JEANNE D'ARC BASIN 3D SEISMIC PROGRAM, ENVIRONMENTAL ASSESSMENT UPDATE, 2006 - 2010

Prepared by

LGL LIMITED
environmental research associates

for

Husky Energy

LGL Report SA884

March 2006

JEANNE D'ARC BASIN 3D SEISMIC PROGRAM, ENVIRONMENTAL ASSESSMENT UPDATE, 2006 - 2010

by

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1.0 INTRODUCTION

Husky Energy Inc. (Husky) is proposing to conduct 3-D seismic surveys and geohazard surveys of their offshore acreage in Jeanne d'Arc Basin in 2006 - 2010. This document is intended as an update to the Environmental Assessment (LGL et al. 2005) and it's Addendums (LGL 2005; LGL and Canning & Pitt 2005a) of the multiyear seismic program in the Jeanne d'Arc Basin on behalf of Husky. In addition, this document updates Husky's geohazard survey EA of Jeanne d'Arc Basin for 2005 (LGL and Canning & Pitt 2005b). Only new and relevant information to seismic and geohazard operations in 2006 - 2010 and to the environmental assessment of the seismic and geohazard program are presented here. The reader is referred to the documents mentioned above for more detail.

2.0 PROJECT DESCRIPTION

Husky is proposing to conduct 3-D seismic surveys of their offshore acreage in Jeanne d'Arc Basin. The seismic program in 2006 would be the second year in a potential six-year program (2005-2010). The first year of this program occurred in 2005 and Husky acquired 500 km^2 of 3D seismic data in the southern portion of Wildrose (see Fig. 2.1). In 2006, Husky proposes to acquire 250 km^2 of seismic data in Wildrose (with the potential to acquire an additional 320 km^2 if time permits) and approximately 600 km^2 of seismic data in the Fortune area. It is anticipated that a typical seismic program would be two months in duration and would occur at some time between 30 May to 30 November, with a likely start date around 1 August for 2006, but possibly earlier in subsequent years. Husky is also proposing to conduct geohazard site surveys at about four potential locations per year (see Fig. 2.1) starting in 2006. For the purposes of this EA update, a 'Project Area' has been defined as the area where Husky intends to conduct seismic (and geohazard) surveys in 2006-2010 (including space for the seismic ship to make turns). The 'Study Area' includes the Project Area plus a 20 km buffer to account for potential environmental effects on Valued Ecosystem Components (VECs). Within the Project Area, the specific areas for seismic operations in 2006 are called 'Wildrose 3D' and 'Fortune 3D' (Fig. 2.1). Any proposed seismic program is dependent upon regulatory approval.

2.1 Location of Proposed Project

Husky proposes to conduct seismic operations on acreage held by Husky Energy within the defined Project Area (46°15' - 47°50' N; 47°15' - 49°15' W). Water depths in the Project Area range from 80 m to 300 m. The Project Area, at its closest point, is 260 km from St. John's.

Husky has two high priority seismic areas for 2006: first priority is 'Wildrose 3D' (250 km^2; see '2006' in Fig. 2.1) and second priority is 'Fortune 3D' (~600 km^2; Fig. 2.1). There is potential that an additional 320 km^2 of seismic data will be acquired in Wildrose 3D (see 'possible 2006' in Fig. 2.1). In total, approximately 1150 km^2 of 3D seismic data may be acquired in the Project Area by Husky in 2006. In future years (2007-2010), as much as 2500 km^2 of seismic data may be acquired in any given year.

Geohazard site surveys (each with typical and maximum dimensions of 10 km x 10 km and 30 km x 30 km, respectively) are proposed to occur at four potential sites in 2006 and perhaps as many per year in following years.

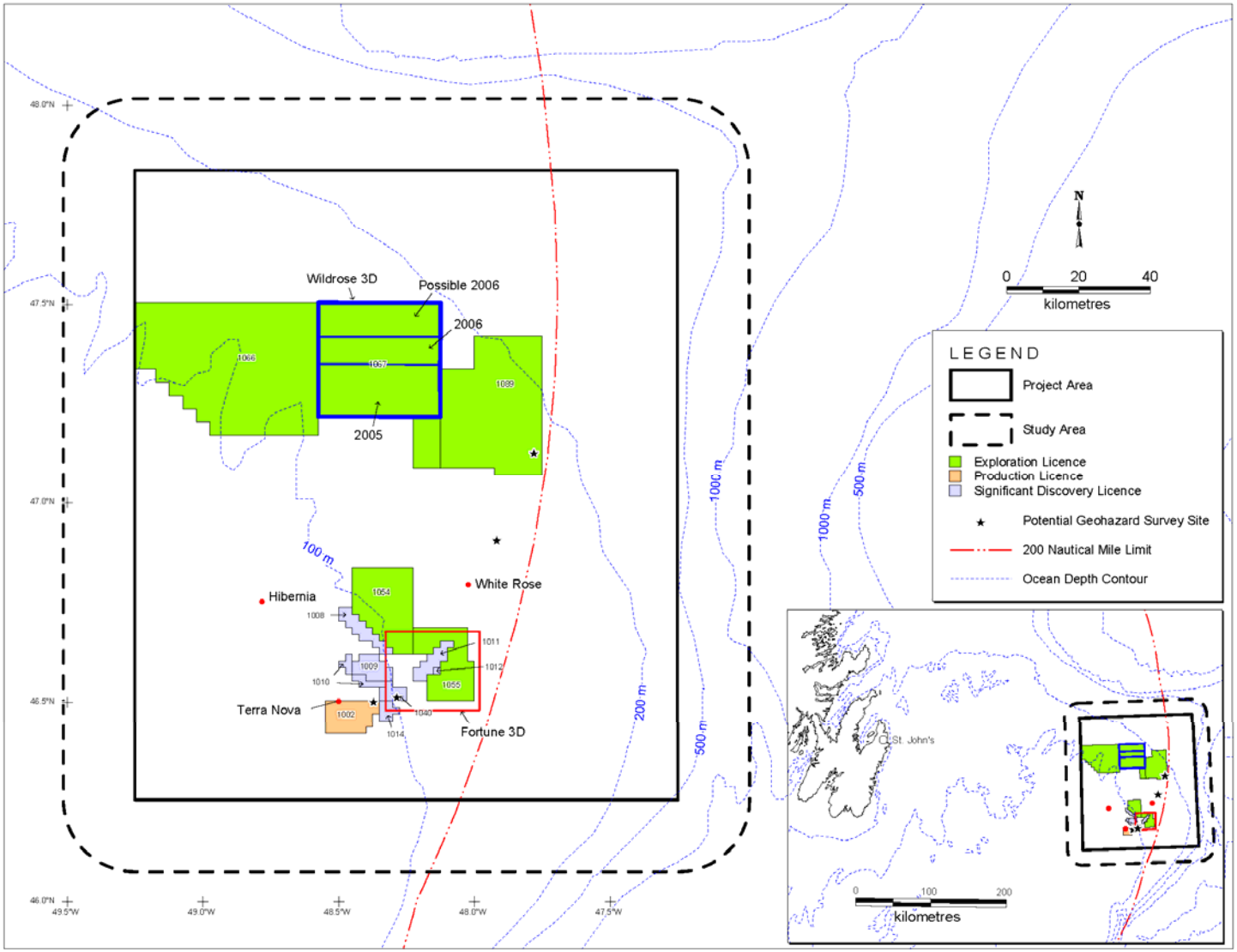

Figure 2.1. Locations of the Project Area, Study Area for 2006 - 2010 and proposed seismic program for 2006 (Wildrose 3D, Fortune 3D).

2.2 Acquisition Duration and Timing

Typically, the total duration of a seismic survey is anticipated to be approximately 62 days. These include about 33-43 days of data acquisition plus additional days for transit, equipment deployment and retrieval, weather and technical downtime. The 2006 seismic program will likely occur during the 1 August to 30 November period. Each geohazard survey program is anticipated to be approximately 7-10 days (as many as 14 days) and surveys will likely occur in late spring and early summer but may occur in May-October in any given year. It is unlikely that seismic and geohazard surveys will overlap temporally.

Retrieval or deployment of the recording streamer equipment in good weather conditions can be accomplished in 3 to 8 days Deployment of the complete airgun arrays will take 6 to 8 h and retrieval about 2 h. Line changes (turns) will take between 2 to 3 h to complete and airguns may be retrieved at this time for repair. Seismic equipment may be retrieved if bad weather is expected.

2.3 Seismic Energy Source Parameters

The following can be considered a "typical 3-D set-up" based on 2006 specs. Typically, the seismic vessel will operate on the order of two 5085 in^3 arrays of 24 Bolt airguns per array or equivalent. In 2006, the largest airgun used will be 290 in^3 and the smallest 105 in^3 and each array will consist of three eight-gun 1695 in^3 sub-arrays. The overall dimensions of the array are 15 m long by 16 m wide and the sub-arrays are spaced 8 m apart. The two 5085 in^3 airgun arrays will fire alternately (flip-flop arrangement) along the survey lines. The centre of the array is deployed about 250 m behind the vessel and at approximately 7 m below the water surface. Airguns will be operated at 2000 psi and the estimated source level of the array is 106.4 bar-m (~255 dB re 1 μPa (0-p)). The airguns in the array are strategically arranged to direct most of the energy vertically rather than horizontally. Additional specifications of the array are contained in LGL and Canning and Pitt (2005a). Husky will require that the seismic operator ramp up its airgun array (over a 30-minute period) after prolonged periods of shutdown.

2.4 Seismic Acquisition Vessel, Data Recording Equipment, and Survey Design

It is anticipated that the M/V *Western Neptune* will be the seismic vessel for the 2006 program, however, an equivalent vessel from the seismic fleet may be substituted for 2006 or later years. [This vessel operated on behalf of Husky in the Jeanne d'Arc Basin in 2005. The *Neptune* was built in 1999 and is 93 m long and 23 m wide with a mean draft of 7.3 m. Its maximum speed is 14.5 knots and it transits at a speed of 12 knots. The *Neptune* has a maximum personnel capacity of 68 individuals. The ship has two main engines (Bergen diesels, 5405 BHP each) that power two four-blade propellers. The *Neptune* also has a bow thruster (Ulstein-Liaaen 800 TV, 1100 KW). Two generators (3000 KVA Van Kaick) are used to supply power and electricity.] The streamer towing speed will be 4.6-4.7 knots. The vessel has a helicopter deck large enough to accommodate an offshore-rated helicopter. The vessel has an incinerator, bilge/oily water separator, oily water/sludge holding tanks, sewage treatment plants and oil spill absorbent/damage control equipment. An echosounder (Simrad EA500) will be used to acquire water depths at each shotpoint. The echosounder emits sound pulses in a narrow beam at nominal frequencies of 18 kHz and 200 kHz. The ship will deploy a workboat to repair streamers when necessary.

Ten streamers (4-8 km in length) will be towed behind the vessel and at a depth of 6-11 m to record the seismic data. The streamers were separated laterally by a distance of 100 m, with a total resultant distance of 900 m between the outside streamers. The *Neptune* employs WesternGeco Q-Marine (Nessie 5) streamers. This type of streamer controls its buoyancy with a fluid called Isopar-M. Isopar-M predominantly consists of isoparaffinic hydrocarbons (C12-C15). In future years (2007-2010), streamer type could vary (e.g., solid streamers).

It is anticipated that seismic data will be acquired along ~62-96 prime lines in 2006 that are all oriented in an east-west direction. Data acquisition is planned to start in the Wildrose area where there are 17 prime lines (plus four infill lines) that are a priority for Husky; this will require about 10 days to complete. The next priority is in the Fortune area, there are 45 prime lines (plus nine infill lines) which will require about 23 days to complete. If time permits, the seismic vessel will return to the Wildrose area to acquire data along an additional 34 prime lines (plus seven infill) which could extend the seismic program by approximately 20 days. Lines may differ in number and/or orientation in subsequent years.

2.5 Geohazard Surveys

Once a potential drilling site is located it is standard offshore industry procedure, and a requirement of the C-NLOPB, that a well site/geohazard survey be conducted. The purpose of the survey is to identify, and thus avoid, any potential drilling hazards such as steep and/or unstable substrates or pockets of “shallow gas”. It involves acquisition of high resolution seismic, side scan sonar, sub-bottom profile, and bathymetric data over the proposed drilling area (s). Typically the seismic data for well site surveys are collected over closer lines (250 m), using smaller equipment and lower pressures, over a shorter time period (e.g., several days) compared to 3-D seismic programs.

Surficial data are collected using a broad band (e.g., 500 Hz to 6 kHz) sparker or boomer as a sound source which provides data as deep as 100 m into the substrate. A single or multi-beam echo sounder is used for bathymetry and a dual frequency side scan sonar system is used to obtain seabed imagery. Seabed video and/or grab samples are used to provide ground-truthing information on the character of the seabed and sediments.

The program will acquire high resolution seismic, side scan sonar, sub-bottom profiler and bathymetric data over the proposed area (s). Survey speed will be on the order of four to five knots. From an operational perspective, the following summarizes the systems to be used during online surveying.

The program, as presently discussed, would see the acquisition of data from a regular survey grid over defined area (s) where jack-up rig and semi-submersible rig may potentially be used. For potential jack-up rig sites, geohazards data will be acquired along transects spaced 50 m apart. Transects will be spaced 250 m apart with tie lines at 500 m at potential semi-submersible drill rig sites. Survey grids (typically 10 km x 10 km) will be centered at potential drill sites (see Fig. 2.1).

Detailed specifications for the Fugro-Jacques vessel M/V *Anticosti* are provided below as a “typical” geohazard survey vessel.

2.5.1 Survey Equipment

The geohazard survey work will likely be conducted from the M/V *Anticosti*, a 54 m long offshore research vessel/tug owned by Cape Harrison Marine, of St. John’s or from a similar vessel. The

Anticosti is the same vessel and equipment utilized by Fugro-Jacques Geosciences (FJG) within eastern Canada over the past few years, and for recent (2004) Petro-Canada, Chevron Canada and Geological Survey of Canada survey programs. Safety policies and programs are in place, and are on file with the C-NLOPB (see list below).

- Bridging Document between Fugro and vessel operator (Cape Harrison Marine)
- HSE plan
- Vessel Safety case
- Fugro safe working procedures for Geophysical work

Differential GPS corrections will be provided via satellite transmission and also via Coast Guard MF beacons (as back-up). Survey speed will average four to five knots during the program

2.5.1.1 Multichannel Seismic Data

High-resolution multichannel seismic data will be acquired with a suite of four sleeveguns (160 in^3 total volume), a 96-channel streamer (6.25 m group and shot interval, 600 m active length), and a TTS 2+ digital recording system. Data will be acquired to two seconds depth, sampled at one millisecond.

The multi-channel seismic source will be comprised of four or more separate sleeveguns, each of 40 in^3 capacity. These are driven by controlled bursts of compressed air to produce an acoustic pulse. They will be deployed within a ladder array, approximately 30 m off the stern of the vessel, and at a depth of 3 m. The compressed air is provided by a diesel-powered compressor on deck. The maximum output from this array has a peak to peak value of 17.0 Bar-metres. This equates with decibel notation of 244.6 dB (peak to peak)//1µPa@1m, or 238 dB (zero to peak)//1µPa@1m.

The Canadian Environmental Assessment Act (*CEAA*) identifies an output level of 275.79 kPa at a distance of one metre from the seismic energy source, as a criterion for inclusion in the list of activities requiring an EA. This is equivalent to a value of 228.69 dB//1µPa@1m. As such, the present acoustic source exceeds the defined threshold level (if considering instantaneous levels).

Rise time for the pulse is approximately four milliseconds, based on a chart provided by the equipment manufacturer. Operating pressure of the guns is a maximum of 2,000 pounds per square inch (psi). The airguns can be ramped up in output prior to start of line to meet guidelines in place.

The streamer will be towed from the port quarter of the vessel. A tail buoy will be used, equipped with a radar reflector and strobe light. Streamer depth will be approximately three metres. Total streamer length will be approximately 650 m.

2.5.1.2 Surficial Data

Fugro-Jacques utilizes a Huntec Deep Tow System (DTS), deployed from the stern of the survey vessel, through an “A” Frame. This system has been proven to be the most effective at providing high resolution sub-bottom profiles from the Grand Banks. The system is towed within the water column, at an altitude of between 20 and 40 m off the seabed. The system will be approximately 150 m behind the survey vessel (dependent on cable deployed, water depth and vessel speed).

The Huntec DTS uses a broad band boomer acoustic source, with frequency bandwidth from 500 Hz to 6 kHz. Power output is typically 500 Joules, but may be increased to 1 kJ if necessary. Rise time of the pulse is less than 0.1 millisecond. The boomer derived pulse is primarily restricted to a 60-degree cone. Maximum peak to peak amplitude is 221 dB relative to 1 µPa at 1 metre. The system utilizes an internal and external hydrophone to record the return signal. Vertical resolution is approximately 10 cm,

with penetration of 40 m in sands, and 100 m in soft sediment. The option exists to use a sparker source, instead of the boomer, if seabed conditions and data quality warrant it. This unit will provide similar output power, albeit at a lower frequency, and in a more omni-directional manner.

Seabed imagery, for the clearance survey, will be acquired with a digital, dual frequency side scan sonar system. Data will be logged to tape and printed in hard copy for on-board assessment. Geo-referenced data will be utilized to create a digital side scan sonar mosaic for inclusion in survey reports. Output power of this system is extremely low, equivalent to an echo sounder in magnitude.

A dual frequency single beam echo sounder or Reson 8101 multi-beam echo sounder will be deployed, if desired. Power output levels of either option are similar to a typical echo sounder commonly used on the Grand Banks. The systems operate at a frequency of 240 kHz.

In the event that potential debris is identified by the side scan or multi-beam systems, a proton magnetometer will be deployed. This system is towed behind the vessel, five to 10 m above the seabed, and emits a low power electromagnetic field.

2.6 Logistical Support

The seismic ship will be accompanied by a picket vessel with responsibilities for communications with other vessels (primarily fishing vessels) that may be operating in the area and for scouting ahead looking for hazards. Heavy re-supply (including water, food, parts and fuel) to the seismic ship will be conducted by offshore supply vessel throughout the duration of the program. A helicopter will be used to ferry personnel and lightweight supplies to the seismic vessel. Helicopter logistic support will be based in St. John's. Husky and contractors maintain offices and shore facilities in St. John's. However, some seismic contractors may prefer to crew change or re-supply in other existing Newfoundland ports, presumably on the Avalon Peninsula because of proximity to the Project Area. No new shore base facilities will be established as part of this Project.

2.7 Waste Management

Waste management aboard the seismic and geohazard vessels will be implemented in a manner consistent with Husky's East Coast Waste Management Plan and the contracted vessels policies and procedures that will be reviewed against the Husky Plan to ensure consistency. Husky's East Coast Waste Management Plan is currently on file with the C-NLOPB.

2.8 Environmental Observers

As in 2005, two biologists (from LGL Limited) experienced in marine mammal and/or seabird surveys will be on board the 3D seismic ship to monitor marine mammals and seabirds and implement appropriate mitigation measures. Seabird and marine mammal data will be collected on an opportunistic basis and safe handling and release of any seabirds (typically petrels) that may become stranded on the vessel will be managed in accordance with guidelines from the Canadian Wildlife Service (CWS). Biologists will be assisted by a Fisheries Liaison Officer (FLO) trained in marine mammal identification and data recording procedures. The biologist qualifications will be consistent with the expectations of the CWS and Fisheries and Oceans (DFO) (per Moulton and Mactavish 2004).

An environmental observer aboard the geohazard survey vessel will monitor marine mammals and seabirds and implement mitigation measures.

2.9 Consultations

Consultations were held during February and March 2006 with relevant government agencies, representatives of the fishing industry and other interest groups. The primary purpose of consultations was to inform stakeholders of Husky's proposed plans, to identify any new issues and concerns, and to gather additional information relevant to the EA report update. Consultations were coordinated by Canning & Pitt Associates, Inc. Consulted groups included:

- Fisheries and Oceans
- Environment Canada
- One Ocean/Fish Food and Allied Workers Union (FFAWU)
- Natural History Society[1]
- Association of Seafood Producers
- Fishery Products International
- Groundfish Enterprise Allocation Council (Ottawa)
- Clearwater Seafoods
- Icewater Seafoods

As part of Husky's on-going consultation procedure, the 2005 Project Description and a location map (area where Husky Energy proposes to undertake 3D seismic operations) were sent to all agencies and stakeholder groups prior to the beginning (April) of the 2005 seismic program in Wildrose. For the proposed 2006 seismic program, the consultants asked each stakeholder to revisit the 2005 documentation as well as new material (location map, project description summary) provided on the proposed 2006 seismic program, and to provide any comments they might have on these proposed 2006 activities. At each meeting, Husky Energy provided more details on the proposed 2006 3D survey operations as well as detailed maps showing the location of 2004 fish harvesting activities in each month of that year.

Information obtained during consultations is summarized below and incorporated into this document. Appendix A provides a list of agency and industry officials consulted for this update.

2.9.1 Issues and Concerns

None of the agencies, interest groups or fisheries industry officials contacted raised any major concerns or issues about the planned 2006 seismic survey activities. Managers representing DFO and Environment Canada had no specific comments or concerns regarding the proposed 2006 survey.

FPI representatives noted that their 2006 fish harvesting activities would not be in the vicinity of proposed 3D survey operations. Company vessels will be fishing yellowtail in 3Lr and 3Nc, both of which are well to the south of the planned survey area. The firm's turbot fishing activities to the north (in the Orphan Basin area) will be completed by April. FPI will be undertaking some industry surveys (northern shrimp, 3PS cod) in 2006, but none of these would be near the 2006 survey activities. (The 3PS cod survey will likely take place in the period November-early December 2006, but FPI managers noted that the Unit 2 redfish survey would not be conducted this year.)

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[1] Meetings with representatives of the Natural History Society were scheduled to take place during the week of 27 February, but were postponed due to poor weather, and a new meeting time is being arranged with the NHS. Further discussion of Husky's 2006 3D survey activities will likely take place when company officials and their consultants meet with NHS representatives to discuss other offshore activities Husky Energy is proposing to undertake in 2006.

The fish harvesting consultant for Icewater Seafoods reviewed the survey information with the captain of the firm's vessel and reported that the firms would not be conducting harvesting operations in the vicinity of the survey area during 2006.

The Executive Director of the Association of Seafood Producers was invited to attend the FPI meeting but was unable to do so because of his busy schedule. However, he indicated that his organization did not have any concerns or issues regarding the proposed 2006 survey operations.

One Ocean and FFAWU representatives did not have any major concerns about the proposed survey. Officials of both agencies indicated that it would be useful if the fisheries maps could indicate the Nova Scotia catch data separately from the Newfoundland data. They also noted that, for future consultations, they would like to receive the fisheries maps as soon as they are prepared for any EA report. There was also some discussion that these fisheries maps might need to be "ground-truthed" with relevant fishers. FFAWU biologists noted that the Union and relevant fishers are involved in an industry survey for crab in various offshore harvesting locations this coming season. This relatively short (24 hour) survey takes place in September.

To date, other fisheries industry managers (GEAC and Clearwater) contacted for consultations have not yet responded.

3.0 PHYSICAL ENVIRONMENT/EFFECTS OF THE ENVIRONMENT ON THE PROJECT

The physical environment of the Jeanne d'Arc Basin and the potential effects of that environment on the Project were discussed in the original EA (see Section 4 *in* LGL et al. 2005).

4.0 SPECIES AT RISK

Since the submission of the original EA (LGL et al. 2005) for Husky's seismic program in Jeanne d'Arc Basin, no new species that may occur in the Project Area have been added to Schedule 1 of the *Species at Risk Act* (*SARA*). Schedule 1 is the official legal list of wildlife species at risk in Canada. Once listed, measures to protect and recover a listed species are designed and implemented for species designated "threatened" or "endangered".

Species that are legally protected under *SARA* (i.e., Schedule 1 "threatened" or "endangered") and which may occur in the Project Area include:

- Blue whale (*Balaenoptera musculus*)—endangered
- North Atlantic right whale (*Eubalaena glacialis*)—endangered
- Leatherback sea turtle (*Dermochelys coriacea*)—endangered
- Northern wolffish (*Anarhichas denticulatus*)—threatened
- Spotted wolffish (*Anarhichas minor*)—threatened

Atlantic wolffish (*Anarhichas lupus*) and Ivory Gull (*Pagophila eburnea*) are listed as "special concern" on Schedule 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 considered at risk that may occur in the Project Area but which have not received legal protection under *SARA* include:

- Harbour porpoise (*Phocoena phocoena*) (Northwest Atlantic population) (Schedule 2– threatened)
- Fin whale (*Balaenoptera physalus*) (Schedule 3 – special concern)
- Sowerby's beaked whale (*Mesoplodon bidens*) (Schedule 3 – special concern)
- Northern bottlenose whale (*Hyperoodon ampullatus*) (Scotian Shelf population: Schedule 3—special concern; Davis Strait population: Not at Risk)
- Atlantic cod (*Gadus morhua*) (Schedule 3—special concern)

Several species relevant to this EA update have undergone recent (re)assessment by COSEWIC and these changes will be reflected in *SARA*. For example, the harbour porpoise was down-listed from threatened to special concern. Conversely, several species could be up-listed if *SARA* follows recent COSEWIC status reports. The Ivory Gull may be up-listed to threatened in the near future (B. Mactavish, pers. comm.). COSEWIC has classified Atlantic cod as endangered (COSEWIC 2005) but in November 2005, the Federal Fisheries Minister announced that Atlantic cod would not be listed as endangered under *SARA*.

Under *SARA*, a "Recovery Strategy" and corresponding "Action Plan" must be prepared by the relevant government agencies (DFO or Environment Canada) for endangered, threatened, and extirpated species. A Management Plan must be prepared by government 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 may occur in the Project Area. It is possible that a Recovery Strategy will be in place for blue whales in the near future (J. Lawson, DFO, pers. comm.). Husky will continue to monitor the development of any *SARA* recovery strategies and action plans.

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

5.0 EXISTING BIOLOGICAL ENVIRONMENT

5.1 Fish and Fisheries

5.1.1 Commercial Fisheries

5.1.1.1 Data Sources

This report updates the 2005 EA and Supplement by employing the latest available domestic commercial fisheries data (for 2005, provided by DFO Maritimes Region and DFO Newfoundland and Labrador Region in February 2005). It also uses these data and similar data for 2003 and 2004 (see LGL et al. 2005) to describe fisheries in the current Study and Project areas, and in relation to specific areas of project activity (Wildrose and Fortune 3D survey areas, potential geohazard surveys). (DFO Maritimes notes that a portion of the Nova Scotia landings of northern shrimp, *Pandalus borealis*, may not appear in the georeferenced data sets.)

Other data sources used to characterize the expected 2006 domestic fisheries in these areas are similar to those used in the 2005 EA – consultations with fishing interests (One Ocean, FFAWU, GEAC, FPI, Clearwater) and with DFO (harvesting plans, quotas, research survey plans).

The methodologies applied for the 2005 EA were followed in this update.

5.1.1.2 Domestic Harvest

As identified in the 2005 EA, two species – northern shrimp and snow crab – have made up nearly the entire domestic harvest in the vicinity of the Study Area (Table 5.1) and the Project Area (Table 5.2) in the last several years.

Table 5.1. Summary of fisheries harvest in the Study Area for the June – November period, 2003-2005.

Species	**Tonnes**	**% of Total**
2003		
Atlantic Halibut	1.9	0.0
American Plaice	1.4	0.0
Northern Shrimp	4,310.3	62.2
Snow Crab	2,615.7	37.7
Total	*6,929.2*	*100.0*
2004		
Northern Shrimp	5,746.0	63.7
Snow Crab	3,274.1	36.3
Total	*9,020.1*	*100.0*
2005		
Northern Shrimp	6,526.6	59.1
Snow Crab	4,507.9	40.9
Total	*11,034.4*	*100.0*

Table 5.2. Summary of fisheries harvest in the Project Area for the June – November period, 2003-2005.

Species	**Tonnes**	**% of Total**
2003		
Northern Shrimp	1,880.2	44.0
Snow Crab	2,392.3	56.0
Total	*4,272.5*	*100.0*
2004		
Northern Shrimp	2,513.2	46.8
Snow Crab	2,860.6	53.2
Total	*5,373.9*	*100.0*
2005		
Northern Shrimp	3,739.2	47.9
Snow Crab	4,060.1	52.1
Total	*7,799.3*	*100.0*

The Wildrose and Fortune 3D survey areas, planned for 2006, have recorded almost exclusively snow crab harvesting in the last few years, as shown in the following tables. Based on these data, the quantity of harvest within the Wildrose area (Table 5.3) has been increasing during the past three fishing seasons. Within the Fortune area (Table 5.4), no snow crab harvest was recorded in 2003, but in the following two years a small catch (<13 tonnes) was reported there.

Table 5.3. Summary of snow crab harvest in the Wildrose 3D Survey Area for the June – November period, 2003-2005.

Year	Tonnes of snow crab	% of Total
2003	65.0	100.0
2004	88.8	100.0
2005	208.1	100.0

Table 5.4. Summary of fisheries harvest in the Fortune 3D Survey Area for the June – November period, 2003-2005.

Species	Tonnes	% of Total
2003		
American Plaice	0.2	100.0
2004		
Snow Crab	12.7	100.0
2005		
Snow Crab	11.3	100.0

5.1.1.3 Harvesting Locations

The following maps (Figures 5.1-5.3) show recorded harvesting locations in relation to the relevant areas for June through November, for the years 2003, 2004 and 2005. May and June catches for all species (mostly crab near the Husky areas) are shown in the fisheries distribution maps in Appendix B. As these maps (and those in the 2005 EA) indicate, most harvesting occurs in the Study Area's northeast quadrant, at depths between 100 m and 500 m, and southeast quadrant outside of the Canadian EEZ. A somewhat lesser concentration occurs to the northwest within the Study Area.

These maps also indicate that this pattern of catch locations is quite consistent from year to year.

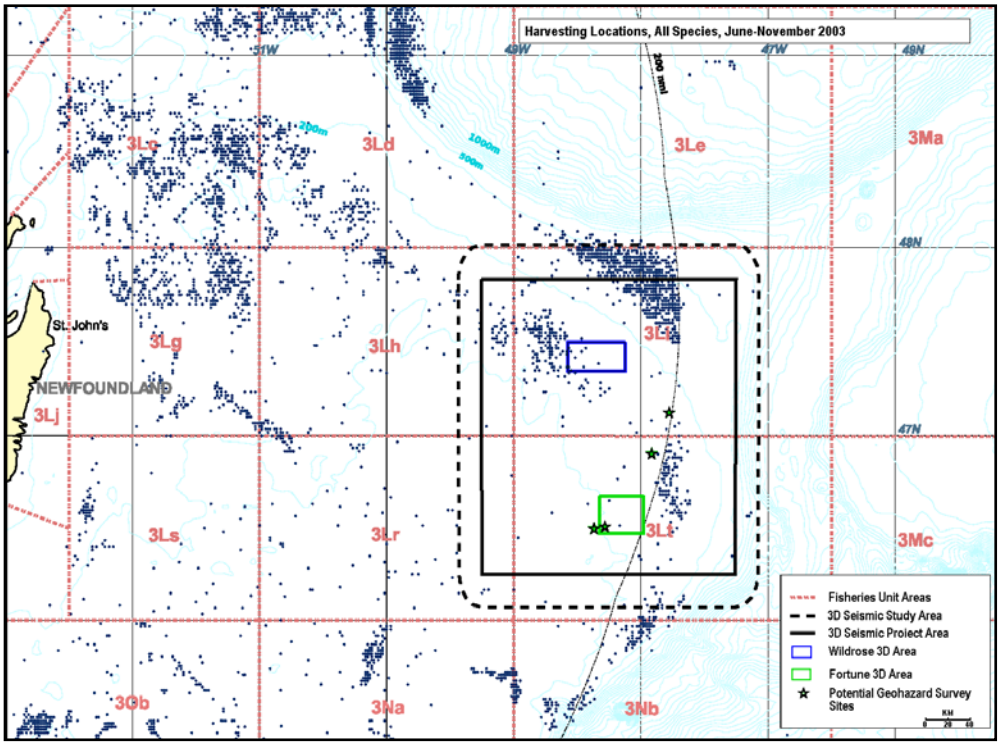

Figure 5.1. Harvesting locations of all commercial species in and near the Project Area for June-November 2003.

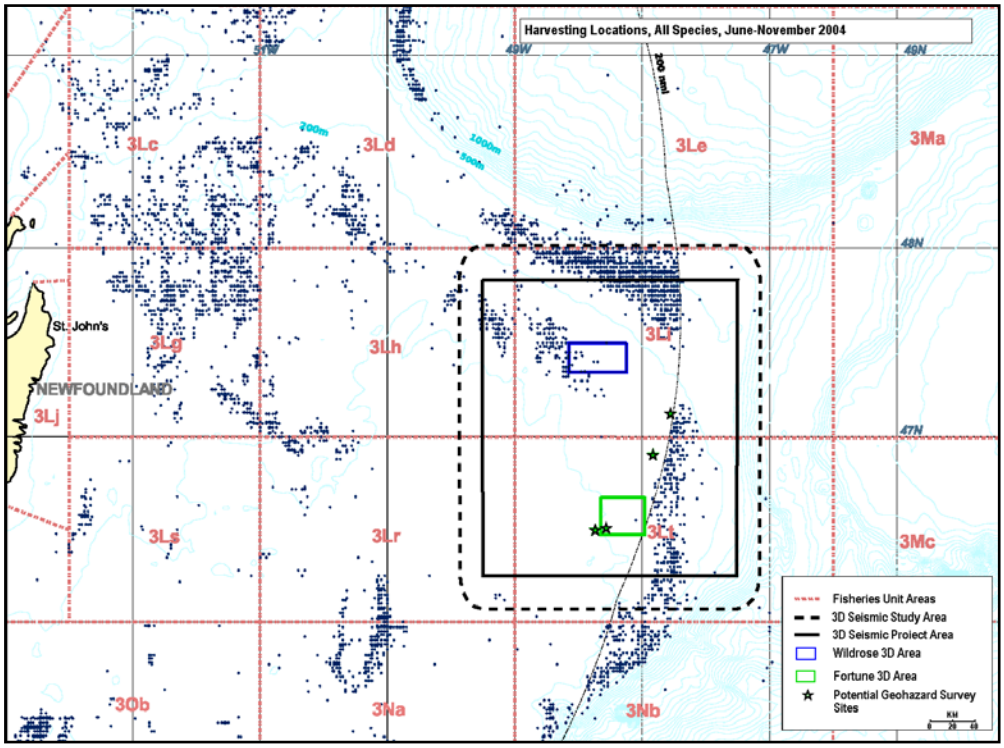

Figure 5.2. Harvesting locations of all commercial species in and near the Project Area for June-November 2004.

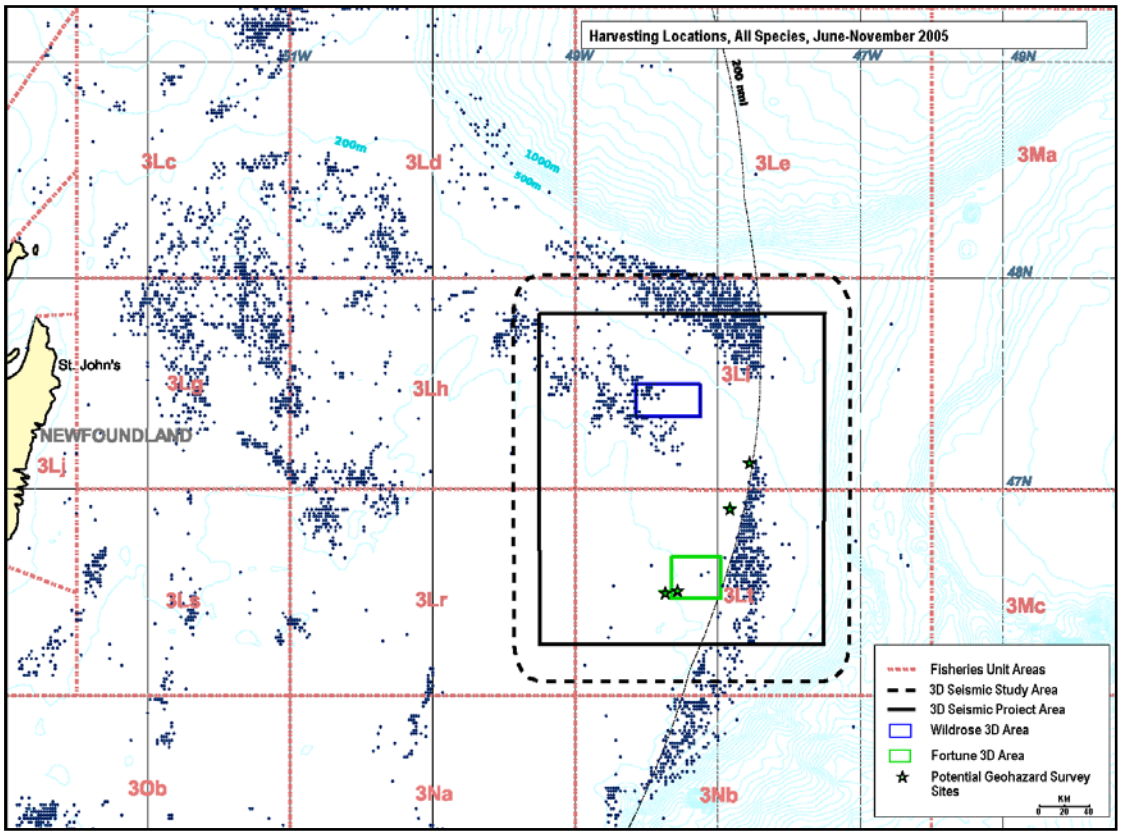

Figure 5.3. Harvesting locations of all commercial species in and near the Project Area for June-November 2005.

5.1.1.4 Seasonal Distribution

In both the Study and Project areas, most harvesting (i.e., the greatest concentration of harvest by quantity of catch) occurs between May and July, as Figures 5.4 and 5.5 illustrate. The following maps (Figs. 5.6-5.11) show the location of the domestic harvest (all species) as reported for 2005, by month for June to November, in relation to the Study and Project Areas. Within Wildrose, the snow crab harvest occurred during June – August in 2003 and June – July in 2004 and 2005. In Fortune, it was taken in June 2004 and July 2005.

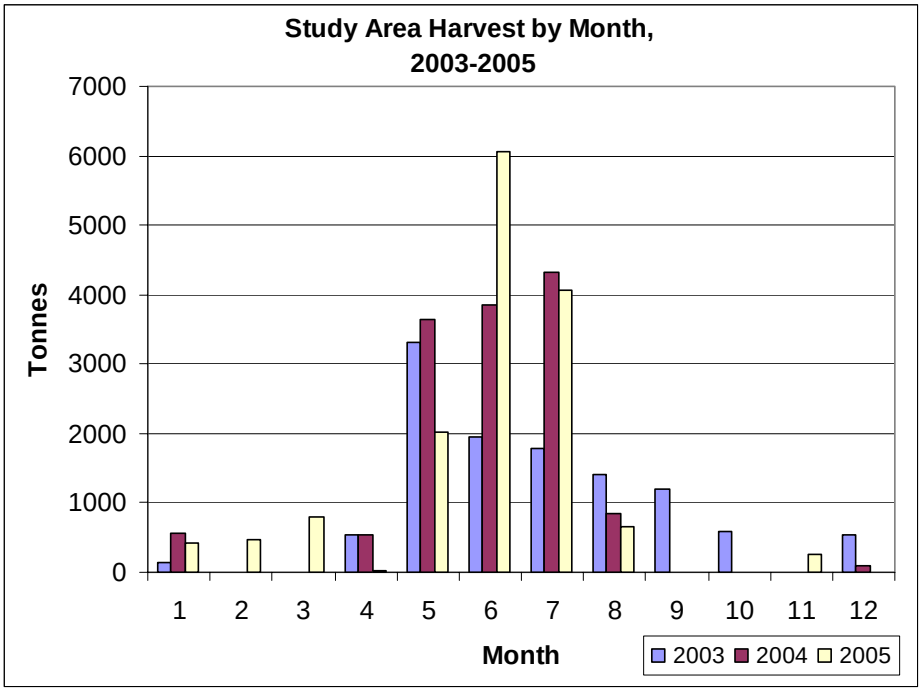

Figure 5.4. Harvest (tonnes) of all commercial species in the Study Area each month in 2003, 2004, and 2005.

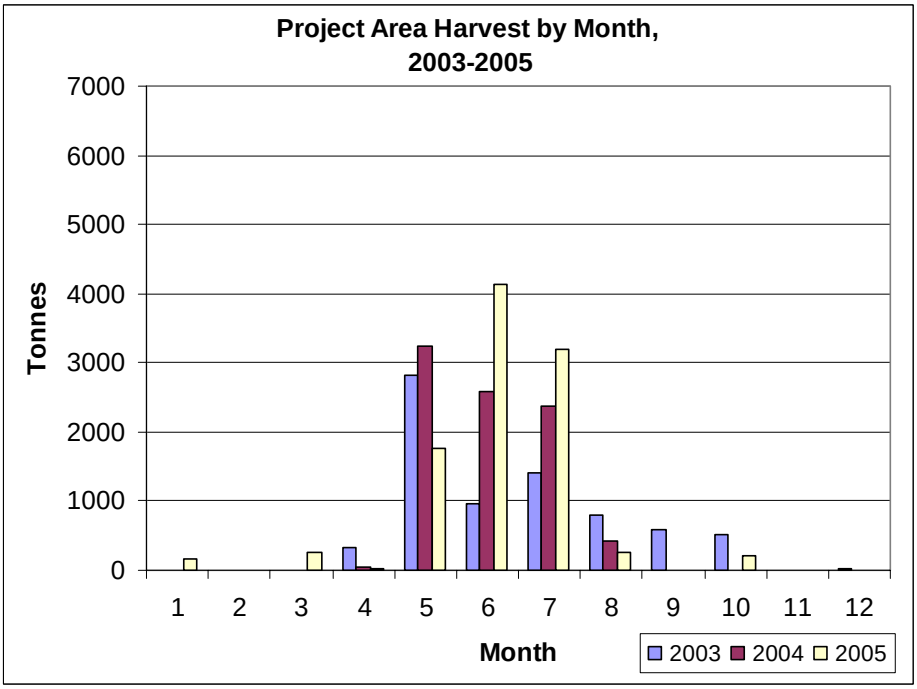

Figure 5.5. Harvest (tonnes) of all commercial species in the Project Area each month in 2003, 2004, and 2005.

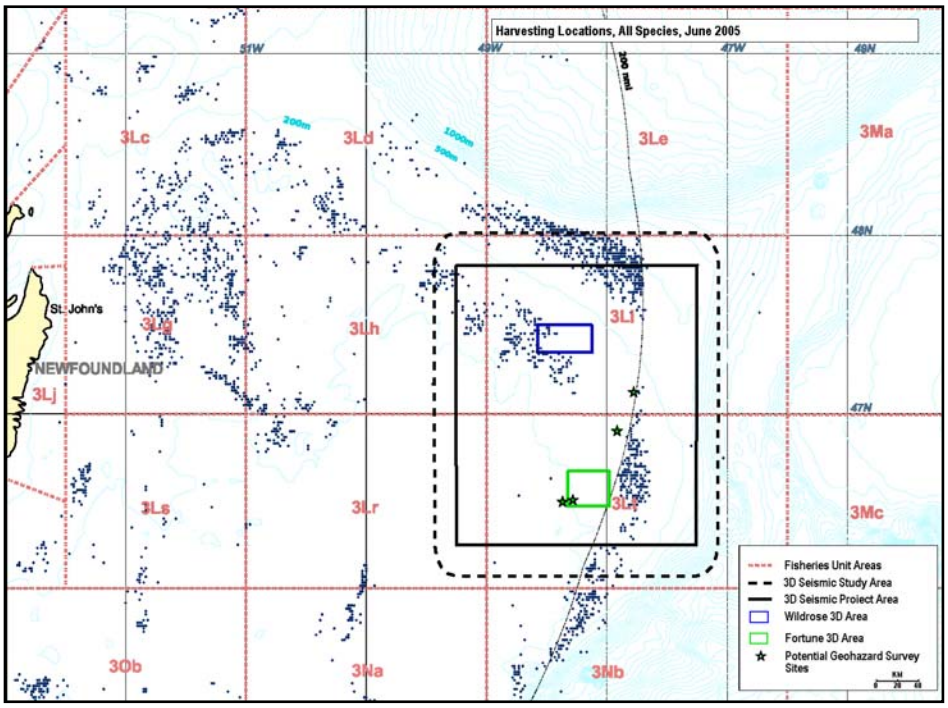

Figure 5.6. Harvesting locations of all commercial species in and near the Project Area for June 2005.

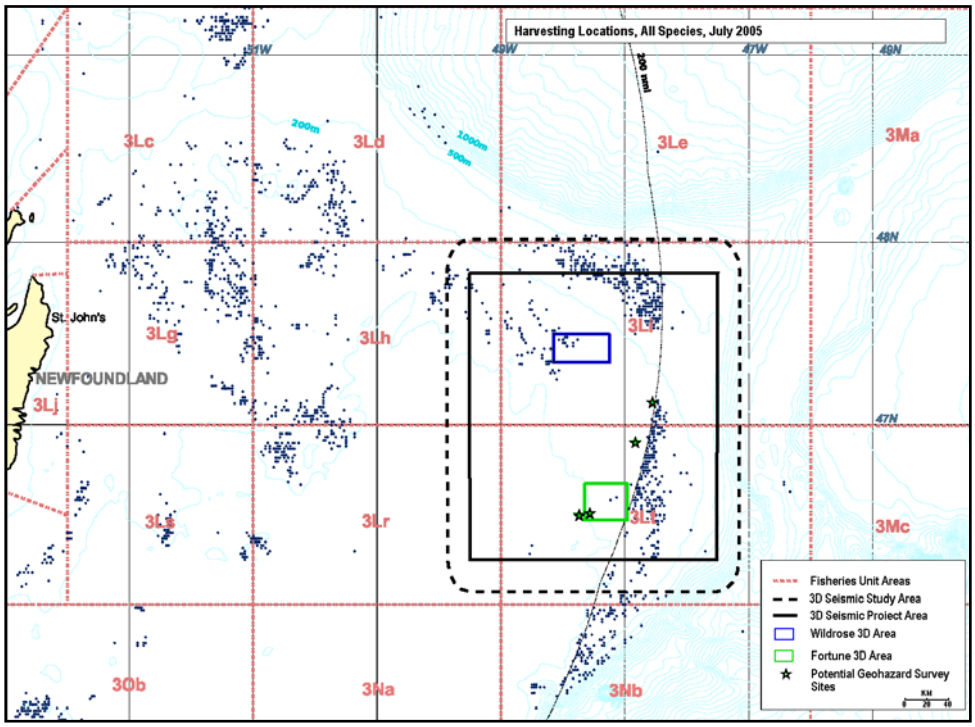

Figure 5.7. Harvesting locations of all commercial species in and near the Project Area for July 2005.

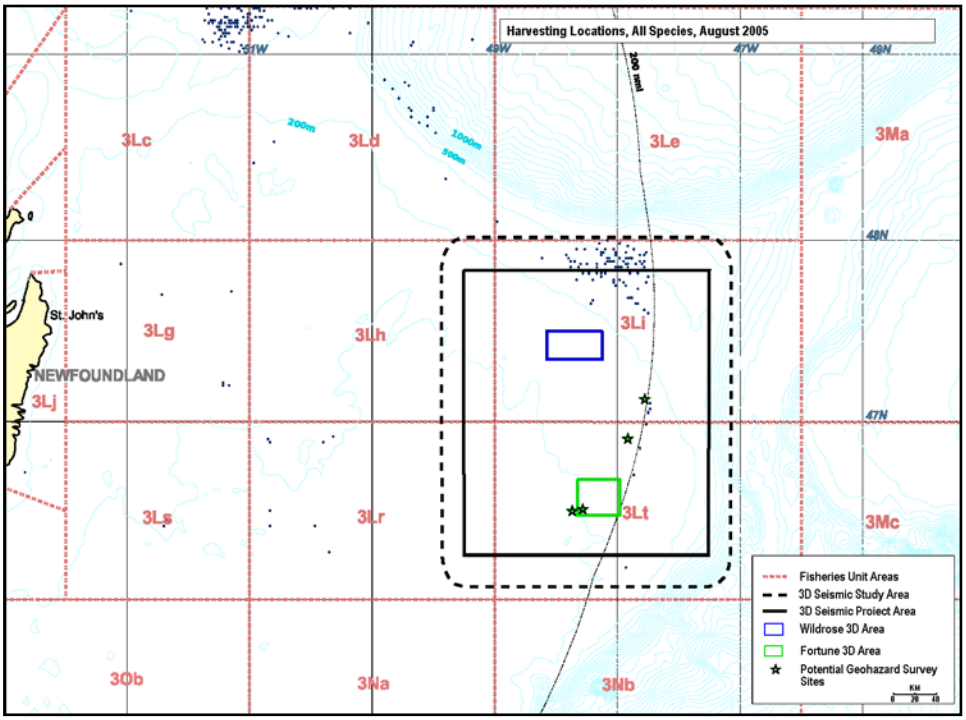

Figure 5.8. Harvesting locations of all commercial species in and near the Project Area for August 2005.

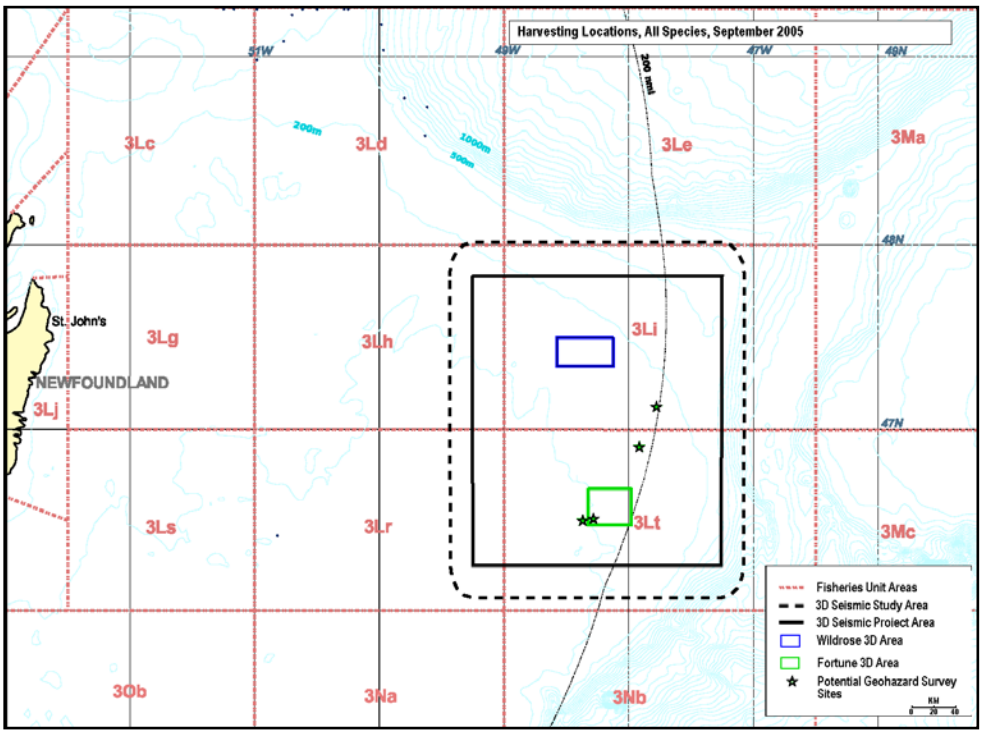

Figure 5.9. Harvesting locations of all commercial species in and near the Project Area for September 2005.

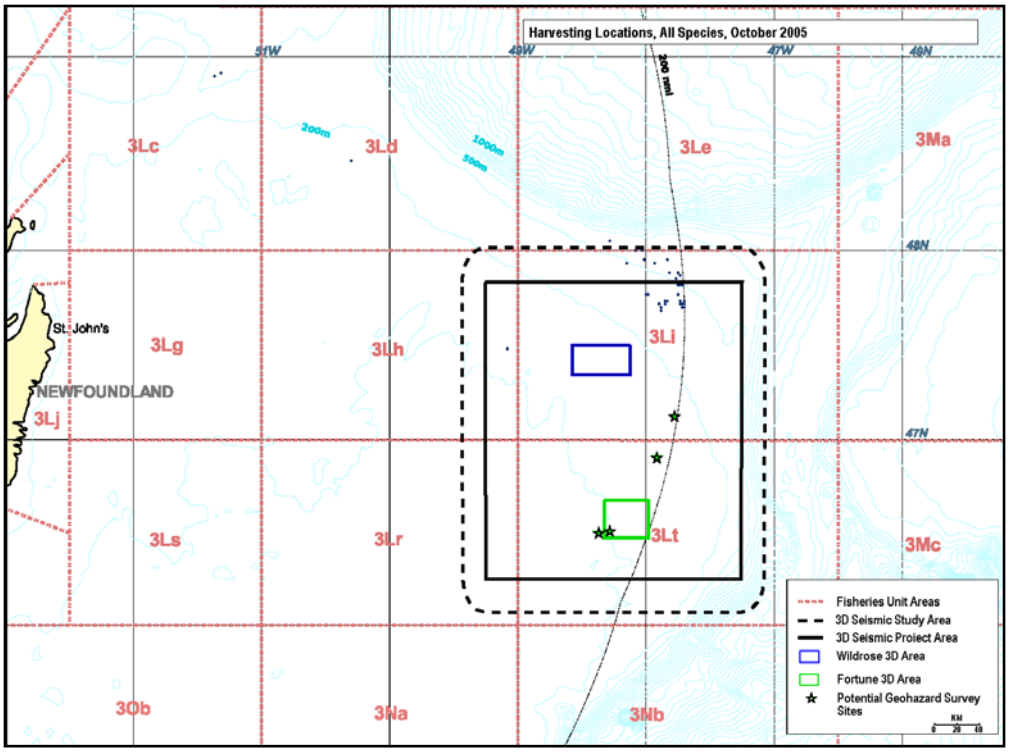

Figure 5.10. Harvesting locations of all commercial species in and near the Project Area for October 2005.

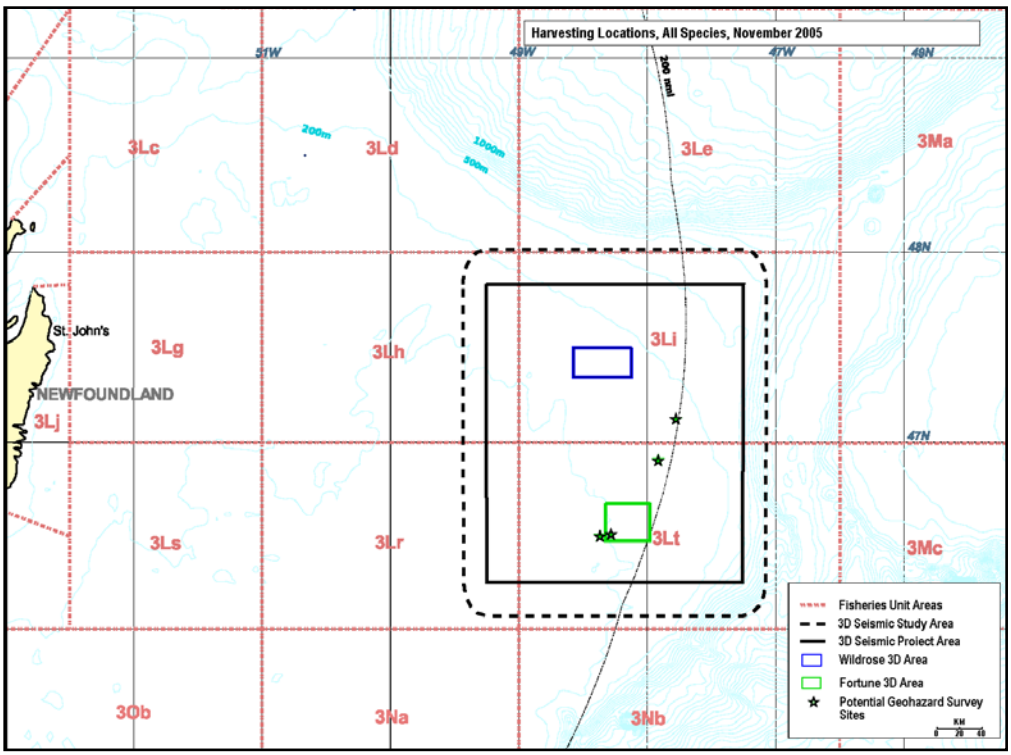

Figure 5.11. Harvesting locations of all commercial species in and near the Project Area for November 2005.

5.1.1.5 Principal Species Fisheries

No significant changes are expected in either the Study Area or Project Area fisheries in 2006 and can generally be expected to be similar in subsequent years. No new or emerging fisheries have been noted for the areas of interest.

Northern Shrimp.— Northern shrimp is harvested using mobile shrimp trawls (as described in the 2005 EA). As Figure 5.12 indicates, effort focused in the Project Area can occur through the summer months and into early fall.

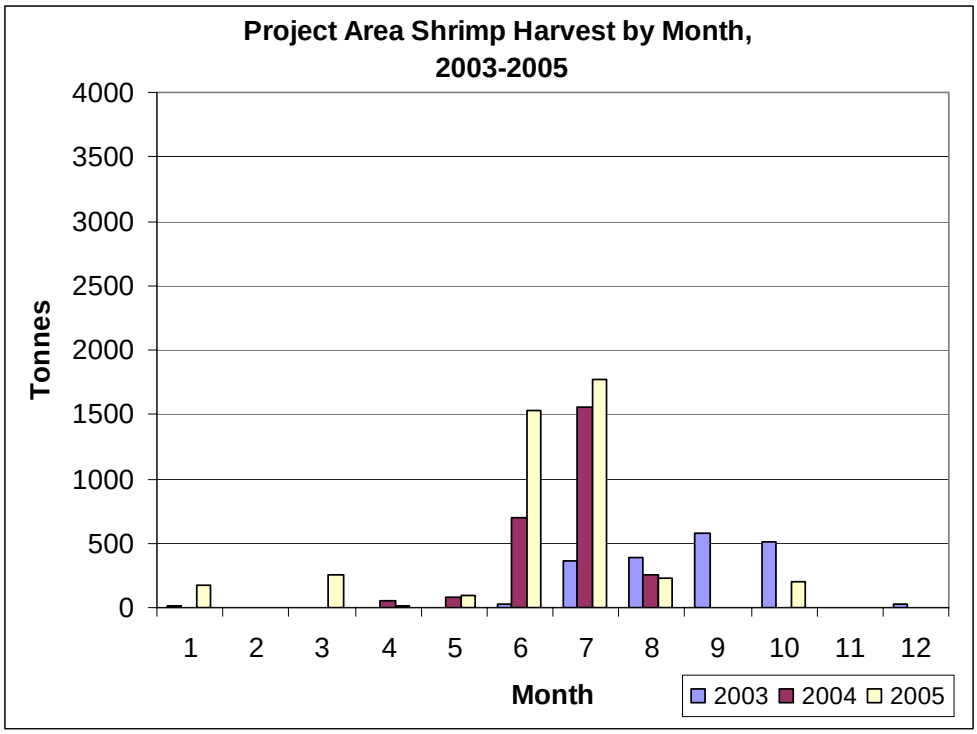

Figure 5.12. Harvest (tonnes) of northern shrimp in the Project Area each month in 2003, 2004, and 2005.

Within the Study and Project areas, the northern shrimp harvest occurs in the northeast quadrant on the shelf slope. The following maps (Figs. 5.13-5.15) show the recorded locations of northern shrimp harvested during June – November 2003 – 2005.

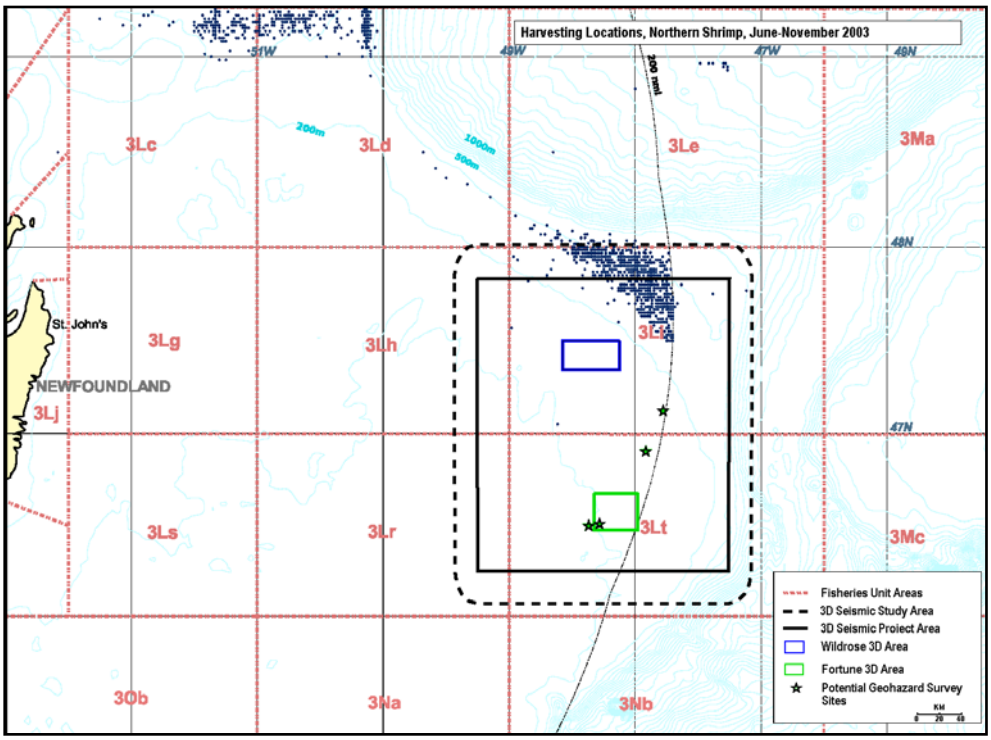

Figure 5.13. Harvesting locations of northern shrimp in and near the Project Area for June-November 2003.

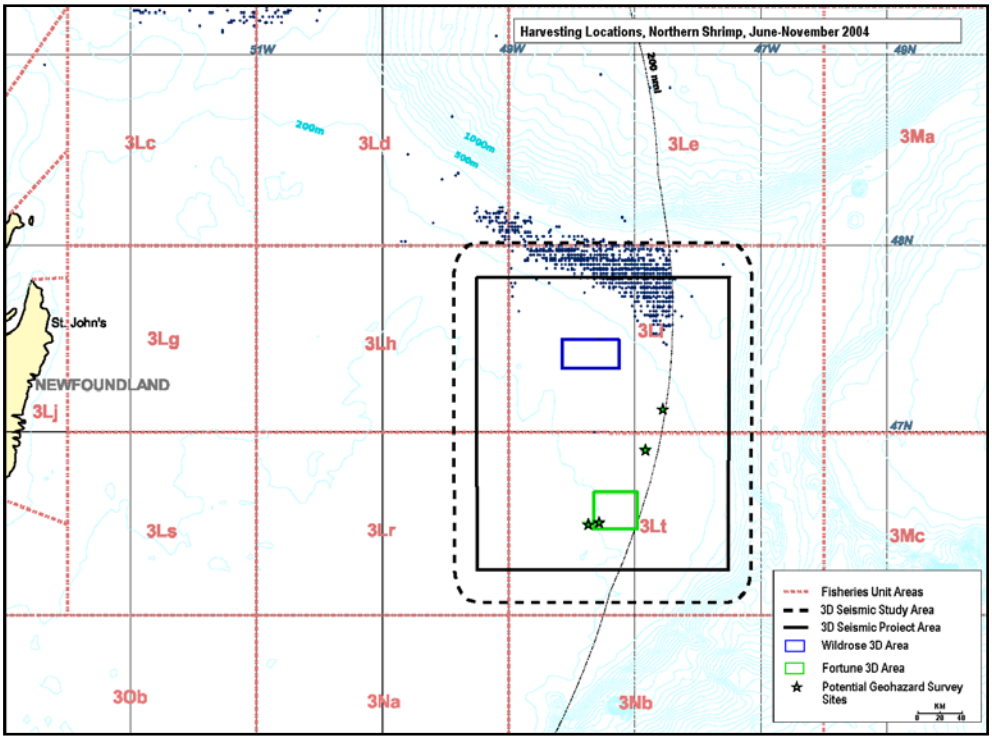

Figure 5.14. Harvesting locations of northern shrimp in and near the Project Area for June-November 2004.

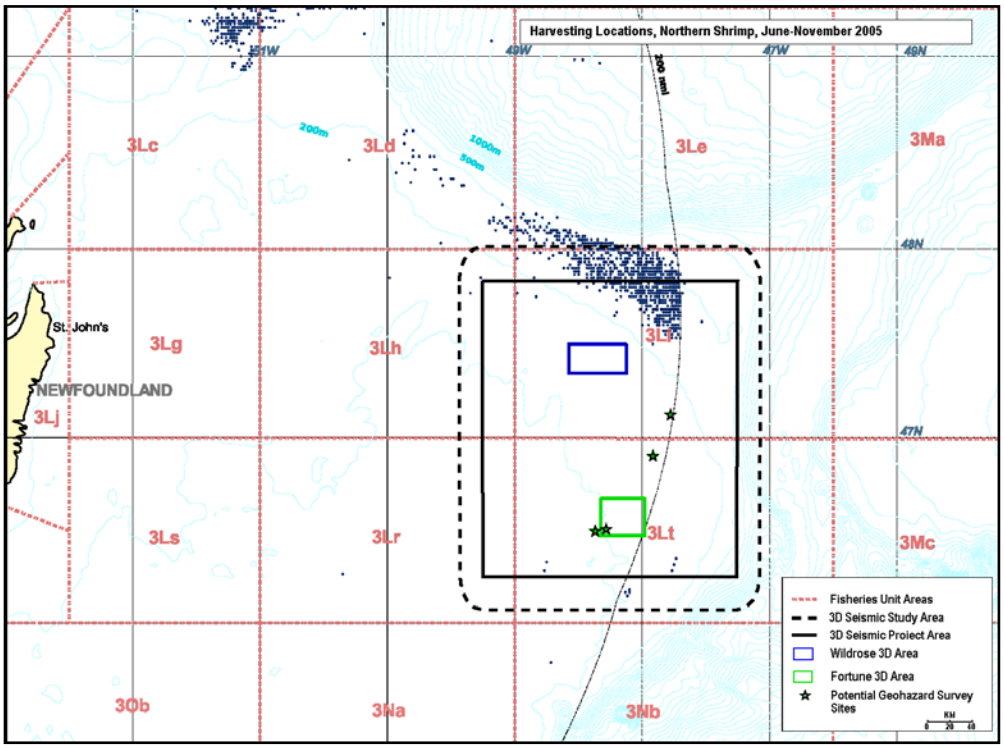

Figure 5.15. Harvesting locations of northern shrimp in and near the Project Area for June-November 2005.

Snow Crab. — Snow crab is the most significant fishery within the relevant areas. Since it is harvested with fixed-gear crab pots, it is the fishery most likely to pose a conflict with survey activities. DFO (T. Blanchard, pers. comm., March 2006) notes that it is aiming for a 1 April 2006 (or very early in April) opening to the crab fishery. The 2006 quotas will be decided at that point.

Figure 5.16 shows the timing of the snow crab harvest within the Project Area in 2003, 2004 and 2005. It is primarily focused during May – July, but can extend into October. In 2005, it ended officially on 31 July.

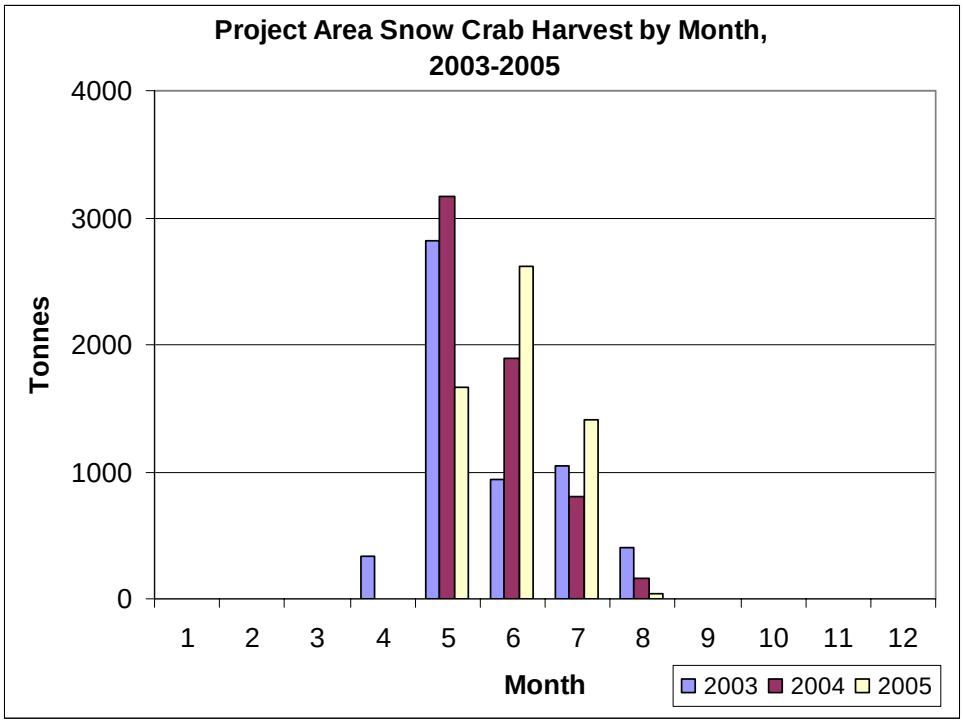

Figure 5.16. Harvest (tonnes) of snow crab in the Project Area each month in 2003, 2004, and 2005.

The following maps (Figs. 5.17-5.19) show the recorded locations of the snow crab harvest for June – November 2003 – 2005 in relation to the Project's components.

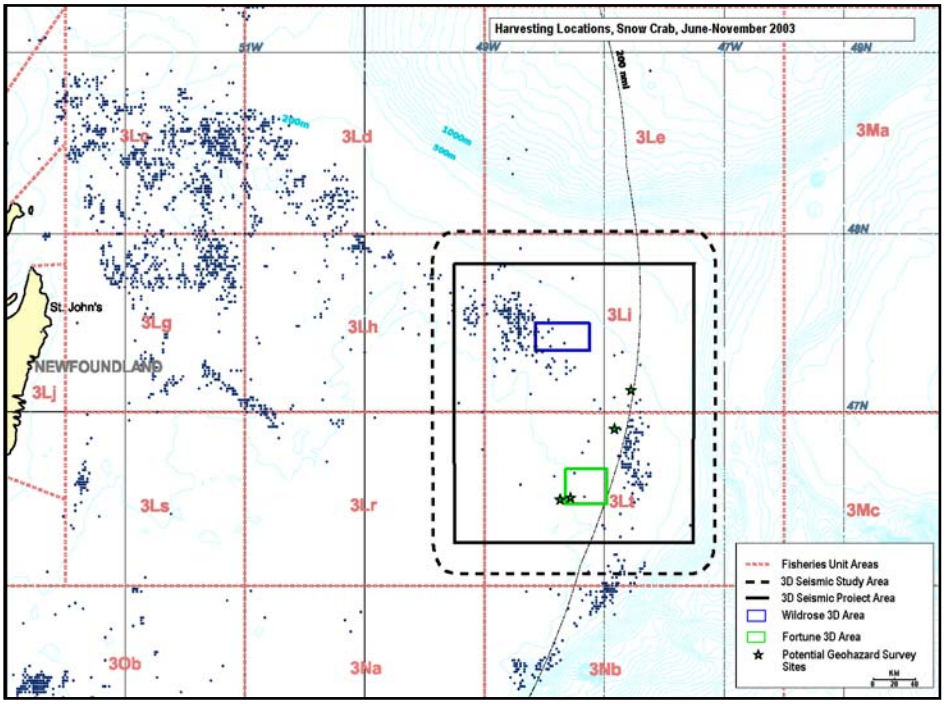

Figure 5.17. Harvesting locations of snow crab in and near the Project Area for June-November 2003.

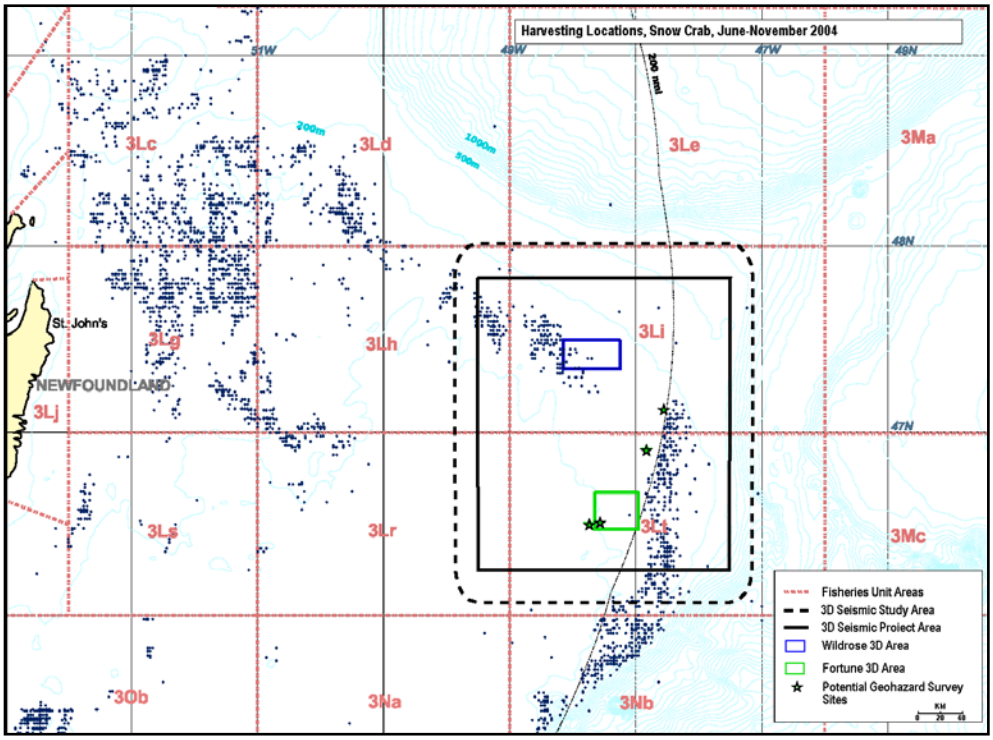

Figure 5.18. Harvesting locations of snow crab in and near the Project Area for June-November 2004.

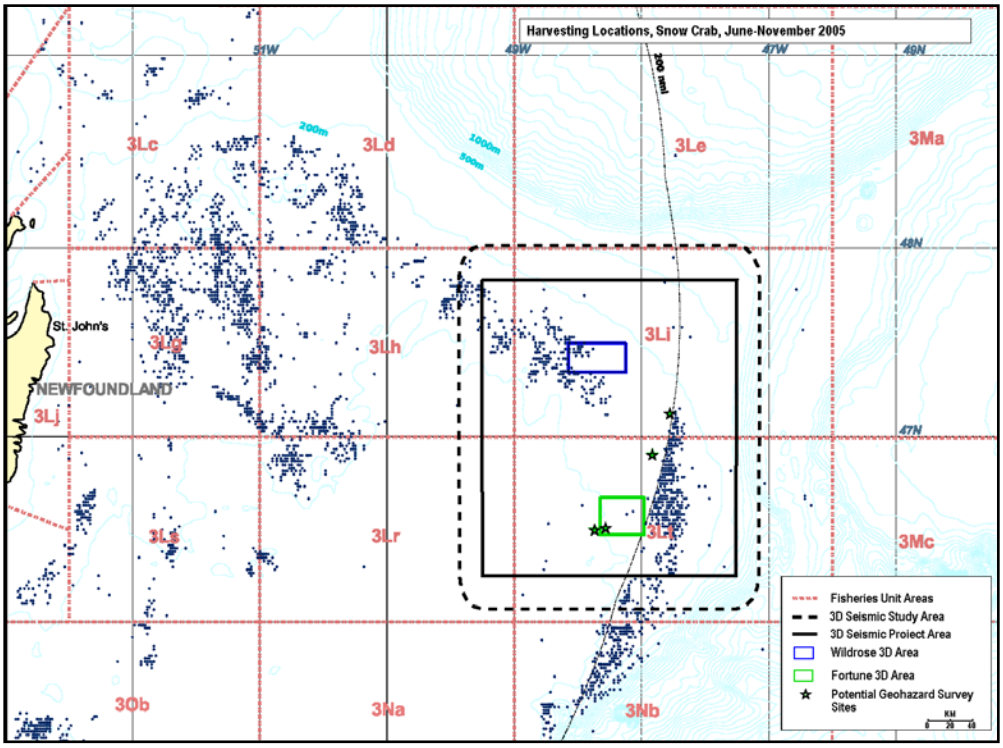

Figure 5.19. Harvesting locations of snow crab in and near the Project Area for June-November 2005.

Other Fisheries.— Although once a groundfish harvesting area, the Study Area has recorded little to no other species harvesting in recent years. Consulted FPI representatives noted that their 2006 groundfish harvesting activities would not be in the vicinity of proposed survey operations. Company vessels will be fishing yellowtail in NAFO Unit Areas 3Lr and 3Nc, located to the west and south of the planned survey area. The firm's turbot fishing activities are to the north of the Study Area (in the Orphan Basin area) and will be completed by April.

The fish harvesting consultant for Icewater Seafoods reviewed the survey information with the captain of the firm's vessel and reported that the firm would not be conducting harvesting operations in the vicinity of the survey area during 2006.

5.1.2 Science Surveys

As in past years, fisheries science surveys will occur in NAFO Division 3L in 2006. At this point in the planning cycle (March 2006), the schedule is still being finalized. DFO notes that there are no major changes planned for the multi-species surveys in 2006 compared to 2005, though there may be one or two new surveys of short duration during the summer (B. Brodie, pers. comm. February 2006).

The 2005 schedule provided by B. Brodie February 2006 (revised to reflect some in-season adjustments) is reproduced below in Table 5.5. Coverage of specific areas/times is usually decided 2-4 weeks ahead of the surveys and other adjustments are often necessary for operational considerations during the surveys.

During recent consultations (February 2006), FFAWU biologists noted that the FFAWU and relevant fishers are involved in an industry survey for crab in various offshore harvesting locations. This relatively short (24 hour) survey takes place in September.

Communications with DFO and the fishing industry regarding their planned surveys must be maintained.

FPI will be undertaking some industry surveys (northern shrimp, cod) in 2006, but none of these will occur near the 2006 survey activities.

5.1.3 Species Profiles

Information provided in subsection 5.4.2.2 of the Husky 3-D EA (LGL et al. 2005) and in the EA Addendum (LGL and Canning & Pitt 2005a) responses to regulator comments remain relevant. The following text describes information that has recently become available.

5.1.3.1 Northern Shrimp

The 2004 biomass estimate of northern shrimp in areas of 3L with water depths ranging between 93 and 274 m was more than 35% higher than the estimate for the same areas in 2003. The fall 2004 biomass index within consistently sampled Division 3L strata was the second highest in the 1995-2004 time series. The spring 2004 biomass index for these same areas was also relatively high, however the spring index is considered to be less precise than the fall index (Orr et al. 2005).

Table 5.5. **DFO science survey schedule for the eastern Grand Banks in 2005.**

Ship/Scientist	Survey and Area	Start Date	End Date	Duration (days)
Teleost				
Brodie	Multi-species 2J 3KLMNO	01-Oct-05	14-Oct-05	14
	Multi-species 2J 3KLMNO	15-Oct-05	28-Oct-05	14
	Multi-species 2J 3KLMNO	29-Oct-05	10-Nov-05	13
	Multi-species 2J 3KLMNO	12-Nov-05	25-Nov-05	14
	Multi-species 2J 3KLMNO	26-Nov-05	09-Dec-05	14
	Multi-species 2J 3KLMNO	10-Dec-05	20-Dec-05	11
Templeman				
Brodie	Multi-species 3LNO	14-May-05	27-May-05	14
		28-May-05	10-Jun-05	14
		11-Jun-05	30-Jun-05	20
Brodie	Multi-species - Grand Banks	01-Oct-05	14-Oct-05	14
	Multi-species - Grand Banks	15-Oct-05	28-Oct-05	14
	Multi-species - Grand Banks	29-Oct-05	10-Nov-05	13
	Multi-species - Grand Banks	12-Nov-05	25-Nov-05	14
		26-Nov-05	09-Dec-05	14
		10-Dec-05	20-Dec-05	11
Needler				
Brodie	Multi-species	10-Oct-05	10-Nov-05	32
Brodie	Multi-species	11-Nov-05	19-Nov-05	9
Shamook				
Taylor	Crab Trapping/Trawling 3-3L	10-May-05	23-May-05	14

5.1.3.2 Snow Crab

Information provided in subsection 5.4.2.1 of the Husky 3-D EA (LGL et al. 2005) and in the EA Addendum (LGL and Canning & Pitt 2005a) responses to regulator comments remains relevant.

Based on the 2004 DFO fall multi-species survey, there was more than a 60% decrease in the exploitable biomass index for snow crab in NAFO Division 3L (DFO 2005a). The offshore CPUE in Division 3L dropped by 24% between 2002 and 2004 (DFO 2005a). However, the CPUE has remained high after the sharp increase between 1991 and 1992. Recruitment in 3L is expected to remain relatively low in the short term (DFO 2005a).

5.1.3.3 Greenland Halibut

Information provided in subsection 5.4.2.3 of the Husky 3-D EA (LGL et al. 2005) and in the EA Addendum (LGL and Canning & Pitt 2005a) responses to regulator comments remains relevant.

Brodie and Power (2005) reported on the 2004 Canadian fishery for Greenland halibut in SA2 + 3KLMNO. The otter trawl fishery in 2004 was located primarily in two areas. One of these areas is on the slope edge at the border between Divisions 3K and 3L, northwest of the proposed Project Area for 2006-2008. Canadian catches in 3L in 2004 totaled less than 800 t, down from total catch weights in each of 2003 and 2002. Most 2004 catches were made during the May to September period.

5.1.4 Species at Risk

Presently, four fish species are listed under *SARA*, three on Schedule 1 and one on Schedule 3. The northern wolffish and spotted wolffish are listed as 'threatened' on Schedule 1 and the Atlantic wolffish is listed as 'special concern' on Schedule 1. The Newfoundland and Labrador population of Atlantic cod is listed as 'special concern' on Schedule 3 of the *SARA*.

5.1.4.1 Wolffish

Information provided in subsection 5.4.3.1 of the Husky 3-D EA (LGL et al. 2005) and in the EA Addendum (LGL and Canning & Pitt 2005a) responses to regulator comments remains relevant. Additional references for wolffishes were provided in the EA Addendum (LGL and Canning & Pitt 2005a).

5.1.4.2 Atlantic Cod

Information provided in subsection 5.4.3.2 of the Husky 3-D EA (LGL et al. 2005) and in the EA Addendum (LGL and Canning & Pitt 2005a) responses to regulator comments remains relevant. The most recent stock assessment of northern cod (DFO 2005b) reflects what has already been provided in the Husky 3-D EA (LGL et al. 2005).

5.2 Seabirds

Information provided in section 5.6 of the Husky 3-D EA (LGL et al. 2005) and in the EA Addendum (LGL and Canning & Pitt 2005a) responses to regulator comments remains relevant. Several reports, including results of the seabird monitoring conducted during Husky's seismic program in 2005, have become available since submission of LGL et al. (2005) and LGL and Canning & Pitt (2005a, b); these reports are discussed below.

5.2.1 Seasonal Occurrence and Abundance of Seabirds in the Study Area

Updated information on the seasonal occurrence and abundance of seabirds that occur regularly in the Study Area are described. Table 5.6 summarizes the predicted abundance status for each species by month. The table uses categories to define a relative abundance of seabirds species observed. Four categories of abundance were used:

- 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.

Table 5.6. Seabird species occurring in the Study Area and predicted monthly abundances. Grey highlight indicates the time period when seismic operations may occur. Blank cells indicate that species are unlikely to be present.

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

Source: Brown (1986); Lock et al. (1994), Baillie et al. (2005), Lang et al. (2006) C = Common, U = Uncommon, S = Scarce, VS = Very Scarce

Since the preparation of the seismic EA (LGL et al. 2005) and its addendum (LGL and Canning & Pitt 2005a), the primary source of new information available is the seabird monitoring results of the Husky 3D seismic program conducted in October and November 2005 (Lang et al. 2006). Two biologists (experienced in conducting seabird surveys) were aboard the seismic ship, the M/V *Western Neptune*, throughout the seismic program which occurred from 1 October to 8 November 2005. The seismic program was conducted within the Project Area, primarily in EL 1067 (Wildrose). Seabird monitoring consisted of 12 ten-minute surveys conducted daily. These 10-minute counts were conducted consecutively in blocks of four counts at three widely spaced times of the day: morning, mid day and evening. The survey method was modeled after the 'Tasker Method' as described in Lang et al. (2006). A total of 320 ten-minutes surveys were conducted during the 2005 seismic program. The results are incorporated in the text below.

In addition, the numbers of breeding pairs of seabirds in Newfoundland have been updated where appropriate (see Table 5.7).

5.2.1.1 Procellariidae (fulmars and shearwaters)

5.2.1.1.1 Northern Fulmar

Northern Fulmar was found to be common in the Study Area during surveys conducted from 1 Oct-8 Nov 2005 (Lang et al. 2006). Densities per 15'N x 30'W block were mostly in the range of 5.0-9.9 and 10.0-99.9 per km². It was the most abundant species observed during the study period. This species is predicted to be common all year in the Study Area.

5.2.1.1.2 Cory's Shearwater

No Cory's Shearwaters were observed during the Husky seismic monitoring program in October and November 2005 (Lang et al. 2006). This species is predicted to be very scarce in the Study Area from July to September.

5.2.1.1.3 Greater Shearwater

Based on seabird monitoring during the Husky seismic monitoring program in October and November 2005, Greater Shearwater was common in the first ten days of October; densities in the 15'N x 30'W blocks ranged from 2.0-4.9 to 10.0-99.9 birds per km² (Lang et al. 2006). Numbers decreased through the latter half of October. None were recorded during systematic in the last three weeks of the survey period. The last incidental sightings occurred on 4 November (20 birds). This species is predicted to be common in the Study Area from May to early November.

5.2.1.1.4 Sooty Shearwater

Sooty Shearwater was uncommon in the first half of October and scarce from mid October to early November in the Study Area (Lang et al. 2006). Mean weekly number of individuals per ten-minute count ranged from 0.5-2.7 during October. The species was recorded only during incidental observations up to the last day of the survey on 8 November. This species is predicted to be uncommon in the Study Area from May to early November.

Table 5.7. Numbers of pairs of seabirds nesting at Important Bird Areas (IBA) 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]	-	Present[a]	4,638[a,e]	Present[a]	20[a]	5,000[a]	-
Great Black-backed Gull	Present[d]	100[a]	-	Present[1]	166[a,e]	Present[a]	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)

5.2.1.1.5 Manx Shearwater

There was only one sighting of a Manx Shearwater (22 October) during Husky's seismic monitoring program in 2005 (Lang et al. 2006). This species is predicted to be scarce in the Study Area from May to October.

5.2.1.2 Hydropbatidae (storm-petrels)

5.2.1.2.1 Leach's Storm-Petrel

Available data from Husky's seismic monitoring program in 2005 showed that the Leach's Storm-Petrel was uncommon in the Study Area in October and November (Lang et al. 2006). Densities of 01.-0.9 birds per km² were recorded during the month of October. Densities decreased during the first week of November and the last sighting occurred on 8 November. This species is predicted to be uncommon to common in the Study Area from April to early November.

5.2.1.2.2 Wilson's Storm-Petrel

No Wilson's Storm-Petrels were observed during the Husky seismic monitoring program in October and November 2005 (Lang et al. 2006). This species is predicted to be scarce in the Study Area from June to September.

5.2.1.3 Sulidae (gannets)

5.2.1.3.1 Northern Gannet

Few Northern Gannets were recorded during the Husky seismic monitoring program in (Lang et al. 2005). Individuals were recorded on just four of the 320 ten-minute surveys. On 12 October, while the seismic ship was avoiding rough seas, 50 Northern Gannets were observed just west of the Study Area. Incidental sightings of up to 15 Northern Gannets per day through October within the Wild Rose seismic area indicate small numbers are regular in the Study Area during fall migration. None were observed diving for food. This species is predicted to be scarce in the Study Area from April to October.

5.2.1.4 Phalaropodinae (phalaropes)

Available data from Husky's seismic monitoring program in 2005 indicate that phalaropes are scarce in the Study Area in October and November. No phalaropes were recorded during the systematic surveys and only nine (all Red Phalaropes), were observed incidentally. This species is predicted to be scarce in the Study Area from May to October.

5.2.1.5 Laridae (skuas, jaegers, gulls and terns)

5.2.1.5.1 Great Skua and South Polar Skua

Seabird monitoring during Husky's seismic program in the Jeanne d'Arc Basin in 2005 resulted in a total of 118 sightings of skua (Lang et al. 2006). Of these sightings, only 25 (16 Great and 9 South Polar Skuas) were identified to species level. Only 22 skuas were observed after mid-October with the

latest sighting occurring on 31 October. This species is predicted to be scarce in the Study Area from May to October.

5.2.1.5.2 Pomarine, Parasitic, and Long-tailed Jaeger

Seabird monitoring during Husky's seismic program in 2005 resulted in a total of 154 jaeger sightings (94 Pomarine, 9 Parasitic, and 51 unidentified jaegers). Just 33 jaegers were observed after mid-October with the latest sighting (Pomarine Jaeger) occurring on 7 November. Long-tailed Jaegers migrate earlier and were not expected in October. This species is predicted to be scarce in the Study Area from May to October.

5.2.1.5.3 Herring, Great Black-backed, Iceland, and Glaucous Gull

Five species of large gull were recorded during seabird monitoring of Husky's seismic program in 2005 (Lang et al. 2006). Herring, Great Black-backed and Glaucous Gulls were scarce to uncommon and Lesser Black-backed and Iceland Gulls were very scarce. Great Black-backed Gull was the most numerous of the large gulls with an average density of 3.2 birds per km² for the entire survey period. This species was observed daily with the highest daily total of 125 gulls (derived mostly from incidental sightings) occurring on 9 October. Herring Gull was next most numerous species recorded but in numbers much lower than the Great Black-backed Gull. Herring Gulls were observed on 21 of the 39 days of the survey period with daily totals ranging from 2-5 individuals. A maximum daily count of 25 Herring Gulls within the Study Area was recorded on 4 November. The first Glaucous Gull observed during seabird monitoring occurred on 12 October and their numbers increased gradually through the survey period with daily totals reaching a maximum of 20 in late October and early November. Only one Iceland Gull (1 November) was recorded in the Study Area whereas west of the Study Area, 25 were observed on 5 November. A total of ten Lesser Black-backed Gulls were observed during Husky's seabird monitoring program (Lang et al. 2006).

Herring Gulls are predicted to be scarce in the Study Area throughout the year. Great Black-backed Gulls are considered uncommon from September to February and very scarce from March to August. Glaucous Gulls are predicted to be scarce in the Study Area from October to April and Iceland Gulls are also considered scarce from November to April. The Lesser Black-backed Gull is predicted to be very scarce from May to December.

5.2.1.5.4 Black-legged Kittiwake

Black-legged Kittiwake was common during seabird monitoring of Husky's seismic program in 2005 (Lang et al. 2006). Densities within the Study Area ranged from 1.0-9.9 birds per km² in areas where the majority of ten-minute counts were conducted. Daily totals from incidental sightings typically ranged from 250-1000 individuals. Birds in first winter plumage were relatively numerous with daily percentages typically comprising 15-25% of the total seabird incidental sightings. This species is predicted to be common in the Study Area from October to May and scarce from June to September.

5.2.1.5.5 Arctic Tern

No Arctic Terns were observed during the Husky seismic monitoring program in October and November 2005 (Lang et al. 2006). This species is predicted to be scarce in the Study Area from May to September.

5.2.1.6 Alcidae (Dovekie, murres, Black Guillemot, Razorbill and Atlantic Puffin)

5.2.1.6.1 Dovekie

Dovekie was found to be fairly common during the Husky seismic monitoring program in October and November 2005 (Lang et al. 2006). Densities within the Study Area ranged from 1.0-9.9 birds per km² in areas where the majority of ten-minute counts were conducted. The first sighting of Dovekies totaled 500 and occurred on 3 October. This species was observed daily from 3 October-8 November in numbers (daily totals) typically ranging from 100-300. Maximum daily totals from incidental sightings were 2000 Dovekies on 13 October, 1500 on 28 October and 2500 on 4 November. Birds were observed on the water and in flight. Distinct movements or migrations of Dovekie involving hundreds of individuals were observed on several dates. Eastward movements were observed on 3, 13, 15 and 16 October, and southward movements were observed on 4 and 5 November. This species is predicted to be common in the Study Area from October to November and uncommon to common from December to May.

5.2.1.6.2 Common Murre

Common Murre was found to be uncommon to occasionally common during the Husky seismic monitoring program in October and November 2005 (Lang et al. 2006). Typical daily totals from incidental sightings ranged from 20-40 Common Murres during the first three weeks of October but numbers decreased to 0-3 sightings per day between 24 October and 8 November. Weekly densities derived from ten-minutes surveys peaked at 7.5 birds per km² in the third week of October. The majority of birds were observed on the water as singles or in small groups of up to five, often in the same general area as Atlantic Puffins. Unlike Thick-billed Murre and Dovekie, no movements in a particular direction were noted. This species is predicted to be scarce to uncommon in the Study Area throughout the year.

5.2.1.6.3 Thick-billed Murre

Thick-billed Murre was found to be uncommon to common during the Husky seismic monitoring program in October and November 2005 (Lang et al. 2006). Densities were 2.0-9.9 birds per km² in the 15’N x 30’W survey blocks within the Study Area. Thick-billed Murre was first observed on 7 October. It was observed almost every day until the end of the survey period on 8 November. Typical daily totals derived from incidental sightings and ten-minute counts ranged from 50-250 murres. Birds were observed on the water and in flight. Distinct movement patterns in which hundreds of individuals were observed were noted. Eastward movements were noted on 13 and 15 October and southward movements occurred during 4-6 November. This species is predicted to be uncommon to common from October to April and very scarce to scarce in the Study Area from May to September.

5.2.1.6.4 Razorbill

There was only one sighting (four birds on 6 October) of Razorbill Murre during the Husky seismic monitoring program in October and November 2005 (Lang et al. 2006). The lack of observations during this time period when the species is a common migrant through near shore areas of eastern Newfoundland, suggests that Razorbill Murres do not often occur on the Northern Grand Banks. This species is predicted to be very scarce in the Study Area from April to November.

5.2.1.6.5 Atlantic Puffin

Atlantic Puffin was considered uncommon during the Husky seismic monitoring program in October and November 2005 (Lang et al. 2006). It was observed on 32 of the 39 days seabird surveys were conducted on the Northern Grand Banks. Daily numbers (totals) derived from incidental observations and systematic surveys typically ranged from 20-50. There was a maximum count of 100 birds on 22 October. Densities (calculated for 15'N x 30'W blocks) ranged from 1.0-4.9 birds per km² and 0-0.9 birds per km² in the southern and northern portions of the Study Area, respectively. The majority of birds were observed on the water as individuals or in small groups of up to five birds. Unlike Thick-billed Murre and Dovekie no large-scale movement patterns of Atlantic Puffins were noted. In the Study Area, this species is predicted to be scarce to uncommon during April to September and uncommon from October to November.

5.2.2 Species At Risk

5.2.2.1 Ivory Gull

Ivory Gull breeds in high Arctic Canada, Greenland and northern Eurasian. It winters among the sea ice within breeding range and slightly farther south. Extends farthest south on the northwestern Atlantic

Ivory Gull probably rarely reaches the Project Area. In unusually heavy ice years, ice may be more prevalent within the Project Area at which time a few Ivory Gulls could be present in February to April. A total of 21 Ivory Gulls reported from drill platforms on the northeast Grand Banks 1999-2002 (Baillie et al. 2005) seems too high and most were reported when there was no ice. This species is unlikely to occur in Project Area during June to November.

5.3 Marine Mammals and Sea Turtles

5.3.1 Marine Mammals

Since the preparation of the seismic EA (LGL et al. 2005) and it's addendums (LGL 2005; LGL and Canning & Pitt 2005a), the primary source of new information available for marine mammals in and near the Study Area is the marine mammal monitoring results of the Husky 3D seismic program conducted in October and November 2005 (Lang et al. 2006). Two biologists (and a fisheries liaison officer) were aboard the seismic ship, the M/V *Western Neptune*, throughout the seismic program which occurred from 1 October to 8 November 2005. The seismic program was conducted primarily in EL 1067 (Wildrose). A summary of the results are provided below. However, these results should be considered preliminary given that the monitoring report is in preparation. Note that the COSEWIC status and *SARA* designations for marine mammals that occur in the Study Area have not changed since the preparation of Husky's original seismic EA.

Given the endangered status of blue whales (*Balaenoptera musculus*), an update of the information for this species provided for in LGL et al. (2005) is also provided here. There is no new information available since the preparation of original seismic EA to suggest that other marine mammals considered endangered by COSEWIC (North Atlantic right whale (*Eubalaena glacialis*), northern bottlenose whale (*Hyperoodon ampullatus*)—Scotian Shelf population) are likely to occur in the Study Area.

5.3.1.1 Summary of Seismic Monitoring Results (Fall 2005)

The marine mammal observers conducted approximately 371 hours of observation along 2859 km trackline from the *Western Neptune* during 1 October to 8 November 2005. Table 5.8 summarizes the marine mammal sightings. A total of 170 marine mammal sightings were made, totaling 530 individuals. Most observations were made in and near 'Wildrose 3D' as this is where seismic operations were conducted in 2005 (Fig. 5.20). Other marine mammal sightings were made when the seismic ship was in transit or sailing away from the seismic area to avoid bad weather on the Grand Banks.

Baleen whales or mysticetes were the most numerous marine mammal observed during late fall in and near the Study Area. Considering all sightings made during systematic watches from the seismic ship, there were 59 confirmed sightings (totaling 79 individuals) of humpback whales (*Megaptera novaeangliae*), which accounted for about 70% of all baleen whale sightings identified to the species level. Humpbacks were sighted in water depths averaging 97 m (Table 5.8). There were 16 sightings (22 individuals) of fin whales (*Balaenoptera physalus*) and nine sightings (totaling nine individuals) of minke whales (*Balaenoptera acutorostrata*). During periods when the airguns were inactive, baleen whale sighting rate was 0.13 sightings/hour in the Project Area (Lang et al. 2006). The sighting rate was highest during periods when a single airgun operated (0.68 sightings/h).

Relatively few dolphins (23 sightings) were sighted from the *Western Neptune* (Table 5.8). In the Project (and Study) Area, there were two sightings of Atlantic white-sided dolphins, one sighting of white-beaked dolphins, one sighting of common dolphins and two sightings of dolphins not identified to species level (Fig. 5.20). A group of six killer whales was sighted northwest of the Project Area in NAFO area 3Ld (Fig. 5.20). There was one sighting of a beaked whale species (potentially a Sowerby's beaked whale) made in the Project Area (Fig. 5.20). Two harbour porpoises were observed in the Project Area in a water depth of 165 m. Long-finned pilot whales (two sightings) were observed north of the Project Area, in slope waters averaging 637 m.

5.3.1.2 Blue Whale

The blue whale is a cosmopolitan species with separate populations (and subspecies) in the North Atlantic (*B.m. musculus*), North Pacific (*B.m. brevicauda*), and Southern Hemisphere (*B.m. intermedia*). The global population is thought to range from 5000-12,000 individuals but a recent and reliable estimate is not available. Blue whale abundance in the North Atlantic is currently thought to range from 600 to 1500 individuals, although more reliable and wide ranging surveys are required for better estimates (Sears and Calambokis 2002). Blue whales concentrate in areas with large seasonal concentrations of euphausiids, its main prey (Yochem and Leatherwood 1985). Little is known about the distribution and abundance of blue whales in the northwest Atlantic—especially the waters off eastern Newfoundland. One area of blue whale concentration is the Gulf of St. Lawrence where 350 individuals have been catalogued photographically (Sears 2002).

There is insufficient data to determine population trends of the blue whale in the northwest Atlantic. The blue whale is considered endangered by COSEWIC (COSEWIC 2002) and is listed as such on Schedule 1 of the *SARA*. Accordingly, a Recovery Strategy is being developed under *SARA* and is likely due for release in the near future (J. Lawson, DFO, pers. comm.) On a global level, the IUCN—World Conservation Union, also considers the blue whale endangered (www.redlist.org). The original

Table 5.8. Summary of marine mammal sightings made from the MV *Western Neptune* during Husky's seismic monitoring program in Wildrose during October and November 2005.

Species	No. of Marine Mammals		Avg. Water Depth (m)
	Sightings	Individuals	
Mysticetes			
Fin whale	16	22	106
Humpback whale	59	79	97
Minke whale	9	9	120
Unidentified	48	61	106
Total	*132*	*171*	
Odontocetes			
Long-finned pilot whale	2	16	637
Atlantic white-sided dolphin	6	128	317
Common dolphin	4	61	126
White-beaked dolphin	2	23	151
Killer Whale	1	6	na
Unidentified dolphin	8	107	114
Unidentified beaked whale	1	1	128
Harbour porpoise	1	2	165
Total	*25*	*344*	
Unidentified Whale	13	15	124
GRAND TOTAL	***170***	***530***	121

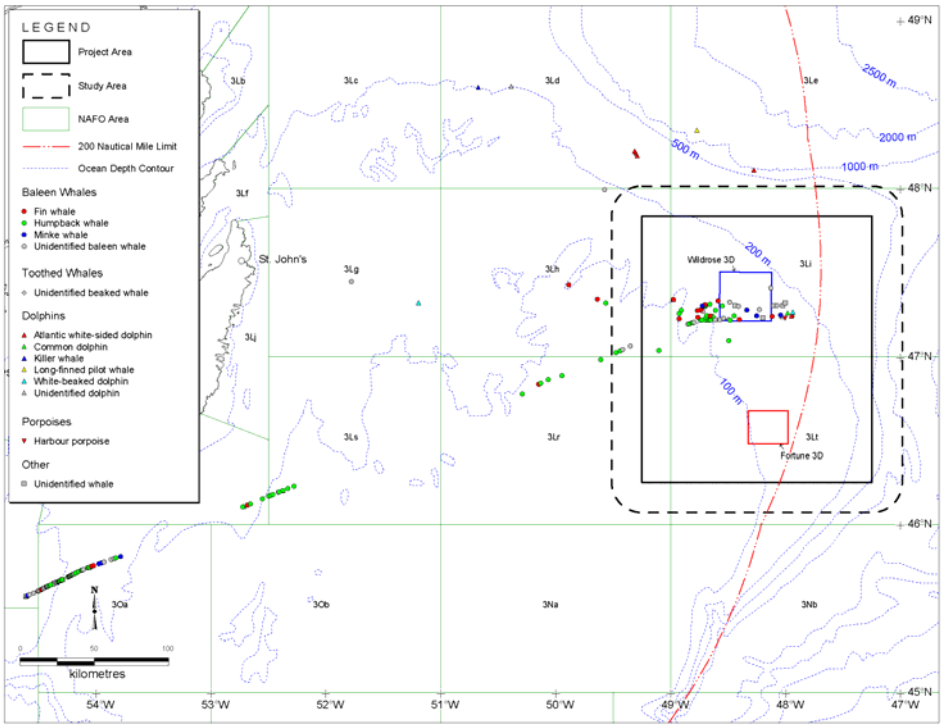

Figure 5.20. Marine mammal sightings made during the 2005 Husky seismic monitoring program from the MV *Western Neptune* (1 October to 8 November 2005).

population was reduced due to whaling and now their biggest threats are thought to be from ship strikes, disturbance from increasing whale watching tours, entanglement in fishing gear, and pollution (Sears and Calambokidis 2002).

Blue whales have a coastal and pelagic distribution and they are known to frequent areas of the Gulf of St. Lawrence, the lower Estuary part of the St. Lawrence, and to a lesser extent the west and southwest coasts of Newfoundland. Most sighting effort and sightings of blue whales have been made along the Quebec North Shore from the Mingan and Anticosti islands region, off the Gaspé Peninsula, and west into the St. Lawrence Estuary to the Saguenay River (Sears and Calambokidis 2002). Little survey effort has been expended in other regions of the Gulf or elsewhere in the northwest Atlantic, especially outside of the summer period. Information on the distribution of blue whales in winter is lacking. Some blue whales become entrapped by ice (during heavy ice years) near the southwest coast of Newfoundland (Stenson et al. 2003). Records of entrapped blue whales date back to 1868 and 41 individual blue whales (23 entrapment events) have been recorded since then. All entrapments with available date information occurred during March and April and based on morphometric analyses most whales were adults and one whale was a pregnant female (Stenson et al. 2003). There have been no confirmed sightings of blue whales in or near the Project Area based upon available data provided by DFO. The closest sighting was made in June 1993, approximately 200 km south of the Project Area, respectively. Most sightings of blue whales in Newfoundland have occurred near the coast, which likely is related to the lack of dedicated marine mammal surveys in offshore waters.

In the Northern Hemisphere, blue whales mate and calve from late fall to mid-winter and become sexually mature at the ages of 5-15 (Yochem and Leatherwood 1985). Blue whales are thought to live for 70-80 years and potentially longer (Yochem and Leatherwood 1985).

Blue whales feed almost exclusively on euphausiids (krill) such as *Thysanoessa raschii* and *Meganyctiphanes norvegica* (Yochem and Leatherwood 1985). Blue whales also feed on copepods (e.g., *Temora longicornis*) and some fish species (Kawamura 1980; Reeves et al. 1998). Areas where blue whales are known to occur correspond to areas where their prey aggregate in great abundance (Simard and Lavoie 1999).

5.3.2 Sea Turtles

As indicated in LGL et al. (2005) and LGL and Canning & Pitt (2005), sea turtles are probably not common in the Jeanne d'Arc Basin area. No sea turtles were observed during the 2005 Husky seismic monitoring program (Lang et al. 2006). Also, leatherbacks equipped with satellite tags did not occur in the Project Area but some did migrate through the Grand Banks south of Newfoundland (James et al. 2005). A draft of the "National Recovery Strategy for the Leatherback turtle (*Dermochelys coriacea*) in Atlantic Canadian waters" has been prepared but was not available on government web sites during preparation of this EA.

6.0 EFFECTS ASSESSMENT

6.1 New and Relevant Information

This section includes a review of relevant "impact" literature that has become available since preparation of the original Husky seismic and geohazard EA (LGL et al. 2005a; LGL 2005; LGL and Canning & Pitt 2005a,b).

6.1.1 Fish and Fisheries

6.1.1.1 Pathological Effects

6.1.1.1.1 Fish

TTS in Fish.— Three freshwater fish species (lake chub, *Couesius plumbeus*; northern pike, *Esox lucius*; broad whitefish, *Coregonus nasus*) were exposed to shots from a 730 in^3 airgun array (Popper et al. 2005). The lake chub is a known hearing specialist. In the case of northern pike, both young-of-the-year (YOY) and adult fish were exposed. The number of exposure shots was either five or twenty. The mean received sound pressure levels were 207.3 dB re 1 µPa $_{0\text{-}P}$, 197.4 dB re 1 µPa $_{90\%\ RMS}$, and 177.7 dB re 1 µPa $_{SEL}$. Using the ABR technique, temporary threshold shifts (TTS) were found in exposed adult northern pike and lake chub, with recovery within 24 hours of exposure. Exposed adult northern pike exhibited threshold shifts ranging from 7 to 22 dB (5 shots). Exposed lake chub exhibited threshold shifts ranging from 14 to 24 dB (5 shots), and 19 to 40 dB (20 shots). No significant TTS was found in either the YOY northern pike or the broad whitefish.

6.1.1.1.2 Invertebrates

Sound Detection. —The hearing abilities of the prawn, *Palaemon serratus*, have been recently studied using the auditory brainstem response (ABR) (Lovell et al. 2005). This work represents the first time that invertebrates have been studied using the ABR recording technique. Lovell et al. found that the prawn responds to sounds ranging in frequency from 100 to 3,000 Hz. They also showed that the statocyst of *P. serratus* is sensitive to the motion of water particles displaced by low frequency sounds with a hearing acuity similar to that of a generalist fish. Measured threshold RMS SPLs ranged from 106 dB re 1 µPa @ 100 Hz to 131 dB re 1 µPa @ 3,000 Hz.

6.1.1.2 Behavioural Effects

6.1.1.2.1 Invertebrates

Andriguetto-Filho et al. (2005) studied the effects of seismic sound on commercial shrimp catches off Brazil. Water depth in the experimental area (approximately 15 km x 5 km) ranged from 2 to 15 m., and substrate was relatively heterogeneous (mud to rock). A total of 12 km of seismic line was conducted. The airgun configuration used was part of an actual commercial seismic prospecting program. Seismic array specifics include four 635 in^3 airguns, each with a source peak pressure equal to 196 dB re 1 µPa @ 1-m. The array was fired every 12 seconds. Although the mean mass and number of shrimp caught after seismic was slightly lower than before seismic, results did not indicate any significant difference.

6.1.2 Marine Mammals

Several monitoring programs designed to monitor the influences of seismic operations on marine mammals and sea turtles have become available recently, including the Husky 2005 monitoring program in Jeanne d'Arc Basin. Monitoring reports include:

- Husky's 2005 Monitoring Program in Jeanne d'Arc Basin (Lang et al. 2006)
- Chevron Canada Limited's 2005 Monitoring Program in Orphan Basin (Moulton et al. 2006a)
- ConocoPhillips' 2005 Monitoring Program in the Laurentian Sub-basin area (Moulton et al. 2006b)
- Lamont-Doherty Earth Observatory's (L-DEO) monitoring programs (MacLean and Koski 2005; Holst et al. 2005a,b; Ireland et al. 2005; Smultea et al. 2005)
- University of Alaska Fairbanks monitoring program in the Arctic Ocean (Haley and Ireland 2006)

Details concerning dates of operation, the types of airgun arrays (including source level), used in each seismic program and the marine mammal monitoring effort are provided in Table 6.1. The results of each monitoring program are summarized in Table 6.2 and described in more detail below.

Several other reports relating to marine mammals and sound have also become available and are summarized below.

6.1.2.1 Hearing Abilities of Marine Mammals

There are very few data on the absolute hearing thresholds of most of the larger, deep-diving toothed whales, such as the sperm and beaked whales. However, Mann et al. (2005) report that a Gervais' beaked whale showed evoked potentials from 5 to 80 kHz, with the best sensitivity at 80 kHz.

6.1.2.2 Disturbance by Seismic Surveys

Husky's 2005 Monitoring Program in Jeanne d'Arc Basin. **—**As already discussed in Section 5.3.1.1., Husky conducted a marine mammal monitoring program in October and November 2005 (see Table 6.1). The limited number of dolphin sightings precluded an analysis of their responses to seismic activity. Baleen whale sighting rates were higher during all seismic periods (0.284 sightings/h) vs. non-seismic periods (0.159 sightings/h); however, sighting rate was lowest during periods when the array was operating at full volume (0.133 sightings/h). The radial distances at which baleen whales were sighted (closest point of approach) were, on average, closer during periods of No Airguns (mean = 1265 m) than during periods of All Seismic (mean = 2077 m). An analysis of the data suggest that, overall, there was no obvious behavioural effect of airgun operations on baleen whales.

Chevron's 2005 Monitoring Program in Orphan Basin. **—** In May to October 2005, a marine mammal monitoring program (from the MV *Geco Diamond* and *Western Patriot*) was conducted during CCL's 3-D seismic program in the Orphan Basin (Moulton et al. 2006a; see Table 6.1). Water depths ranged from 1108-2747 m. The acoustic sources from the *Diamond* were two 5085 in^3 arrays (24 airguns) and the *Patriot* operated two 3000 in^3 (32 airguns) arrays; the arrays operated from each vessel fired alternatively.

Table 6.1. Summary of recent seismic programs and the corresponding marine mammal monitoring programs. (PAM = Passive acoustic monitoring.)

			Airgun Source			Hours of Visual Observation		Hours of PAM	
Location	Water Depth (m)	Dates	No./Type of Guns	Total Volume	Source Level (dB re 1 µPa @ 1 m (0-pk))	Seismic	Non-seismic	Seismic	Non-seismic
Jeanne d'Arc Basin	68-376	1 Oct - 8 Nov 2005	24 Bolt	5085 in^3	254.5	130.4	37.7	na	na
Orphan Basin	1108-2747	12 May - 11 Oct 2005	24 Bolt; 32 Sleeve guns	5085 in^3; 3000 in^3	254.5; 253.4	1146	328	na	na
Laurentian Sub-basin	122-3014	14 Jun - 29 Sep 2005	24 Bolt	5085 in^3	254.5	811	240	na	na
Gulf of Alaska	30-3000	22 Aug - 23 Sep 2004	2 GI	210 in^3	237	77	193	na	na
NE Pacific	1600-5000	20 Oct-3 Nov 2004	10 1500C Bolt; 12 1500C Bolt	3050 in^3; 3705 in^3	248; 250	45	58	45	7
E Tropical Pacific	20-5000	21 Nov - 22 Dec 2004	3 GI (each 105 in^3); 3 GI (each 45 in^3)	315 in^3, 105 in^3	240.7	255	33	609	23
S Gulf of Mexico	<100	7 Jan - 20 Feb 2005	20 Bolt	6970 in^3	253.5	201	147	200	51
Aleutians	100-3500	20 Jul - 20 Aug 2005	1 GI	45 in^3	231	9	105	na	na
Arctic Ocean	233-4873	5 Aug - 26 Sep 2005	2 Sodera G.	500 in^3	236	205	230	98	0

Table 6.2. Summary of marine mammal sighting and observed effects of seismic programs during recent monitoring programs.

Location	Species Observed			Others	Seismic Effects [a, b]
	Dolphins	Baleen Wh	Large Toothed Wh.		
Jeanne d'Arc Basin	Atl. White-sided, Common, White-beaked Dolphin	Fin, Humpback, Minke	Beaked whale (Unidentified)	Harbour porpoise	**Baleen wh.** sighting rates higher during all seismic periods vs. non-seismic periods; however, sighting rate was lowest during periods when the array was operating at full volume. CPA signif. farther away during seismic vs. non-seismic periods; behaviours
Orphan Basin	LF Pilot Wh., Atl. White-sided, Bottlenose, SB Common, Striped, White-beaked dolphin	Fin, Sei, Humpback, Minke	Sperm, Northern Bottlenose, Sowerby's Beaked	Harbour porpoise, harp seal	**Dolphin** sighting rates were slightly higher during non-seismic vs. seismic periods (not signif.); CPA signif. farther away during seismic vs. non-seismic periods; behaviours similar during seismic & non-seismic periods. **Baleen wh.** sighting rates signific
Laurentian Sub-basin	LF Pilot Wh., Atl. White-sided, SB Common, Bottlenose, Striped, Risso's Dolphin	Blue, Fin, Sei, Humpback, Minke	Sperm, Northern Bottlenose	--	**Dolphin** sighting rates were lower during non-seismic vs. seismic periods (not signif.); similar CPAs during seismic vs. non-seismic periods; behaviours similar during seismic & non-seismic periods. **Baleen wh.** sighting rates were slightly lower during non
Gulf of Alaska	Killer Wh.	Blue, Fin, Humpback	Sperm	Dall's porpoise, Harbour porpoise, harbour seal, Stellar sea lion	Sighting rates and CPAs of two most abundant MM species (**humpbacks and Dall's porpoises**) were not significantly different during seismic and non-seismic periods. Humpbacks appeared more likely to swim away during seismic vs. non-seismic periods; the beha
NE Pacific [c]	Unidentified species	--	Sperm		Too few sightings.
E Tropical Pacific	Bottlenose, Pantropical Spotted, Spinner, SB Common, Risso's Dolphin; False Killer Wh., SF Pilot Wh.	Humpback, Minke	--	--	**Cetacean** sighting rates lower during seismic vs. non-seismic periods; CPA farther away during seismic periods; dolphins frequently observed bowriding during seismic periods.
S Gulf of Mexico	Atl. Spotted, Bottlenose, Pantropical Dolphin	--	--	--	Based on a small sample size, **dolphin** CPA was smaller during non-seismic vs. seismic periods and acoustic detection rates were were higher during non-seismic vs. seismic times.
Aleutians	Killer Wh.	Fin, Humpback, Minke	Sperm	Dall's porpoise, Harbour porpoise, Northern fur seal	**Dall's porpoise** CPA closer during non-seismic vs. seismic periods; **sperm whale** CPA similar during seismic and non-seismic periods. Behaviour of Dall's porpoise and sperm whales similar during seismic & non-seismic periods
Arctic Ocean	--	--	--	Ringed seal, bearded seal, polar bear	No statistical difference in **seal** CPA during seismic and non-seismic periods. Behaviour of seals similar (mostly swam away) during seismic and non-seismic periods.

[a] 'Significance' refers to statistically significant results.
[b] CPA refers to closest point of approach to the seismic ship.
[c] Other species seen during transit to the seismic area included: blue, fin, humpback, sei and minke whales; northern right whale dolphin; California sea lion, harbor seal, northern fur seal.

Dolphin sighting rates were slightly higher during non-seismic periods (0.122 sightings/h) than during Array seismic (0.078 sightings/h) and All Seismic (0.093 sightings/h; Array, Ramp up, One Airgun and Testing combined), and the differences between sighting rates during seismic and non-seismic periods were not statistically significant when rates were compared on a weekly basis. The radial distances at which dolphins were sighted (closest point of approach) were, on average, closer during periods of No Airguns (mean = 652 m) than during periods of Array seismic (mean = 881 m) and All Seismic (mean = 807 m); these differences were statistically significant. An analysis of the data suggest that, overall, there was no obvious behavioural effect of airgun operations on dolphins.

Baleen whale sighting rates were lower during Array seismic (0.032 sightings/h) and All Seismic (0.037 sightings/h) vs. during non-seismic periods (0.116 sightings/h). However, when sighting rates were compared on a weekly basis (to account for temporal variation in baleen whale occurrence), there was no statistically significant difference during periods with vs. without airgun activity. The radial distances (closest point of approach) at which baleen whales were sighted were, on average, farther away from the seismic ship during periods of No Airguns (mean = 973 m) vs. Array seismic (mean = 832 m) and All Seismic (816 m); but these differences were not statistically different. A higher proportion of baleen whales were observed swimming away from the seismic ship during seismic operations vs. non-seismic periods insofar as could be determined by visual observations from the seismic vessel. There was no indication that seismic operations elicited a change in swim speed.

Toothed whale sighting rates were slightly lower during Array seismic (0.020 sightings/h) and All Seismic (0.021 sightings/h) vs. during non-seismic periods (0.034 sightings/h). However, when sighting rates were compared on a weekly basis, there was no statistically significant difference during periods with vs. without airgun activity. The radial distances (closest point of approach) at which toothed whales were sighted were, on average, closer to the seismic ship during periods of No Airguns (mean = 965 m) vs. Array seismic (mean = 1139 m) and All Seismic (1127 m); but these differences were not statistically different. Based upon observations from the seismic vessels, there were no obvious indications that the behaviours of toothed whales were negatively affected by airgun operations.

ConocoPhillips' 2005 Monitoring Program in Laurentian Sub-basin.—In June to September 2005, a marine mammal monitoring program (from the MV *Western Neptune*) was conducted during ConocoPhillips' 3-D seismic program on the Laurentian Sub-basin (Moulton et al. 2006b; see Table 6.1). Water depths ranged from 122-3014 m. The acoustic sources were two 5085 in^3 arrays consisting of 24 airguns which fired alternatively.

Dolphin sighting rates were lower during periods when the airguns were inactive (0.171 sightings/h) than during Array seismic (0.411 sightings/h) and All Seismic (0.385 sightings/h; Array, Ramp up, One Airgun and Testing combined). These differences in sighting rates during non-seismic vs. seismic periods were not statistically significant when rates were compared on a weekly basis (to account for temporal variation in dolphin occurrence). The radial distances (CPA) at which dolphins were sighted were, on average, very similar during periods of No Airguns (mean = 1233 m) than during periods of Array seismic (mean = 1169 m) and All Seismic (mean = 1130 m). An analysis of the data suggests that there was no obvious behavioural effect of airgun operations on dolphins. The observed swim speed of dolphins did not support the hypothesis that dolphins would be more likely to swim fast during seismic operations and swim at a slower pace during non-seismic periods if airgun operations were negatively affecting this marine mammal group. Relatively similar proportions of dolphins were observed milling, swimming towards, parallel, and away from the seismic ship during seismic vs. non-seismic periods.

Baleen whale sighting rates were slightly lower during periods when the airguns were inactive (0.088 sightings/h) than during Array seismic (0.101 sightings/h) and All Seismic (0.134 sightings/h; Array, Ramp up, One Airgun and Testing combined). These differences in sighting rates during non-seismic vs. seismic periods were not statistically significant when rates were compared on a weekly basis. The radial distances (CPA) at which baleen whales were sighted were, on average, farther away from the seismic ship during periods of No Airguns (mean = 1928 m) vs. Array seismic (mean = 1650 m); this difference was not statistically significant. Average sighting distances were similar (and not significantly different) during periods of No Airguns vs. All Seismic (mean = 1949 m). There was no indication that the likelihood for a baleen whale to "swim away" was higher during seismic operations vs. non-seismic periods insofar as could be determined by visual observations from the seismic vessel.

Toothed whale sighting rates were slightly lower during Array seismic (0.030 sightings/h) and All Seismic (0.031 sightings/h) vs. during non-seismic periods (0.042 sightings/h). Most sightings of toothed whales occurred beyond the safety zone. The radial distances (CPA) at which toothed whales were sighted were, on average, closer to the seismic ship during periods of No Airguns (mean = 1226 m) vs. Array seismic (mean = 1500 m) and All Seismic (1891 m); but these differences were not statistically different. Based upon observations from the seismic vessels, there were no obvious indications that the behaviours of toothed whales were negatively affected by airgun operations. The movement direction of toothed whales relative to the seismic vessel was quite variable.

L-DEO Monitoring Studies in 2004 and 2005.—Since the preparation of LGL et al. (2005) the results of five seismic monitoring studies conducted for L-DEO have become available. The findings are summarized in Tables 6.1 and 6.2 and provided in more detail below.

In August and September 2004, a marine mammal monitoring program was conducted during a L-DEO seismic program in the **Gulf of Alaska** in waters ranging from 30-3000 m (MacLean and Koski 2005). The seismic source was a two airgun 210 in^3 array (Table 6.1). The results suggest that the low-intensity seismic sound source used during this cruise may have affected the behavior of some marine mammals near the seismic vessel RV *Maurice Ewing* but, if so, those effects were small. The sighting rates of the humpback whale and Dall's porpoise, the two species comprising the majority of sightings, were not significantly different during seismic and non-seismic periods. Also, the densities of all cetaceans combined were similar during seismic and non-seismic periods. Some cetaceans tended to be sighted closer to the observation vessel during non-seismic vs. seismic periods. However, for Dall's porpoises and humpback whales, the CPA were not significantly different between seismic and non-seismic times. Dall's porpoises frequently approached and sometimes rode the bow wave of the *Ewing*. Humpback whales appeared to be slightly more likely to swim away during seismic than non-seismic times, and approached the vessel only during non-seismic times. Dall's porpoises swam parallel, swam away, or approached the vessel in similar proportions during seismic and non-seismic times.

In late October to early November 2004, a marine mammal monitoring program (visual plus passive acoustic monitoring) was conducted during a L-DEO seismic program in the **northeastern Pacific Ocean** in waters ranging from 1600-5000 m (Smultea et al. 2005). The seismic source was comprised of 10-12 Bolt airguns with a total volume of 3050-3705 in^3 (Table 6.1). Most marine mammal sightings (45 sightings) were made during transit to the seismic area (from San Diego to offshore Washington State). Within the area where seismic operations were conducted, there was one visual (and acoustic) detection of a sperm whale, plus three acoustic detections of probable sperm whales and nine

acoustic detections of potential dolphins. It is uncertain why so few marine mammals were observed in the seismic area, but low densities may be related to the deep pelagic waters characteristic of the seismic area.

In late November and December 2004, a marine mammal monitoring (visual plus passive acoustic monitoring) program was conducted during a L-DEO seismic program in the **Eastern Tropical Pacific Ocean** off Central America in waters ranging from 20-5000 m (Holst et al. 2005a). Two seismic sources were used: three GI airguns (each 105 in^3) and three GI airguns with a total volume of 105 in^3 (Table 6.1). Monitoring results suggest that the low-intensity seismic sound sources used during the surveys may have displaced or affected the behaviour of some marine mammals near the seismic vessel, but if this did occur, the zone of influence was small. Interpretation of the sighting data collected during this study are limited by the small sample sizes. The sighting rates of cetaceans were higher during non-seismic vs. seismic periods. Dolphins and whales tended to be sighted farther away from the ship during seismic vs. non-seismic periods. Dolphins were observed bowriding on nine occasions: eight during seismic and once during non-seismic periods. Because PAM effort in the absence of seismic operations was limited, it was not possible to compare acoustic detection rates during seismic and non-seismic periods.

In January and February 2005, a marine mammal monitoring program was conducted during a L-DEO seismic program off the Northern Yucatan Peninsula in the **southern Gulf of Mexico** in waters <100 m (Holst et al. 2005b). The seismic source was comprised of 20 Bolt airguns with a total volume of 6970 in^3 (Table 6.1). Very few marine mammals (all dolphins) were observed visually in and near the seismic area (n = 13, 6 during non-seismic and seismic periods, respectively). Based on these sightings, dolphins were seen closer to the airgun array when the airguns were off (mean = 178 m) vs. on (mean = 472 m). A total of 13 acoustic detections (all dolphins, three detections matched with visual sightings) were made during PAM; five of these occurred when the airguns were operational. Some dolphins called in the presence of airgun pulses, but acoustic detection rates were reduced during seismic vs. non-seismic periods. The authors suggest that animals exposed to airgun sounds decreased their sound production rate or intensity or (in some cases) avoided the seismic ship, or both.

During July and August 2005, a marine mammal monitoring program was conducted during a L-DEO seismic program near the **Aleutian Islands** (Ireland et al. 2005) in waters ranging from 100-3500 m. A single GI airgun with a volume of 45 in^3 was used as the acoustic source (Table 6.1). There were relatively few hours of airgun operations. Sperm whales were the most abundant marine mammal observed. Sperm whales were sighted at similar CPA distances during seismic (2897 m) and non-seismic (2503 m) periods. Dall's porpoise were seen closer to the airgun when it was off than when it was on (mean CPA 651 vs. 1588 m). During both seismic and non-seismic periods, sperm whales were most often seen logging at the surface and Dall's porpoise were observed swimming parallel to the seismic ship.

University of Alaska 2005 Monitoring Program, Arctic Ocean.—During August and September 2005, a marine mammal monitoring program was conducted during a University of Alaska Fairbanks research cruise across the Artic Ocean in waters ranging from 233-4873 m (Haley and Ireland 2006). The seismic source was comprised of two airguns with a total volume of 500 in^3 (Table 6.1). Ringed and bearded seals were the only marine mammal species identified in open-water in the area where seismic operations were conducted. Polar bears and ringed seals were observed hauled out on the sea ice. The CPA of seals in water were similar during seismic (mean = 238 m) and non-seismic (mean = 284 m) periods and seals were usually observed swimming away from the seismic ship during periods when the

airguns were active and inactive. Seals first observed on the ice usually remained hauled out as the vessel passed. There were no acoustic detections of marine mammals during the research cruise.

6.1.2.3 Potential Hearing Impairment and Physical Effects

TTS.—Finneran et al. (2005) examined the effects of tone duration on TTS in bottlenose dolphins. Bottlenose dolphins were exposed to 3 kHz tones for periods of 1, 2, 4 or 8 s, with hearing tested at 4.5 kHz. For 1-s exposures, TTS occurred with sound exposure levels (SEL) of 197 dB, and for exposures >1 s, SEL ≥195 dB resulted in TTS. At SEL of 195 dB, the mean TTS (4 min after exposure) was 2.8 dB. Finneran et al. (2005) suggested that an SEL of 195 dB is the likely threshold for the onset of TTS in dolphins and white whales exposed to mid-frequency tones.

Mooney et al. (2005) exposed a bottlenose dolphin to octave-band noise ranging from 4 to 8 kHz at SPLs of 160 to 172 dB re 1 μPa for periods of 1.8 to 30 min. Recovery time depended on the shift and frequency, but full recovery always occurred within 40 min (Mooney et al. 2005). They reported that to induce TTS in a bottlenose dolphin, there is an inverse relationship of exposure time and SPL; as exposure time was halved, an increase in noise SPL of 3 dB was required to induce TTS.

Additional data are needed in order to determine the received sound levels at which small odontocetes would start to incur TTS upon exposure to repeated, low-frequency pulses of airgun sound with variable received levels. Given the results of the aforementioned studies and a seismic pulse duration (as received at close range) of ~20 ms, the received level of a single seismic pulse might need to be on the order of 210 dB re 1 μPa rms (~221–226 dB pk-pk) in order to produce brief, mild TTS. Exposure to several seismic pulses at received levels near 200–205 dB (rms) might result in slight TTS in a small odontocete, assuming the TTS threshold is (to a first approximation) a function of the total received pulse energy. Seismic pulses with received levels of 200–205 dB or more are usually restricted to a radius of no more than 100 m around a seismic vessel.

To better characterize this radius, it would be necessary to determine the total energy that a mammal would receive as an airgun array approached, passed at various CPA distances, and moved away. At the present state of knowledge, it would also be necessary to assume that the effect is directly related to total energy even though that energy is received in multiple pulses separated by gaps. The lack of data on the exposure levels necessary to cause TTS in toothed whales when the signal is a series of pulsed sounds, separated by silent periods, is a data gap.

6.1.2.4 Strandings and Mortality

As discussed in Husky's original seismic EA (LGL et al. 2005), several marine mammal strandings have been attributed to high intensity, mid-frequency naval sonar operations. It is important to note that seismic pulses and mid-frequency sonar pulses are quite different. Because seismic and sonar sounds have considerably different characteristics and duty cycles, it is not appropriate to assume that there is a direct connection between the effects of military sonar and seismic surveys on marine mammals. However, evidence that sonar pulses can, in special circumstances, lead to hearing damage and, indirectly, mortality suggests that caution is warranted when dealing with exposure of marine mammals to any high-intensity pulsed sound.

A stranding of beaked whales (15 whales) happened on 24–25 September 2002 in the Canary Islands, where naval maneuvers were taking place. Based on the strandings in the Canary Islands, Jepson et al. (2003) proposed that cetaceans might be subject to decompression injury in some situations.

Fernández et al. (2005a) showed those beaked whales did indeed have gas bubble-associated lesions and fat embolisms. Fernández et al. (2005b) also found evidence of fat embolism in three beaked whales that stranded 100 km north of the Canaries in 2004 during naval exercises. Examinations of several other stranded species have also revealed evidence of gas and fat embolisms (e.g., Arbelo et al. 2005; Jepson et al. 2005a; Méndez et al 2005). Most of the afflicted species were deep divers. Gas and fat embolisms may occur if cetaceans ascend unusually quickly when exposed to aversive sounds, or if sound in the environment causes the destabilization of existing bubble nuclei (Potter 2004; Arbelo et al. 2005; Fernández et al. 2005a; Jepson et al. 2005b). Previously it was widely assumed that diving marine mammals are not subject to the bends or air embolism.

6.1.2.5 Non-auditory Physiological Effects

As outlined in LGL et al. (2005), possible types of non-auditory physiological effects or injuries that might theoretically occur in marine mammals exposed to strong underwater sound might include stress, neurological effects, bubble formation, and other types of organ or tissue damage. However, studies examining such effects are limited. If any such effects do occur, they would probably be limited to unusual situations. Those could include cases when animals are exposed at close range for unusually long periods, or when the sound is strongly channeled with less-than-normal propagation loss, or when dispersal of the animals is constrained by shorelines, shallows, etc.

Romano et al. (2004) examined the effects of single underwater impulse sounds from a seismic water gun (up to 200 kPa) and single pure tones (up to 201 dB re 1 μPa) on the nervous and immune systems of a beluga and a bottlenose dolphin. They found that neural-immune changes to noise exposure were minimal. Although levels of some stress-released substances (e.g., catecholamines) changed significantly with exposure to sound, levels returned to baseline after 24 hours. Further information about the occurrence of noise-induced stress in marine mammals is not available at this time. However, it is doubtful that any single marine mammal would be exposed to strong seismic sounds for sufficiently long that significant physiological stress would develop. This is particularly so in the case of seismic surveys where the tracklines are long and/or not closely spaced.

Jepson et al. (2003) first suggested a possible link between mid-frequency sonar activity and acute and chronic tissue damage that results from the formation *in vivo* of gas bubbles, based on 14 beaked whales that stranded in the Canary Islands close to the site of an international naval exercise in September 2002. Although the interpretation that the effect was related to decompression injury was initially unproven (Piantadosi and Thalmann 2004; Fernández et al. 2004), Fernández et al. (2005a) showed that the beaked whales did indeed have gas bubble-associated lesions and fat embolisms. Fernández et al. (2005b) also found evidence of fat embolism in three beaked whales that stranded 100 km north of the Canaries in 2004 during naval exercises. Examinations of other stranded cetacean species have revealed evidence of gas and fat embolism; most of them deep-diving species. Arbelo et al. (2005) reported on two Blainville's beaked whales that stranded in Gran Canaria and Tenerife, respectively, that showed gas embolisms. Jepson et al. (2005a) showed that several U.K.–stranded cetaceans, including Risso's dolphins, short-beaked common dolphins, a Blainville's beaked whale, and a harbor porpoise, revealed gas embolic lesions. In addition, 14 of 84 cetaceans that stranded in the Canary Islands between 1995 and 2003 (Méndez et al 2005) showed lung fat embolisms, including dwarf and pygmy sperm whales, sperm whales, Cuvier's beaked whales, a Blainville's beaked whale, and a bottlenose dolphin.

Gas and fat embolisms may occur if cetaceans ascend unusually quickly when exposed to aversive sounds, or if sound in the environment causes the destabilization of existing bubble nuclei (Potter 2004;

Arbelo et al. 2005; Fernández et al. 2005a; Jepson et al. 2005b). Thus, air and fat embolisms could be a mechanism by which exposure to strong sounds could, indirectly, result in non-auditory injuries and perhaps death. However, even if those effects can occur during exposure to mid-frequency sonar, there is no evidence that those types of effects could occur in response to airgun sounds. The only available information on acoustically-mediated bubble growth in marine mammals is modeling assuming prolonged exposure to sound. However, Crum et al. (2005) tested *ex vivo* bovine liver, kidney, and blood to determine the potential role of short pulses of sound to induce bubble nucleation or decompression sickness. In their experiments, supersaturated bovine tissues and blood showed extensive bubble production when exposed to low-frequency sound. They speculated that marine mammal tissue may be affected in similar ways under such conditions.

6.1.3 Sea Turtles

6.1.3.1 Disturbance by Seismic Surveys

Since the preparation of LGL et al. (2005) the results of two seismic monitoring studies with sea turtle data conducted for L-DEO have become available. In late November and December 2004, a monitoring program was conducted during a L-DEO seismic program in the Eastern Tropical Pacific Ocean off Central America near turtle nesting beaches in waters ranging from 20-5000 m (Holst et al. 2005a). Two seismic sources were used: three GI airguns (each 105 in^3) and three GI airguns with a total volume of 105 in^3 (Table 6.1). Sea turtles (primarily Olive ridley) were regularly sighted from the seismic ship during airgun operations; there were 102 sightings totaling 107 individuals (56 Olive ridley, 1 leatherback, and 50 unidentified sea turtles). Fifteen sea turtles (9 Olive ridley, 1 Green, and 5 unidentified sea turtles) were sighted during non-seismic periods. On average, turtles were observed closer to the GI gun array when the airguns were inactive (mean = 127 m, n = 15) vs. active (mean = 320 m, n = 102). Most sea turtles during both seismic and non-seismic periods, were observed logging at the surface, and did not display an apparent avoidance response. Relatively few turtles were observed moving away from the vessel. Three pairs of sea turtles were seen mating near the seismic ship during airgun operations.

In January and February 2005, a monitoring program was conducted during a L-DEO seismic program off the Northern Yucatan Peninsula in the southern Gulf of Mexico in waters <100 m (Holst et al. 2005b). The seismic source was comprised of 20 Bolt airguns with a total volume of 6970 in^3 (Table 6.1). A total of 29 sea turtle sightings involving 29 individuals occurred from the seismic ship; 7 during seismic and 22 during non-seismic periods. Hawksbill and loggerhead sea turtles were identified. On average, turtles were observed at similar distances from the airgun array when it was operating (mean = 284 m, n = 7) and when the airguns were inactive (mean = 290 m, n = 14). Most sea turtles during both seismic and non-seismic periods, were observed logging (resting) at the surface, and did not display an apparent avoidance response.

6.2 Application of Effects Assessment

For this EA update, the same methodology as described in Section 6.1 of LGL et al. (2005) was used to re-evaluate potential effects of Husky's 2006 - 2010 seismic program on the VECs. The effects assessment considers mitigation measures. VECs include:

- Fish and Fisheries
- Marine Birds

- Marine Mammals
- Sea Turtles
- Species at Risk

The frequency and duration of Husky project activities for 2006 are mostly the same as those described in LGL et al. (2005); the exception is that the 2006 seismic program may be 62 days in duration (33-43 days of data acquisition) vs. the estimated 83-95 days of data acquisition estimated for 2005. However, this does not affect the Duration rating (level 2 or 1-12 months). The same seismic ship and equipment or equivalent used during the 2005 survey will be used in 2006. The 2007 – 2010 surveys may be of a similar duration and magnitude.

6.2.1 Mitigation and Follow-up

The mitigation and follow-up procedures described in LGL et al. (2005) and LGL and Canning & Pitt (2005a,b) will be employed during the proposed 2006-2010 seismic and geohazard program in Jeanne d'Arc Basin. Mitigation measures included:

- Ramp-up of the seismic arrays over a 20 to 40 minute period
- Monitoring by EOs for marine mammals and sea turtles at least 30 minutes prior to ramp up. If a marine mammal or sea turtle is sighted within the safety zone (500 m) during the 30 minutes prior to ramp up, ramp up will be delayed until the animal has moved beyond the safety zone or 20 minutes have passed since the last sighting.
- Shutdown of the seismic array if an endangered baleen whale (blue whale or North Atlantic right whale) is sighted within the safety zone. The array will only be ramped up after the whale has moved beyond the safety zone or 20 minutes has passed since the last sighting.
- Reducing lighting on board the seismic ship to minimum safe levels.
- Retrieving and releasing stranded seabirds according to appropriate guidelines.
- Notification to fishers of the timing and location of planned seismic activities via "Notice to Mariners" and "Notice to Fishers" as well as consultations with appropriate fishing groups.
- DFO research survey consultations.
- Use of a picket vessel to scout ahead of the seismic ship for fishing activity and gear.
- Use of a FLO to monitor and communicate with fishing vessels in the area.
- Damage compensation program for fishers
- Helicopters maintaining a high altitude.
- Contingency plan for spill response measures.

Follow-up procedures will include:

- In the unlikely event that sea turtles or mammals are injured or killed by Project activities, a report will be filed with C-NLOPB and the need for follow-up monitoring assessed.
- Any dead or distressed marine mammals will be reported immediately to the C-NLOPB.
- A marine mammal and seabird monitoring report, based on data collected by EOs will be submitted to the C-NLOPB.

6.2.2 Fish and Fisheries

Fish.—There is no new information regarding the physical (pathological and physiological) effects of seismic sound on fish and invertebrates that would change the effects assessment conducted in LGL et al. (2005). Literature sources on this topic that have become available after the submission of the original EA have been included in preceding sections. The 3-D seismic program proposed for 2006 is predicted to have *negligible to low* physical effects on the various life stages of fish over a duration of *1-12 months* in an area *<1 km*^{2}. Therefore, any physical effects of the Project on the fish VEC would be *not significant*.

There is no new information regarding the disturbance (behavioural) effects of seismic sound on fish and invertebrates that would change the effects assessment conducted in LGL et al. (2005). Literature sources on this topic that have become available after the submission of the original EA have been included in preceding sections. The 3-D seismic program proposed for 2006 is predicted to have *negligible to low* disturbance (behavioural) effects on the various life stages of fish over a duration of *1-12 months* in an area *1-10 km*^{2}. Therefore, any disturbance (behavioural) effects of the Project on the fish VEC would be *not significant*.

SARA Species.—The fish VEC was defined in LGL et al. (2005) as including four of the five fish species presently listed under *SARA*; northern wolffish, spotted wolffish, Atlantic wolffish, and Atlantic cod. Northern and spotted wolffish are listed as 'threatened' on Schedule 1, Atlantic wolffish as 'special concern' on Schedule 1, and various populations of Atlantic cod as 'special concern' on Schedule 3. The fifth fish species referred to above is Atlantic salmon (*Salmo salar*) in the Inner Bay of Fundy. This population is not relevant to this update.

As indicated in LGL et al. (2005) and in the text above, the physical and disturbance (behavioural) effects of seismic on these *SARA* species are assessed as *not significant*.

Commercial Fishery VEC.— The conclusions of the assessment in the 2005 EA and Addendums as they relate to the commercial fisheries are still valid, with the mitigations described in those documents. In particular it will be important to ensure avoidance of snow crab fixed gear (especially in the Wildrose area) and to maintain contact with DFO and industry to exchange information and avoid conflict with science surveys.

As discussed in previous sections, there is typically minimal commercial harvesting within the 2006 Program Area (1.2% and 1.8% of the total catch weights within the Study Area and Project Area, respectively, during the 2003-2005 period). Mitigations such as advisories will lessen the potential for effects and a compensation program for gear loss will lessen any potential effects to *negligible*. The highest probability of any interaction between the seismic survey and commercial fishing would be at the western part of the Wildrose 3D Area in June and July (Figures 5.6 and 5.7). The primary commercial fishery gear type used in this part of the 2006 Program Area is the snow crab pot, a fixed-gear type. No new publications on the effects of seismic sound on fisheries have become available since the submission of LGL et al. (2005). Also, no new information regarding the disturbance (behavioural) effects of seismic on fish and invertebrates that would change the effects assessment conducted in LGL et al. (2005) is available.

As indicated in a previous section, the 3-D seismic program proposed for 2006 is predicted to have *negligible to low* disturbance (behavioural) effects on the various life stages of the fish VEC over a duration of *1-12 months* in an area *1-10 km*^{2}. Therefore, any disturbance (behavioural) effects of the Project on the commercial fishery VEC would be *not significant*.

6.2.3 Marine Birds

The 2005 Husky monitoring program in the Project Area provided data on seabird distribution and abundance for the autumn period. During October and November, most abundant species observed were Northern Fulmar, Black-legged Kittiwake, Dovekie, and Thick-billed Murre. Greater Shearwater was relatively abundant during the first week of October but numbers decreased substantially later in the monitoring period. There is no new information available on the effects of seismic (and geohazard) sounds on seabirds since the submission of LGL et al. (2005). It is thought that alcids, which spend relatively long periods of time underwater, would have the most potential to be exposed to some level of seismic and geohazard sound. However, as discussed in the original Husky seismic EA (and observed in the field), the presence of the ship and associated gear typically lead to birds moving away from the immediate area. In 2006, the seismic vessel will use semi-solid streamers where the fluid is highly segregated into small pockets, and thus the risk of a spill of sufficient size to affect seabirds is extremely low (LGL et al. 2005).

During the Husky monitoring program in 2005, 107 Leach's Storm-Petrels stranded, 89% of these birds stranded before 13 October. The exact number of Leach's Storm-Petrels that perished as a result of stranding is not known. About 30% of the birds were found dead or moderately soaked with kerosene and later died. About 70% of the birds were released in good condition and believed to have survived. EOs aboard the seismic ship will regularly search for and release stranded seabirds; this mitigation measure should reduce seabird mortality substantially.

The effects assessment in LGL et al. (2005; subsection 6.5.11) remains unchanged for seabirds. *No significant effects* on seabirds are predicted for any of the Project activities.

SARA Species.—Ivory Gull (listed as "special concern" under Schedule 1 of *SARA*), as it is associated with ice, is expected to be scarce in the Jeanne d'Arc Basin. No Ivory Gulls were observed there in late fall 2005 (Lang et al. 2006). As with other seabirds, any effects of the seismic program on Ivory Gulls would be *not significant*.

6.2.4 Marine Mammals

Husky's monitoring program in 2005 provided new and relevant distribution and abundance data on marine mammals within the Project Area (see Fig. 5.20). Baleen whales, and to a lesser extent, dolphins, regularly occur within the Project Area during autumn months (Lang et al. 2006). Based on a review of the literature that has become available since the submission of LGL et al. (2005), LGL (2005), and LGL and Canning & Pitt (2005a,b), there is no new information that would change the effects assessment conducted in the original seismic EA. Results of recent ship-based monitoring programs, including the Husky 2005 program, generally support previous studies that marine mammal response to seismic operations are variable. Typically, sighting rates of marine mammals are lower when airguns are active and marine mammals are sighted slightly farther away during seismic operations (based on visual observations from seismic ships). However, in some cases, the opposite results (especially for delphinids) were observed. Also, some marine mammals are more likely to swim away during seismic periods but others approach the ship, and attempt to bow ride. As indicated in LGL et al. (2005), it is likely that some marine mammals may exhibit localized (or perhaps larger) avoidance of the seismic ship.

The extent of this potential disturbance effect is unknown. Using the noise criteria from LGL et al. (2005) of 160 dB re 1 μPa (rms) for disturbance, and the corresponding 3-12 km distances were these sound levels were predicted to occur, results in a geographic extent of 28-452 km^2 or 11-100 km^2 to 101-

1,000 km^2 for the seismic ship. The Study Area is not known or suspected to be essential breeding or feeding habitat for marine mammals, including species listed under Schedule 1 of *SARA*. The implementation of mitigation measures from the seismic and geohazard ship, would reduce the likelihood of hearing impairment and potential physical effects. Available evidence suggests that if marine mammals avoid the seismic ships, displacement would be temporary. Effects of the 2006 seismic program on marine mammals are predicted to be the same as those presented in Table 6.11 *in* LGL et al. (2005). The monitoring and mitigation plan in place for marine mammals will minimize the potential for impacts. *No significant effects* on marine mammals are predicted for any of the Project Activities.

SARA Species.—Blue whales (listed as endangered under Schedule 1 of *SARA*) may occur in the Study Area, particularly during summer, but there have been no confirmed blue whale sightings in the Jeanne d'Arc Basin. A blue whale sighting was made 200 km south of the Project Area in NAFO Area 3Nd. Blue whales are likely uncommon and the implementation of appropriate mitigation measures will minimize the potential for impacts. North Atlantic right whales (listed as endangered under Schedule 1 of *SARA*) are highly unlikely to occur in the Study Area. However, in the rare chance that this species is sighted during the proposed seismic program, mitigation measures outlined in Section 6.2.1 will be implemented.

6.2.5 Sea Turtles

Sea turtles are expected to be uncommon in the Study Area because it is near the northern limit of their range. No sea turtles were sighted during the Husky monitoring program in 2005. There is no new information available on the effects of seismic sound on sea turtles since the submission of the original seismic EA and its addendum. With the appropriate mitigation measures in place, the effects assessment in LGL et al. (2005; Section 6.5.15.2, see Table 6.12) remains unchanged for sea turtles. *No significant effects* on sea turtles are predicted for any of the Project Activities.

SARA Species.— Leatherback sea turtles (listed as endangered under Schedule 1 of *SARA*) are expected to be uncommon in the Jeanne d'Arc Basin during summer and fall. However, if this species is sighted during the proposed seismic program, mitigation measures outlined in Section 6.2.1 will be implemented.

6.2.6 Summary of Residual Effects

As indicated in LGL et al. (2005) and based upon new information available since the submission of the original EA, it is predicted that there will be no significant residual effects from the proposed seismic program in Jeanne d'Arc Basin (Table 6.3).

6.2.7 Cumulative Effects

The original EA (LGL et al. 2005) and this update have assessed cumulative effects within the Project and thus the residual effects described in Section 6.2 include any potential cumulative effects from the Husky seismic and geohazard survey activities in Jeanne d'Arc Basin.

It is also necessary to assess cumulative effects from other activities outside the Project that are planned for the area. These activities may include:

Table 6.3. Significance of potential residual environmental effects of the proposed 2006 seismic program on VECs in the Jeanne d'Arc Basin (adapted from LGL et al. 2005; note that "Probability of Occurrence" and "Scientific Certainty" ratings are not included as there were no predicted significant effects).

Valued Environmental Component: Fish, Fisheries, Birds, Turtles, Mammals				
	Significance Rating	**Level of Confidence**	**Likelihood**	
Project Activity	**Significance of Predicted Residual Environmental Effects**		**Probability of Occurrence**	**Scientific Certainty**
Vessel Presence/Lights	NS	3	-	-
Sanitary/Domestic Wastes	NS	3	-	-
Atmospheric Emissions	NS	3	-	-
Garbage (N/A)	-	-	-	-
Noise				
Array – physical effects	NS	3	-	-
Array – behavioural effects	NS	3	-	-
Boomer – physical effects	NS	3	-	-
Boomer – behavioural effects	NS	3	-	-
Sidescan sonar – physical effects	NS	3	-	-
Sidescan sonar – behavioural effects	NS	3	-	-
Helicopters	NS	3	-	-
Shore Facilities (N/A)	-	-	-	-
Accidental Spills	NS	2	-	-

Key:

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

Significance is defined as a medium or high magnitude (2 or 3 rating) and duration greater than 1 year (3 or greater rating) and geographic extent >100 km^2 (4 or greater rating).

Level of Confidence: based on professional judgment:
1 = Low Level of Confidence
2 = Medium Level of Confidence
3 = High Level of Confidence

Probability of Occurrence: based on professional judgment:
1 = Low Probability of Occurrence
2 = Medium Probability of Occurrence
3 = High Probability of Occurrence

Scientific Certainty: based on scientific information and statistical analysis or professional judgment:
1 = Low Level of Confidence
2 = Medium Level of Confidence
3 = High Level of Confidence
N/A = Not Applicable

[a] Not Applicable. There will not be any new onshore facilities required. Existing infrastructure will be used.

- Commercial fishing [Note that there are no recreational or aboriginal fisheries in Jeanne d'Arc Basin.]
- Vessel traffic (e.g., transportation, defense, yachts)
- Hunting (e.g., seabirds, seals)
- Offshore oil and gas industry

Commercial fishing has been discussed in detail in Section 5.1. Commercial fishing activities, by their nature, cause mortality and disturbance to fish populations and may cause incidental mortalities or disturbance to seabirds, marine mammals, wolffish, and sea turtles. It is predicted that the 2006 seismic and geohazard surveys will not cause any mortality to these VECs (with the potential exception of small numbers of seabirds, predominantly Leach's Storm-Petrels) and thus, there will be no or negligible cumulative effect from mortalities. There is some potential for cumulative effect from disturbance (e.g., fishing vessel noise) but there will be directed attempts by both industries to avoid each other's active areas and times.

In the summer, the main North Atlantic shipping lanes between Europe and North America lie to the north of Jeanne d'Arc Basin into the Strait of Belle Isle. In the winter, that traffic shifts to the main shipping lanes along the southern Grand Banks into the Gulf of St. Lawrence. Thus, potential for cumulative effects with other shipping is predicted to be negligible to low.

Hunting of seabirds (mostly murres) in Newfoundland and Labrador waters predominantly occurs near shore from small boats and thus, there is little or no potential geographic (and temporal) overlap of hunting activities with the proposed Husky seismic program. Similarly, most, if not all, seal hunting would occur inshore of Jeanne d'Arc Basin in the Gulf of St. Lawrence and at the Front; the seal hunt occurs during late spring.

Offshore oil and gas industry 2006 projects listed on the C-NLOPB/CEAA registry (www.cnlopb.nl.ca as viewed 27 March 2006) and relevant to this EA include:

- Labrador Shelf and Davis Strait 2D Seismic Program (TGS-NOPEC)
- Port au Port Seismic Program (Tekoil and Gas)
- Jeanne d'Arc Basin Exploration Drilling Program (Husky)
- Jeanne d'Arc Basin Exploration Drilling Program (Norsk Hydro)
- Jeanne d'Arc Basin Wellsite Survey (Norsk Hydro)

In addition, there are three existing offshore production developments (Hibernia, Terra Nova and White Rose) on the northeastern part of the Grand Banks.

As listed above, there are two other seismic programs proposed for Newfoundland and Labrador waters in 2006:

1. Gulf of St. Lawrence on the west coast of Newfoundland (Tekoil and Gas).
2. Labrador Shelf/Davis Strait area (TGS-NOPEC).

Thus, there is little potential for cumulative effects from other seismic programs in 2006 as both programs are well over 1,000 km from the Husky Project Area. In addition, all seismic programs will use mitigation measures such as ramp ups and shutdowns of the airgun arrays (as per CNOPB 2004).

In 2006, Husky is proposing to drill four to six exploration/delineation wells in the White Rose SDA (and within the Project Area), with operations starting as early as April and ending in December. In addition, Norsk Hydro is proposing to drill up to one exploration/delineation well on SDL 1040 (West

Bonne Bay) beginning as early as "mid-2006" and two more in 2007. SDL 1040 is located within Husky's Fortune 3D seismic area. Therefore, drilling operations, including geotechnical and geohazards surveys, may overlap with Husky's proposed seismic operations in 2006. However, Husky's seismic program will require spatial separation from other noise sources so as to ensure the recording of high quality seismic data. Any cumulative effects (i.e., disturbance) from seismic and drilling operations, if they occur, will be additive (not multiplicative or synergistic) and are predicted to be not significant.

7.0 ACKNOWLEDGEMENTS

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Dave Taylor, Judith McIntyre, and Stephen Anfort (Husky) coordinated and provided technical information for the EA Update. Dave Taylor and Judith McIntyre provided comments on the EA update.

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APPENDIX A: INDUSTRY AND AGENCY GROUPS CONSULTED

Persons Consulted

The following agencies and individuals were consulted about Husky Energy's planned 2006 3D seismic surveys.

Fisheries and Oceans, Newfoundland Region

James Meade, Senior Regional Habitat Biologist

Sigrid Kuehnemund, Senior Regional Habitat Biologist

Fraser Davidson, Research Biologist, Biological and Physical Oceanographic Section

Bill Brodie, Research Scientist (DFO Science Surveys)

Environment Canada (Environmental Protection Branch)

Glenn Troke, EA Coordinator

Fredricka Kirstein, EA Coordinator (Halifax office)

Rick Wadman, Manager, Ocean Disposal

Natural History Society

Dr. Len Zedel, MUN (consultation planned for later)

One Ocean

Maureen Murphy, Research Assistant

FFAWU

Sherry Glynn, Fisheries Biologist

Keith Sullivan, Fisheries Biologist

Association of Seafood Producers

E. Derek Butler, Executive Director

Fishery Products International

Derek Fudge, Manager, Fleet Administration and Scheduling

William Savory, FPI Offshore Captain

Icewater Seafoods

Michael O'Connor, Fish Harvesting Consultant

Groundfish Enterprise Allocation Council (Ottawa)

Bruce Chapman, Executive Director

Clearwater Seafoods (Nova Scotia)

Christine Penney, Director of Corporate Affairs

APPENDIX B: CATCHES FOR ALL SPECIES – FISHERIES DISTRIBUTION MAPS

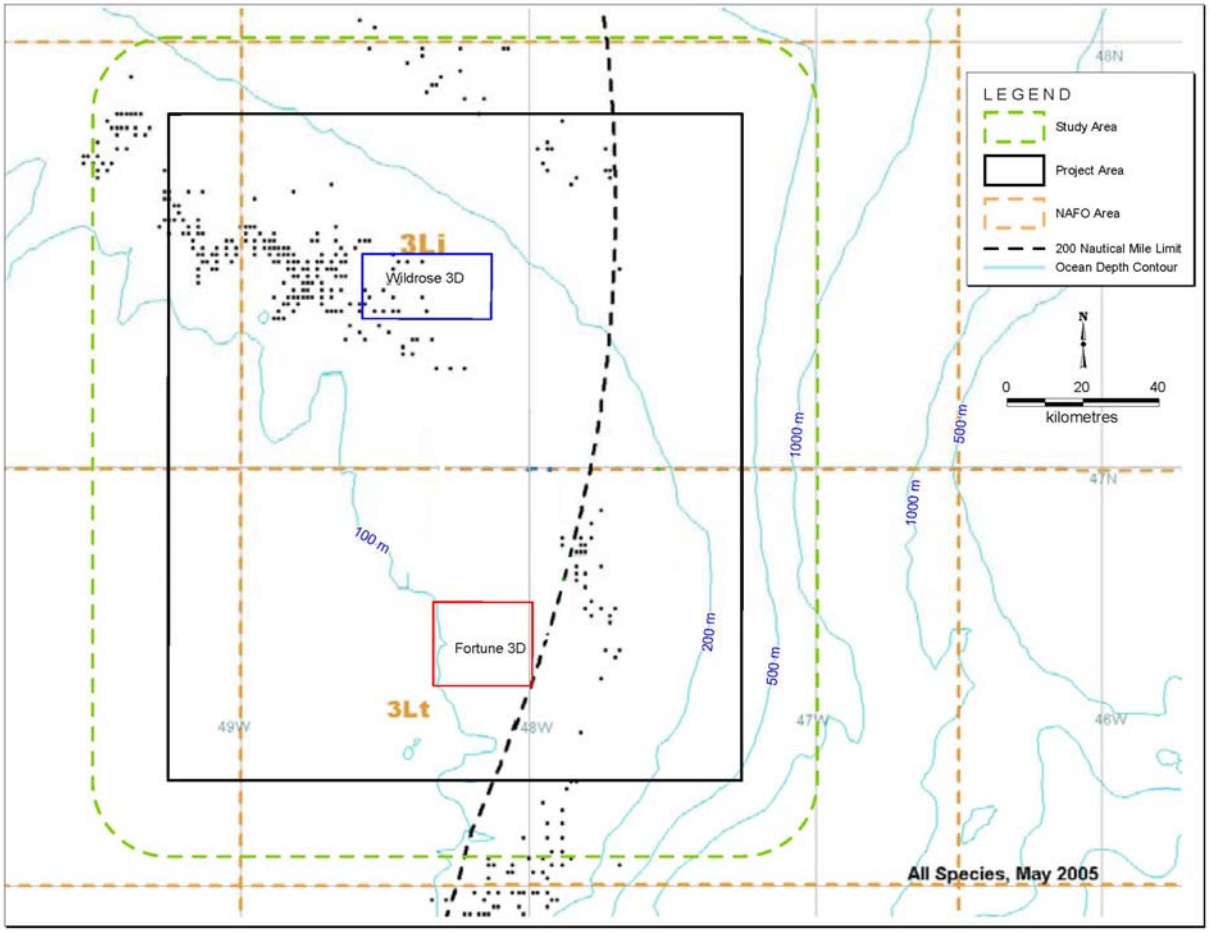

Figure 1. Distribution of "All Species" Catches in May 2005.

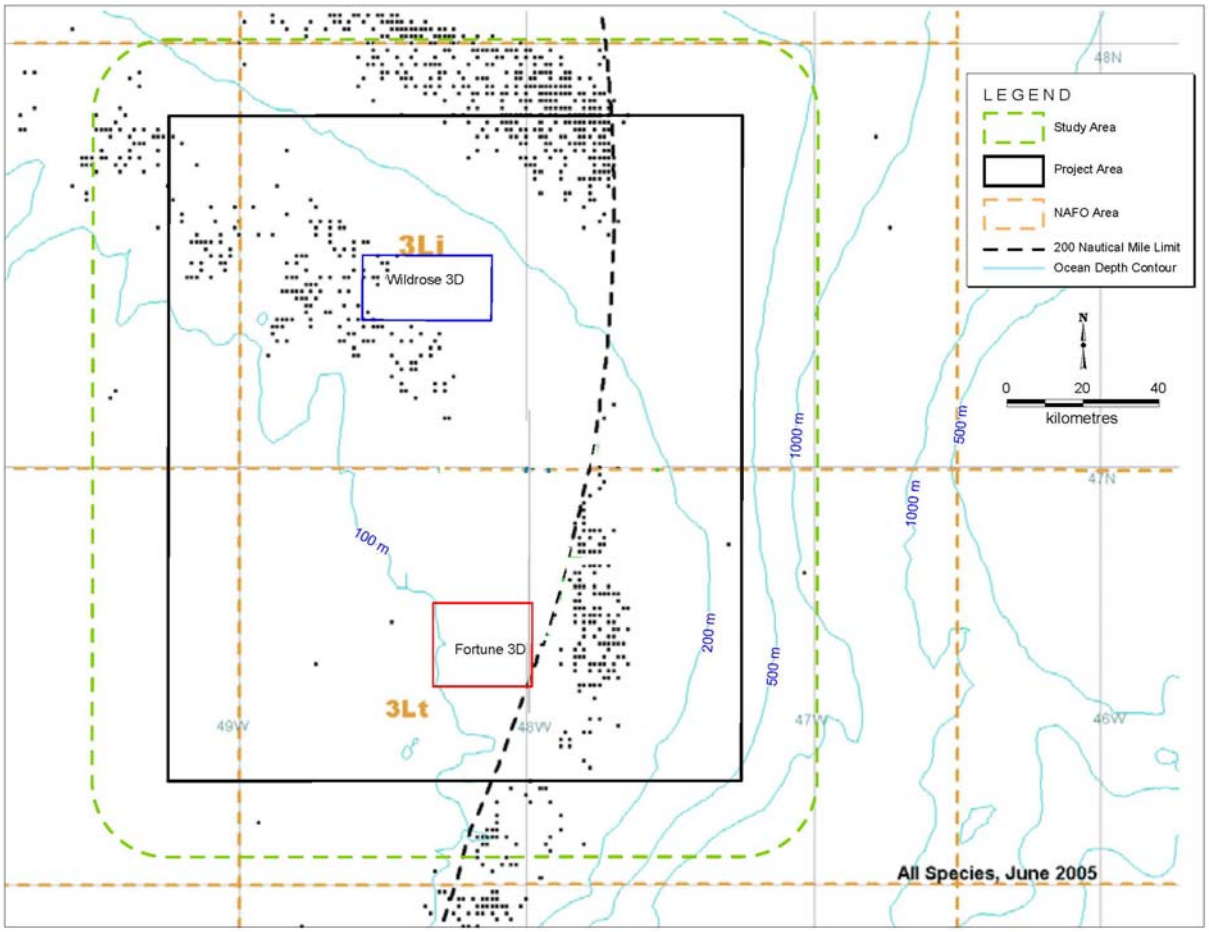

Figure 2. Distribution of “All Species” Catches in June 2005.