlantic (Dahlheim and Heyning 1999). However, they are seldom reported on the Scotian Shelf (Breeze et al. 2002) and were not reported during ConocoPhillips' monitoring program in 2005. There are no abundance estimates available for killer whales in this area; however, sightings of this animal in the area are likely to be rare.

Long-finned Pilot Whale

Pilot whales are widely distributed throughout the world's oceans. There are two species of pilot whales, long-finned pilot whales and short-finned pilot whales (*Globicephala macrorhynchus*), distinguished most easily by their disparate distributions, with short-finned pilot whales being primarily tropical while long-finned pilot whales are mostly distributed antitropically (Olson and Reilly 2002). Long-finned pilot whales are abundant throughout the North Atlantic ocean as far north as 70°N (Bernard and Reilly 1999), with some evidence of segregation between the western and eastern North Atlantic (Bloch and Lastein 1993).

Pilot whales exhibit great sexual dimorphism; males are longer than females and have more pronounced melons and larger dorsal fins (Olson and Reilly 2002). Molecular evidence suggests that pilot whale pods are composed of related individuals with little or no dispersal of either males or females from their natal group (Amos et al. 1993). Pilot whales pods are known to strand frequently en masse. Gowans and Whitehead (1995) reported an average groups size of 10 (±8) for pilot whales in The Gully, and Whitehead et al. (1998) reported an average group size of 11.4 for 54 sightings of long-finned pilot whales in The Gully. Long-finned pilot whales produce whistles with dominant frequencies in the range of 1 kHz to 8 kHz and echolocate using clicks with frequencies ranging from 6 kHz to 11 kHz (reviewed by Thomson and Richardson 1995).

An aerial survey of the Gulf of St. Lawrence found long-finned pilot whales to be located predominantly in the southeast portion of the Gulf in deep water with steep bottom relief (Kingsley and Reeves 1998). The overall density of long-finned pilot whales in that study was 0.0072/km^2 (CV = 0.65) for the entire Gulf of St. Lawrence. Long-finned pilot whales seen in The Gully were found in water depths ranging from 23 m to 2,100 m (Gowans and Whitehead 1995). A density of 0.0323 (CV = 0.57) long-finned pilot whales per km^2 was reported from aerial surveys on the eastern Scotian Shelf in 1995 (Palka 2001 *in* JWEL 2003). Long-finned pilot whales were also sighted during a shipboard survey of the eastern Scotian Shelf out to the Laurentian Channel in 2002 (Clapham and Wenzel 2002). A total of 183 groups of pilot whales (1,940 individuals) were recorded during ConocoPhillips' seismic survey in the Project Area (Moulton et al. 2006a). Pilot whales were sighted in all survey months (June to September) but highest sighting rates occurred in July (0.21 sightings/h) and August (0.20 sightings/h). They were seen in both survey Blocks in depths ranging from 500 to 2,500 m. The largest group size was 80. Based on the available evidence, long-finned pilot whales appear to be common in the proposed Project Area, particularly in deeper water areas.

Bottlenose Dolphin

Bottlenose dolphins are distributed worldwide in tropical and temperate oceans (Wells and Scott 1999). There are two distinct bottlenose dolphin types: a shallow water type, mainly found in coastal waters, and a deep water type, mainly found in oceanic waters (Duffield et al. 1983; Hoelzel et al. 1998; Walker et al. 1999). In coastal areas, bottlenose dolphins usually inhabit shallow waters along the upper slope (Davis et al. 1998). However, they can dive to depths up to 535 m for periods up to 12 minutes (Schreer and Kovacs 1997). In higher latitudes, the distribution of coastal bottlenose dolphins appears to be seasonal, with a more northerly range in the summer (Shane et al. 1986; Wells and Scott 1999).

Bottlenose dolphins form groups that are organized on the basis of age, sex, familial relationship, and reproductive condition (Berta and Sumich 1999). Whitehead et al. (1998) reported a mean group size of

11.3 for eight sightings of bottlenose dolphins in seven years of study in The Gully. The breeding season of bottlenose dolphins is in the spring (Boyd et al. 1999).

Bottlenose dolphins produce sounds that range from 0.8 kHz to 24 kHz and ultrasonic echolocation signals at 110 kHz to 130 kHz (reviewed by Thomson and Richardson 1995). They are able to hear sounds ranging from well below 1 kHz to well above 100 kHz, with limited sensitivity to frequencies as low as 100 Hz (Johnson 1967; Richardson 1995). The hearing ability of bottlenose dolphins is rather well known due to our ability to study well-trained captive animals. Johnson (1967) measured the hearing sensitivity of a single male bottlenose dolphin and found that animal to have its greatest hearing sensitivity (45 dB re 1 µPa) at around 50 kHz. Au et al. (2002) measured the hearing sensitivity of a single 18-year-old female bottlenose dolphin and produced an audiogram remarkably similar to that of Johnson (1967). Ridgway and Carder (1997) presented evidence of individual variation in the hearing sensitivities of eight (four male and four female) bottlenose dolphins, and Brill et al. (2001) reported age-related hearing loss in a 33-year-old male bottlenose dolphin. Bottlenose dolphins have been shown to alter their behaviour in response to experimentally produced sounds resembling distant underwater explosions (Finneran et al. 2000).

Whitehead et al. (1998) reported occasional sightings of bottlenose dolphins in The Gully during late summer and suggested that this was likely the extreme northeast limit of their range in the northwest Atlantic. Bottlenose dolphins sighted in The Gully were found in water depths ranging from 230 m to 1,700 m (Gowans and Whitehead 1995). A density of 0.0156 (CV = 0.76) bottlenose dolphins per km^2 was reported from aerial surveys on the eastern Scotian Shelf in 1995 (Palka 2001 *in* JWEL 2003). Bottlenose dolphins were also sighted during a shipboard survey of the eastern Scotian Shelf out to the Laurentian Channel in 2002 (Clapham and Wenzel 2002). There were seven sightings of this species in the Project Area during ConocoPhillips' seismic program (Moulton et al. 2006a). They were recorded only in August and September and only in the Western Block. Sightings occurred in depths ranging from 381 to 1,550 m. Group size ranged from six to 30 individuals. Based on these studies, bottlenose dolphins appear to be uncommon in the proposed Project Area.

Striped Dolphin

Striped dolphins have a cosmopolitan distribution in tropical to warm temperate waters (Perrin et al. 1994). Their preferred habitat seems to be deep water (Davis et al. 1998) along the edge and seaward of the continental shelf, particularly in areas influenced by warm currents (Waring et al. 2002). The northern limit of their distribution in the North Atlantic seems to be a function of the meandering of the Gulf Stream (Archer 2002) and most sightings have been south of 43°N (Archer 2002).

Striped dolphins are fairly gregarious (groups of 20 or more are common) and active at the surface (Whitehead et al. 1998). Gowans and Whitehead (1995) reported a mean group size of 10 (±8) for striped dolphins in The Gully, and Whitehead et al. (1998) noted a mean group size of 13.42 in 29 sightings of striped dolphins in The Gully. School composition varies, with groups that consist of adults, juveniles, or adults and juveniles (Perrin et al. 1994). Striped dolphins produce sounds at 6 kHz to 24 kHz (reviewed by Thomson and Richardson 1995) and can hear sounds in the range of 0.5 kHz to 160 kHz, with their most sensitive hearing range being between 29 kHz and 123 kHz (Kastelein et al. 2003).

Whitehead et al. (1998) noted striped dolphins to be common in The Gully in the late summer when water temperatures were about 15°C or above. Within The Gully, striped dolphins are found in deeper waters in the southern portion of the canyon and south of the shelf break. Gowans and Whitehead (1995) reported that striped dolphins in The Gully were found in waters depths from 800 m to 2,500 m. The Gully appears to be the most significant habitat for striped dolphins in Canadian waters (Whitehead et al. 1998); although there are many offshore areas that lack systematic survey effort. Waring et al. (2004) provided a minimum abundance estimate of 44,500 for striped dolphins off the US Atlantic coast. Only five sightings of this species were recorded during ConocoPhillips' seismic survey in the Project Area and two of these sightings were well south of the survey Blocks on the abyssal plain (Moulton et al. 2006a). Water depths at the locations of these sightings ranged from 1,069 to 3,481 m. There are no abundance estimates available for striped dolphins in the Project Area, but sightings of this species in the area are likely to be uncommon.

Short-beaked Common Dolphin

Common dolphins are widely distributed in tropical and temperate oceans around the world. The northernmost limit of their range is typically about 50°N in the Atlantic (Evans 1994). In the northwest Atlantic, they have been sighted in August as far north as 47°N off Newfoundland (Gaskin 1992). Common dolphin distribution has been shown to be associated with steep underwater topography (Evans 1994).

Common dolphins often travel in fairly large groups; schools of hundreds or even thousands are commonly seen, although their basic social units likely number less than 30 individuals (Evans 1994). Scott and Cattanach (1998) noted that common dolphins in the eastern Tropical Pacific formed larger groups in the morning and smaller groups in the later afternoon and at night. Whitehead et al. (1998) reported an average group size of 15.6 for short-beaked common dolphins off Nova Scotia. Like other dolphins, common dolphins are highly vocal (Evans 1994) and echolocate using ultrasonic pulsed signals. They produce sounds at 2 kHz to 18 kHz and ultrasounds at 23 kHz to 67 kHz (reviewed by Thomson and Richardson 1995).

Whitehead et al. (1998) noted that common dolphins were very abundant in the southern half of The Gully in the later part of the summer, with thousands of individuals present in the area in July and August. Common dolphins seen in The Gully were found in water depths ranging from 60 m to 2,500 m (Gowans and Whitehead 1995). A density of 0.0130 (CV = 0.98) common dolphins per km^2 was reported from aerial surveys on the eastern Scotian Shelf in 1995 and one of the groups sighted during that survey was seen in the northwestern part of the Laurentian Sub-basin (Palka 2001 cited *in* JWEL 2003). Common dolphins were also sighted during a shipboard survey of the eastern Scotian Shelf out to the Laurentian Channel in 2002 (Clapham and Wenzel 2002). There were 43 sightings of this species in the Project Area during ConocoPhillips' seismic survey in 2005, mostly in the Eastern Block (Figure 4.56; Moulton et al. 2006a). Group size varied from one to 80 individuals. Nearly all of the sightings occurred in June and July, with the highest sighting rate in June (0.10 sightings/h). They were seen most often in waters 500 to 1,000 m deep (0.09 sightings/h). Waring et al. (2004) provided a minimum abundance estimate of 30,768 (CV = 0.32) for common dolphins off the US Atlantic coast. Common dolphins are likely common in the Project Area during summer.

Atlantic White-sided Dolphin

Atlantic white-sided dolphins occur in temperate and sub-Arctic portions of the North Atlantic, where they are quite abundant (Reeves et al. 1999a). These animals are fairly gregarious, commonly seen in groups of 50-60 and occasionally seen in groups numbering hundreds of individuals (Reeves et al. 1999a). Whitehead et al. (1998) reported a mean group size of 8.8 for Atlantic white-sided dolphins in The Gully, and Kingsley and Reeves (1998) reported a mean group size of 8.3 for Atlantic white-sided dolphins in the Gulf of St. Lawrence. The calving season of Atlantic white-sided dolphins in the North Atlantic occurs from May to August, with a peak in June and July (Reeves et al. 1999a). Atlantic white-sided dolphins produce whistles with dominant frequencies between 6 kHz and 15 kHz (reviewed by Thomson and Richardson 1995).

Sightings of Atlantic white-sided dolphins in the Gulf of St. Lawrence occurred around the margins of the Gulf in areas with steep bottom relief (Kingsley and Reeves 1998). A density of 0.0529 (CV = 0.47) Atlantic white-sided dolphins per km^2 for the entire Gulf of St. Lawrence was found in that study. Whitehead et al. (1998) noted that Atlantic white-sided dolphins were found in substantial numbers in The Gully throughout the summer, with a preference for deep waters in and near the canyon. Atlantic white-sided dolphins seen in The Gully were found in water depths ranging from 100 m to 2,200 m (Gowans and Whitehead 1995). A density of 0.2588 (CV = 0.54) Atlantic white-sided dolphins per km^2 was reported from aerial surveys on the eastern Scotian Shelf in 1995 (Palka 2001 cited *in* JWEL 2003).

Atlantic white-sided dolphins were also sighted during a shipboard survey of the eastern Scotian Shelf out to the Laurentian Channel in 2002 (Clapham and Wenzel 2002). During ConocoPhillips' seismic survey of the Project Area in 2005, 47 sightings of Atlantic white-sided dolphins were recorded, in groups ranging in size from one to 150 animals (Moulton et al. 2006a). They were recorded in both survey Blocks (Figure 4.56) and were most commonly seen in July (0.11 sightings/h). These sightings occurred in water depths ranging from 380-2,743 m and were most frequent in waters 500 to 1,000 m (0.15 sightings/h) and 1,000 to 1,500 m (0.09 sightings/h) deep (Moulton et al. 2006a). The total population of Atlantic white-sided dolphins in the North Atlantic may be as high as a few hundred thousand (Reeves et al. 1999a). Waring et al. (2004) provided a minimum abundance estimate of 51,640 (CV = 0.38) for the Atlantic white-sided dolphins off the US Atlantic coast. Based on the available information, Atlantic white-sided dolphins are likely to be common in the Project Area.

White-beaked Dolphin

White-beaked dolphins are found in cold temperate and sub-Arctic waters in the North Atlantic (Reeves et al. 1999b). Populations in the eastern and western North Atlantic appear to be distinct (Kinze 2002). White-beaked dolphins are less abundant in the western North Atlantic than in the eastern portion of their range, with the greatest abundances occurring in this region off Labrador and southwest Greenland (Kinze 2002).

White-beaked dolphins occur in schools up to several hundreds or thousands in number, although groups of 30 animals or so are most common (Kinze 2002). Kingsley and Reeves (1998) found a mean group size of 8.65 white-beaked dolphins in the Gulf of St. Lawrence. White-beaked dolphins produce squeals with a dominant frequency range of 8 kHz to 12 kHz and echolocate at frequencies up to 325 kHz (reviewed by Thomson and Richardson 1995).

Sightings of white-beaked dolphins in the Gulf of St. Lawrence occurred predominantly in the northeastern portion of the Gulf and into the Strait of Belle Isle (Kingsley and Reeves 1998). A density of 0.0119 (CV = 0.79) white-beaked dolphins per km^2 for the entire Gulf of St. Lawrence was found in that study. White-beaked dolphins have stranded along the southern coast of Newfoundland (Hai et al. 1996). White-beaked dolphins have not been reported for The Gully, although they are found in inshore Nova Scotia waters (Whitehead et al. 1998). There were no sightings of white-beaked dolphins in a shipboard survey of the eastern Scotian Shelf out to the Laurentian Channel in 2002 (Clapham and Wenzel 2002). During ConocoPhillips' seismic program in 2005 there was only one sighting of six individuals of this species in the Project Area. This sighting occurred well northeast of the Eastern Block of the survey area in 113 m of water (Moulton et al. 2006a). Based on the available information, white-beaked dolphins are likely to be uncommon in the Project Area.

Risso's Dolphin

Risso's dolphin is widely distributed in tropical and warm temperate oceans (Reeves et al. 2002). It is usually found over deep water (>300 m) where they feed almost exclusively on squid. They are abundant worldwide but are probably rare in the Project Area (Reeves et al. 2002). There is one sighting from the lower Laurentian Channel (Baird and Stacey et al. 1991). A total of five sightings of Risso's dolphins (41 individuals) were made in the Project Area during ConocoPhillips' 2005 seismic program (Moulton et al. 2006a). Four sightings were in July and one occurred in June. Three sightings were made in the Eastern Block and the remaining two were southeast of that block (Figure 4.56). The sightings were recorded in deeper water, ranging from 857 to 3,598 m in depth. Risso's dolphins are likely uncommon to rare in the Project Area.

Harbour Porpoise

The harbour porpoise is found in shelf waters throughout the northern hemisphere, usually in waters colder than 17°C (Read 1999). The northernmost limit of their range is 70°N, but they are present in northern coastal waters only during the summer months (IWC 1996). Harbour porpoises can be divided into genetically different subpopulations within the western North Atlantic. These include: the Bay of Fundy/Gulf of Maine, Gulf of St. Lawrence, and eastern Newfoundland (Wang et al. 1996; Westgate and Tolley 1999). Harbour porpoises found off Atlantic Canada appear to be physically distinct from those off west Greenland, in the eastern North Atlantic, and in the North Sea (Lockyer et al. 2001), and harbour porpoises from the northwest and northeast Atlantic appear to be genetically distinct (Rosel et al. 1999). The Northwest Atlantic harbour porpoise population is presently listed under Schedule 2 of *SARA* as Threatened and is considered of Special Concern by COSEWIC. It is currently under consideration for listing under Schedule 1 of *SARA*.

Harbour porpoises are usually seen in small groups of one to three animals, often including at least one calf; occasionally they form much larger groups (Bjørge and Tolley 2002). Harbour porpoises feed independently on small schooling fishes (Read 1999). They echolocate using clicks with frequencies that were reported by Au et al. (1999) to have peaks from 125 kHz to 130 kHz and by Tielmann et al. (2002) to have peaks from 125 kHz to 136 kHz, with a mean peak frequency of 131 kHz. The hearing capability of the harbour porpoise was first measured by Andersen (1970) using a captive 3.5-year-old female harbour porpoise, which was found to have its most sensitive hearing in the frequency range of 4 kHz to 40 kHz. More recently, Kastelein et al. (2002a) found a two-year old stranded male harbour porpoise to have hearing capabilities from 0.25 kHz to 180 kHz. Its range of best hearing was from 16 kHz to 140 kHz; the maximum hearing sensitivity of that animal was between 100 kHz and 140 kHz (~33 dB re 1 µPa).

Sightings of harbour porpoises in the Gulf of St. Lawrence occurred in shallow waters out to about a depth of 285 metres (Kingsley and Reeves 1998). A density of 0.0545 (CV = 0.26) harbour porpoises per km^2 for the entire Gulf of St. Lawrence was found in that study. Harbour porpoises were sighted only once in The Gully during seven years of studies (Whitehead et al. 1998). No harbour porpoises were seen during ConocoPhillips' 2005 seismic program in the Laurentian Sub-basin (Moulton et al. 2006a). The best estimate of abundance for the Gulf of Maine/Bay of Fundy subpopulation of harbour porpoises is 89,700 (CV = 0.22) (Waring et al. 2004). Harbour porpoise have been observed in deep waters (Orphan Basin) off the coast of Newfoundland during summer (Moulton et al. 2006b). Based on the available information, the occurrence of harbour porpoises within the Project Area is likely to be uncommon.

4.9.2. Seals

Four species of phocid are known or expected to occur in the Laurentian Sub-basin: grey seal, harp seal, harbour seal, and hooded seal (Table 4.18). None of these four seal species are listed under *SARA*.

Table 4.18. Pinnipeds with Known or Expected Occurrences in the Project Area.

Species		Occurrence	Season	Habitat	*SARA*/COSEWIC Status
Common Name	**Scientific Name**				
True Seals	***Phocidae***				
Grey seal	*Halichoerus grypus*	Common	Primarily summer	Coastal	Not assessed
Harbour seal	*Phoca vitulina*	Uncommon	Year-round	Coastal	Not assessed
Harp seal	*Pagophilus groenlandica*	Uncommon	Late winter/early spring	Ice	Not assessed
Hooded seal	*Cystophora cristata*	Uncommon	Primarily late winter	Ice	Not assessed

4.9.2.1. Grey Seal

Grey seals are distributed in coastal areas of the North Atlantic, off eastern Canada, Iceland, the United Kingdom, and Norway during the breeding season from September to December (Bonner 1981).

Outside the breeding season, they range farther. The northwest Atlantic stock of grey seals occurs in the Gulf of St. Lawrence and around Nova Scotia and Newfoundland and Labrador. The largest breeding colony in the North Atlantic is on Sable Island, east of Nova Scotia, with about 85,000 individuals (Hall 2002). Stocks of grey seals in the northeastern and northwestern Atlantic are thought to be genetically distinct (NAMMCO 1997).

Grey seal dives last, on average, from 4-10 minutes, with a maximum duration of 30 minutes (Hall 2002). Typical dive depths in the United Kingdom were 60 metres to 200 metres, with dives >300 metres occasionally reported (Hall 2002). Grey seals produce sounds in the frequency range of 0.1 kHz to 16 kHz (reviewed by Thomson and Richardson 1995).

Female grey seals give birth between September and March (Hall 2002). In Canada, the peak pupping season occurs in January (Hall 2002). Pups are nursed for approximately 18 days and the female mates again near the end of the lactation period either on land or in the water (Hall 2002). Grey seals from Sable Island disperse after the breeding period, moult during May and June, and move northward during July to September, returning to Sable Island to breed in October to December (Stobo et al. 1990). Most grey seals likely return to breed in the same area where they were born (Bonner 1981). However, the distributional overlap between the Gulf of St. Lawrence and Sable Island grey seal populations is extensive, and there is evidence of the direct transfer of breeding adults between the two areas (Stobo et al. 1990). Presumably, at least some portion of these individuals pass through the Project Area. None were seen in the Project Area during ConocoPhillips' 2005 seismic survey (Moulton et al. 2006a). There are no abundance estimates available for grey seals in the Project Area, but sightings of grey seals in the area could be common at times.

4.9.2.2. Harbour Seal

Harbour seals have one of the largest distributions of any pinniped. They can be found in most coastal waters of the North Atlantic and North Pacific to as far north as about 80°N off Spitzbergen (Bigg 1981). The western North Atlantic harbour seal (*Phoca vitulina concolor*) ranges from north Florida to north Baffin Island and along the southwestern and southeastern coasts of Greenland (Bigg 1981). While harbour seals are thought to be primarily a coastal species, Bjørge et al. (2002) demonstrated that harbour seals tagged off Norway dispersed a mean distance of 69 km from where they were tagged, with a maximum distance of 463 km.

Harbour seal pups are born in late spring or summer, and mating occurs in the water around the time that the pups are weaned, at about four weeks of age (Burns 2002). Moulting occurs during midsummer to early fall, during which time harbour seals haul out more frequently than at most other times of the year. Harbour seals produce social sounds in the frequency range of 0.4 kHz to 3.5 kHz (reviewed by Thomson and Richardson 1995).

The population size of western Atlantic harbour seals is not known with any degree of certainty. From 30,000-40,000 were thought to be present in Canadian waters in 1993 (Burns 2002). The harbour seal population size in Atlantic Canada was estimated to be 31,900 in 1996 and, at that time, it was increasing at a rate of 5.6% per year (Hamill and Stenson 2000). No harbour seals were sighted during ConocoPhillips' seismic program in the Project Area in 2005 (Moulton et al. 2006a). The Project Area is within the range of the harbour seal; however, as they are predominantly a coastal species, harbour seals are likely to be uncommon in the area.

4.9.2.3. Harp Seal

Harp seals range throughout the North Atlantic and Arctic Oceans from the Gulf of St. Lawrence to Russia (Lavigne 2002). They are one of the most abundant pinniped species, with an estimated population size in 2000 of 5.2 million (95% C.I. = 4.0-6.4 million) in the northwest Atlantic (Healey and Stenson 2000). This population size appears to have been stable since 1996. Harp seals that whelp in the northwest Atlantic (in the Gulf of St. Lawrence and off southern Labrador/northern Newfoundland) are genetically distinct from those that whelp in the northeast Atlantic (Perry et al. 2000).

The northwest Atlantic harp seal population summers in the Canadian Arctic and Greenland, migrating south to the Gulf of St. Lawrence or off southern Labrador and northern Newfoundland where pups are born on the ice in late February or March (DFO 2000). Both male and female harp seals become sexually mature between four and eight years of age (Sergeant 1991). Females nurse their pups for about 12 days, then mate and disperse. Older seals aggregate to moult off northeastern Newfoundland and in the northern Gulf of St. Lawrence in April and May. After that time, they disperse and migrate northward (DFO 2000). Harp seals dive to a maximum of about 370 metres, and dives can last for up to 16 minutes (reviewed by Schreer and Kovacs 1997). Harp seals produce sounds in the frequency range of <0.1 kHz to >10 kHz (reviewed by Thomson and Richardson 1995).

While the Project Area is within the harp seal's range, it is not within one of the areas where harp seals are known to aggregate. Hence, harp seal presence in the area is likely to be uncommon. None were seen in the Project Area during ConocoPhillips' 2005 seismic survey (Moulton et al. 2006a).

4.9.2.4. Hooded Seal

The range of the hooded seal encompasses a large portion of the North Atlantic from as far south as Nova Scotia to as far north as north of Svalbard in the Barents Sea, including waters surrounding Greenland and Iceland (Kovacs 2002). It is not uncommon for hooded seals, particularly young animals, to be found outside their normal range. Hooded seals are migratory, congregating to breed in spring in the Gulf of St. Lawrence, north of Newfoundland, in the Davis Strait, and east of Greenland (Kovacs 2002). After breeding, hooded seals move to moulting areas on the southeast and northeast coasts of Greenland. Hooded seals disperse widely in the summer and fall (Kovacs 2002). There are no good estimates of the hooded seal population size because this species is difficult to survey, but the total population probably numbers on the order of half a million (Kovacs 2002).

The hooded seal breeding season lasts only 2-3 weeks in each area. Females give birth in loose pack ice areas and nurse their pups for a mere four days, during which time the pups consume up to 10 litres of milk per day (Kovacs 2002). Mating occurs in the water after weaning. Hooded seals are quite solitary outside the breeding season and, as a result, their vocal repertoire is quite simple (Kovacs 2002). They produce sounds in the frequency range of 0.1 kHz to 1.2 kHz (reviewed by Thomson and Richardson 1995).

There are no abundance estimates of hooded seals available for the Project Area. While it is within their range, the Project Area is not within one of the areas where hooded seals are known to aggregate. Hence, hooded seals are likely to be uncommon within the Project Area. No members of this species were recorded during the ConocoPhillips' 2005 seismic survey in Project Area (Moulton et al. 2006a).

4.9.3. Sea Turtles

Three species of sea turtle could potentially occur in the Project Area (Table 4.19). In order of decreasing abundance in North American waters, these are: the loggerhead turtle (*Caretta caretta*), the leatherback turtle (*Dermochelys coriacea*), and the Kemp's ridley turtle (*Lepidochelys kempii*). Both loggerheads and leatherbacks are common in the waters off Newfoundland during the summer and fall (Goff and Lien 1988; Marquez 1990; Witzell 1999). Less is known about the distribution of Kemp's ridley turtles in eastern Canada, although they are thought to be rare (Breeze et al. 2002). Adults of this species are rarely found beyond the Gulf of Mexico; however, juvenile animals range as far north as Newfoundland (Ernst et al. 1994). During ConocoPhillips' 2005 seismic survey in the Project Area a sea turtle of unknown species and a (deceased) leatherback turtle (see below) were sighted.

Table 4.19. Sea Turtles with Known or Expected Occurrences in the Project Area.

Species	Occurrence	Season	Habitat	*SARA* Status
Leatherback turtle	Uncommon	Summer	Channel	Schedule 1: Endangered
Loggerhead turtle	Rare	Summer	Channel	
Kemp's ridley turtle	Very rare	Summer	Channel	

Adapted from Table 3.15 *in* JWEL (2003).

General information on the distribution and biology of sea turtles that occur in Atlantic Canada is available in Breeze et al. (2002), on the NOAA Fisheries Office of Protected Resources web site (http://www.nmfs.noaa.gov/pr/species/turtles/), and from the Nova Scotia Leatherback Turtle Working Group (http://www.seaturtle.ca).

4.9.3.1. Leatherback turtle

The leatherback is the largest living turtle, attaining up to 219 cm in length and over 900 kg. It also may be the most widely distributed reptile, ranging throughout the Atlantic, Pacific, and Indian Oceans and into the Mediterranean Sea (Ernst et al. 1994). Leatherbacks are predominantly pelagic and are highly carnivorous, consuming mostly invertebrates. Although they occasionally ingest algae or vertebrates, their preferred prey is jellyfish. Leatherbacks are less genetically diverse than other sea turtle species and may have less rigid homing instincts (Dutton et al. 1999).

The worldwide population of leatherbacks is currently censused at between 26,000 and 43,000 (Dutton et al. 1999). This number is not far from the evolutionary effective population size, estimated to be between 45,700 and 60,000 calculated from observed genetic diversity (Dutton et al. 1999). The current population is thought to be declining, as major nesting colonies have declined in the last 20 years, although Dutton et al. (1999) report an increase in leatherbacks nesting in Florida over the last few years. There are no estimates of the population size in Canada; however, adult leatherbacks are thought to be a regular part of the Newfoundland marine fauna in the summer and fall (Goff and Lien 1988; Witzell 1999). The leatherback turtle is listed under Schedule 1 of *SARA* as Endangered. In the United States, the leatherback turtle is also listed as Endangered under the *Endangered Species Act* (http://www.nmfs.noaa.gov/pr/species/turtles/).

Data from the US Pelagic longline fishery observer program have added to the knowledge of leatherback distribution off Newfoundland (Witzell 1999). Nearly half of the leatherbacks (593 captures) caught incidentally by this fishery between 1992 and 1995 from the Caribbean to Labrador were captured in waters on and east of the 200-m isobath off the Grand Banks (Witzell 1999). Animals were caught in this region during all months from June to November with the bulk of captures from July to September. Not surprisingly, leatherback captures within these waters corresponded closely with fishing effort, both clustered near the 200 m isobath. Two leatherback turtles were sighted during a shipboard survey east of the Scotian Shelf out to the Laurentian Channel in 2002 (Clapham and Wenzel

2002). Breeze et al. (2002) state that adult leatherback turtles are regularly observed on the Scotian Shelf from June to October. James et al. (2005) analyzed satellite telemetry, morphometric and fishing entanglement data to identify high-use habitat of leatherbacks in Northwest Atlantic waters. It was shown that leatherbacks do not migrate along specific routes but that they utilize broad areas of the Atlantic. Leatherback sea turtles did exhibit foraging site fidelity to shelf and slope waters off Canada and the northeastern United States (James et al. 2005). Satellite tagged leatherbacks did occur within and near the Project Area.

A decomposing leatherback was photographed during ConocoPhillips' 2005 seismic program in the Project Area. It was found on 23 July 2005 in waters 997 m deep at 44.885ºN, 55.167ºW and likely had been dead for a considerable period of time (Moulton et al. 2006a). Although there are no estimates available for the density of leatherback turtles in the Project Area, they are likely a regular part of the marine fauna in the area.

4.9.3.2. Loggerhead turtle

The loggerhead is the largest hard-shelled turtle in the world (typically 85 cm to 100 cm) and also the most abundant sea turtle in North American waters (Ernst et al. 1994). They wander widely throughout their range, and can be found in coastal areas or sometimes more than 200 km out to sea. Loggerheads are omnivorous, predominantly consuming many types of invertebrates but also algae and vascular plants (Ernst et al. 1994). The North American population, which is thought to be declining, has been estimated to number between 9,000 and 50,000 adults (Ernst et al. 1994). The loggerhead turtle has not been assessed by COSEWIC. In the United States, they are listed as Threatened under the *Endangered Species Act* (http://www.nmfs.noaa.gov/pr/species/turtles/).

Loggerheads found in Canadian waters tend to be smaller than their counterparts in coastal US waters (Witzell 1999) so are likely younger animals. Ninety percent of females nesting in the Atlantic do so in the southeastern United States in what appear to be demographically independent groups based on mitochondrial DNA haplotype distributions (Encalada et al. 1998). How genetic distinctions in nesting areas may relate to genetic structure within the Project Area has not been investigated.

Data from the US Pelagic longline fishery observer program have added to the knowledge of loggerhead distribution off Newfoundland (Witzell 1999). Seventy percent of loggerheads (936 captures) caught incidentally by this fishery between 1992 and 1995 from the Caribbean to Labrador were captured in waters on and east of the 200-m isobath off the Grand Banks. Animals were caught in this region during all months from June to November with a peak in captures during September. Within these waters, loggerhead captures corresponded closely with fishing effort, both being clustered near the 200 m isobath, where oceanographic features lead to the concentration of prey species for both the turtles and the swordfish and tuna that are the targets of the longline fishers.

Loggerheads are not observed as frequently as leatherbacks on the Scotian Shelf (Breeze et al. 2002). During a seismic monitoring program on the Scotian Slope in 2003, four loggerhead turtles were sighted in late July and early August in waters ~3,000 m deep (Moulton and Miller 2004). Although there are no estimates available for the density of loggerhead turtles in the Project Area, they are likely to be rare.

4.9.3.3. Kemp's ridley turtle

Kemp's ridleys are predominantly carnivorous, eating a variety of invertebrates but also some marine plants and algae. They prefer shallow water, and while adults rarely range beyond the Gulf of Mexico, juveniles can be found as far north as Newfoundland (Ernst et al. 1994). There are no estimates on the number of Kemp's ridley turtles occurring in Canadian waters. Breeze et al. (2002) list them as accidental visitors to eastern Canada and state that the Scotian Shelf is not believed to an important habitat for them. Almost all nesting of Kemp's ridleys occurs along a single beach in Rancho Nuevo, Mexico. The number of females nesting there dropped from as many as 40,000 over 50 years ago to a low of around 700 in the late 1980s, but saw a steady increase in the 1990s as a result of conservation measures (Marquez et al. 1999). The number of Kemp's ridleys that visit the Project Area is unknown, but it is likely to be extremely rare. The status of the Kemp's ridley turtle has not been assessed by COSEWIC. In the United States, the Kemp's ridley turtle is listed as Endangered under the *Endangered Species Act* (http://www.nmfs.noaa.gov/pr/species/turtles/).