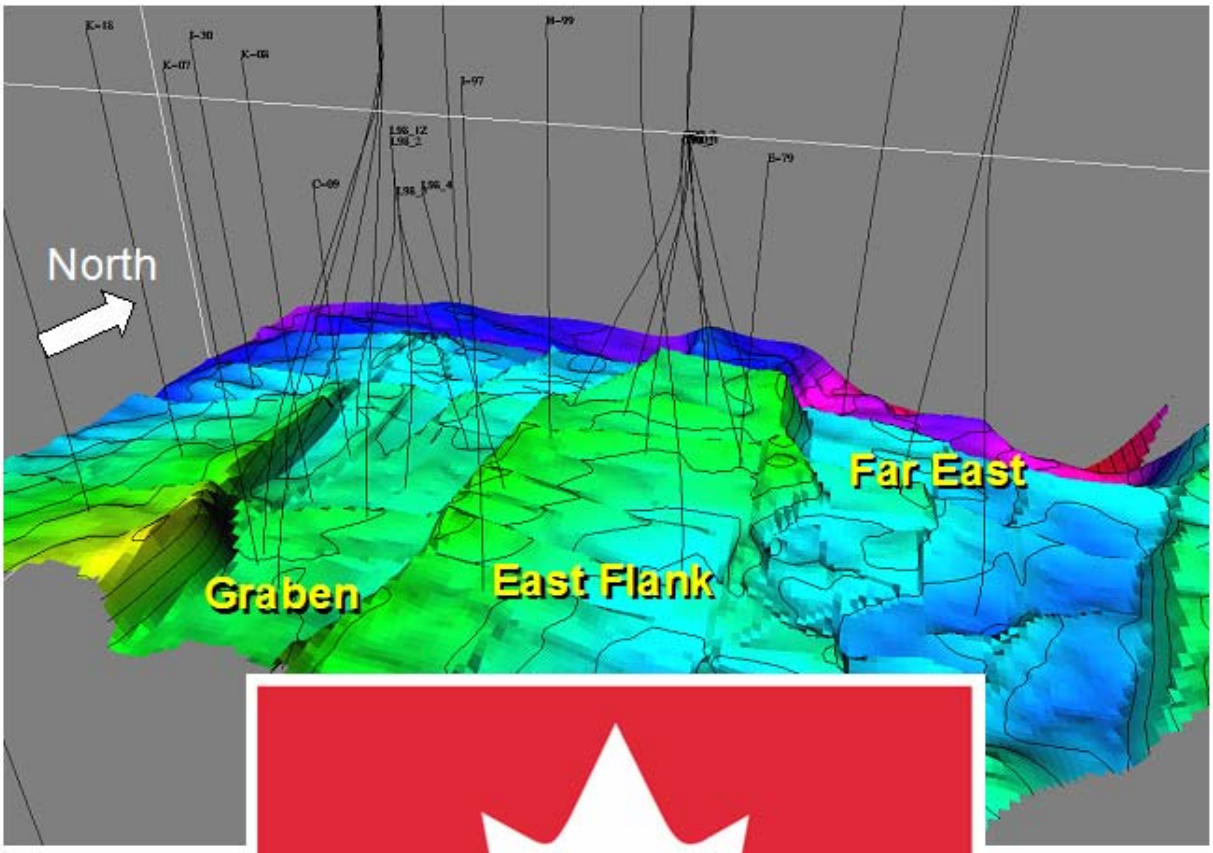
Vertical Seismic Profiling
Environmental Assessment
Terra Nova Development



PETRO-CANADA

Vertical Seismic Profiling Environmental Assessment Terra Nova Development

Prepared by

LGL Limited
environmental research associates
P.O. Box 13248, Stn. A
St. John's, NL A1B 4A5
709-754-1992 (p)
709 754-7718 (f)

Prepared for

Petro-Canada
235 Water Street
St. John's, NL A1C 1B6

June 2006

LGL File SA890

Suggested format for citation:

LGL Limited. 2006. Vertical Seismic Profiling Environmental Assessment Terra Nova Development. LGL Rep. SA890. Rep. by LGL Limited, St. John's, NL, for Petro-Canada, St. John's, NL. 55 p.

Table of Contents

Page

List of Figures

List of Tables

1.0 Introduction

Petro-Canada proposes to undertake vertical seismic profiling (VSP) activities at its Terra Nova Development in the Jeanne d'Arc Basin (see Figure 1) in support of remaining delineation and production wells at Terra Nova. This document provides a description of the proposed VSP activities that may occur for the duration of the life of the Terra Nova Development. Vertical seismic profiling consists of an airgun array sound source, typically less powerful than those used during routine seismic surveys, deployed at locations near the rig with receivers placed in the well. The purpose of the technique is to tie in or ground-truth the geological data with geophysical information. The technique is described in detail below.

This document builds upon the original environmental assessment (EA) of VSP activities at Terra Nova submitted in March 2004 (LGL 2004a) and wellsite geohazard survey EAs (LGL 2004b, 2005). The reviewer is referred to the EIS and associated documents for detailed information on the Terra Nova Development and associated activities, the biophysical environment, and the effects assessment for activities other than VSP (Petro-Canada 1996 a,b, 1997, 1998). Additional relevant information is also contained in the *Terra Nova Baseline Environmental Characterization Data Report* (Petro-Canada 1998).

2.0 Project Description

2.1 Contacts at Petro-Canada

Relevant contacts at Petro-Canada for the VSP activities and related documentation include:

Executive Contact:

William Fleming
Asset Manager, Terra Nova
Scotia Centre, 235 Water Street
St. John's, NL
A1C 1B6
Telephone: 709 778-3541

Drilling Contact:

Jason Evans
Well Design Lead
Petro-Canada East Coast Operations
Suite 201, Scotia Centre
235 Water Street
St. John's, NL
(709) 778-3684
Email: jevans@petro-canada.ca

Environment Contact:

Urban Williams
Petro-Canada
235 Water Street
St. John's, NL
A1C 1B6
Phone: (709) 778-3764
Email: uwilliams@petro-canada.ca

2.2 Regulatory Context

'Check shots,' of which VSP surveys can be considered an extension (A. Kaderali, Husky, pers. comm.), are now required by the Canada-Newfoundland and Labrador Offshore Petroleum Board (C-NLOPB or the 'Board'). The following is excerpted from the *Joint Guidelines Respecting Data Acquisition and Reporting* (C-NOPB and C-NSOPB 2003).

"A check shot survey is required for all exploration and delineation wells. The Board, in consultation with the operator, may request the operator to acquire a vertical seismic profile (VSP), where it would contribute to resolving uncertainty associated with seismic interpretation.

It is likely that geophysical surveys will be needed in some development wells to acquire additional control for the seismic interpretation of the field. In such instances, the Board may request that an operator conduct such survey(s) should they be necessary."

The Board is mandated by the *Atlantic Accord Implementation Act*. Offshore seismic on federal lands is now subject to screening under the *Canadian Environmental Assessment Act (CEAA).* Because seismic survey activities have the potential to affect seabirds, marine mammals, and fish and fisheries, Fisheries and Oceans and Environment Canada are the primarily interested agencies. Relevant environmental legislation, in addition to *CEAA*, includes the *Fisheries Act*, the *Oceans Act* the *Migratory Bird Act* and the *Species at Risk Act* (*SARA).* As the VSP will be conducted from the drill rig with the assistance of a typical standby supply vessel, there are no new issues related to the *Navigable Waters Act* other than those already considered under the Terra Nova Development EIS.

2.3 Rationale

The VSP surveys are required to meet C-NLOPB and operator requirements. The surveys ground-truth the geological data with the geophysical data.

2.4 Alternatives to the Project

As the VSP surveys are a regulatory requirement by the Board and a technical requirement for operations, there is no alternative to them *per se*. However, there are alternatives within the project in the form of different types of VSP survey as described below.

2.5 Location and Water Depth

The locations of the VSP surveys are within the Terra Nova Development area about 350 km east-southeast of St. John's (Figure 1). Water depths in the Terra Nova area range from 90 m to 95 m.

2.6 Physical Site Conditions

Meteorological and oceanographic conditions are described in detail in Petro-Canada (1996 a,b) and are not repeated here.

2.7 Site layout

The site layout for the Terra Nova Development wells is shown in Figure 2. This area can be considered to be the Project Area and includes all of Petro-Canada's production licenses.

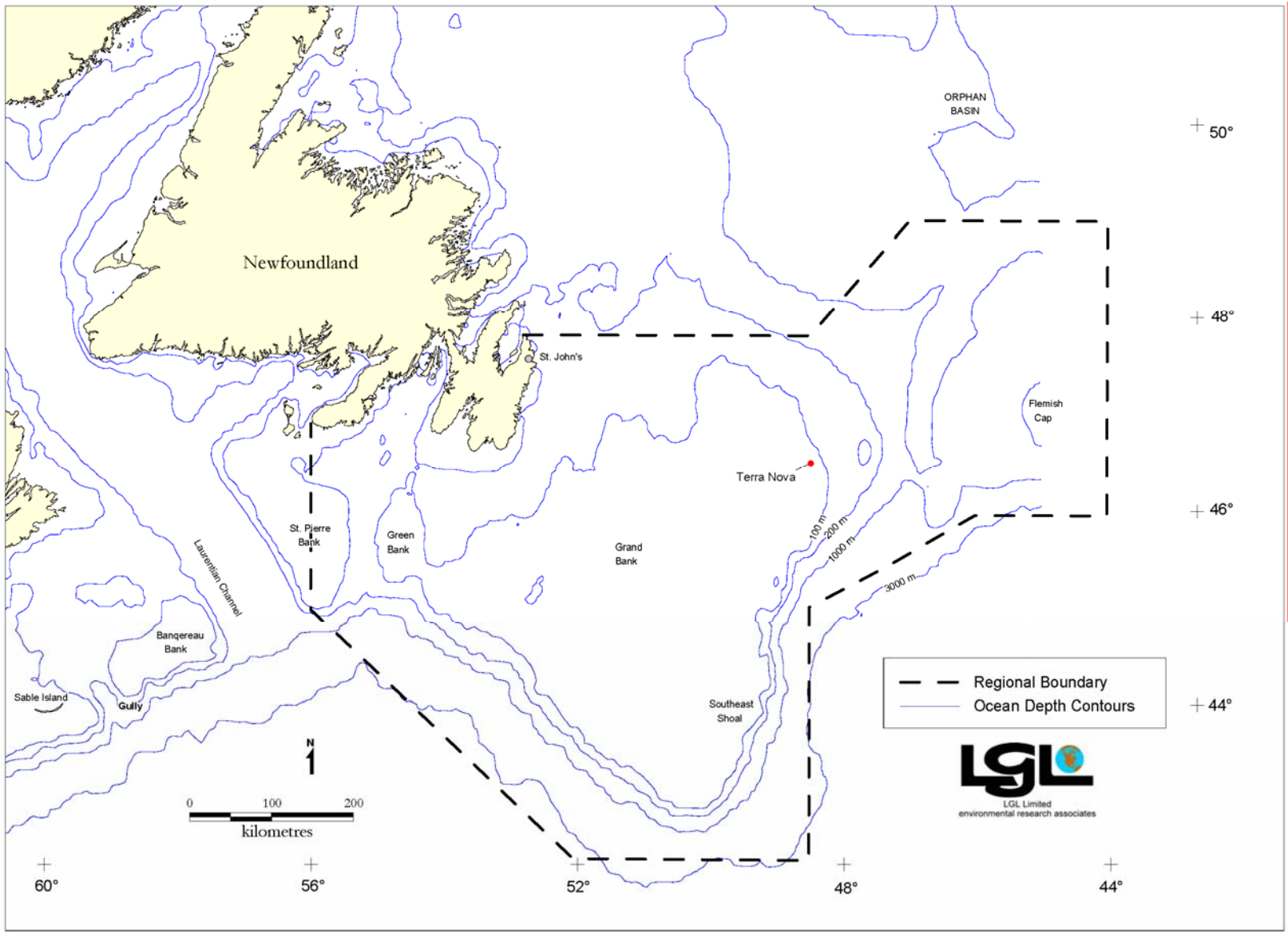


Figure 1. Location of Terra Nova Development and Associated VSP Activities.

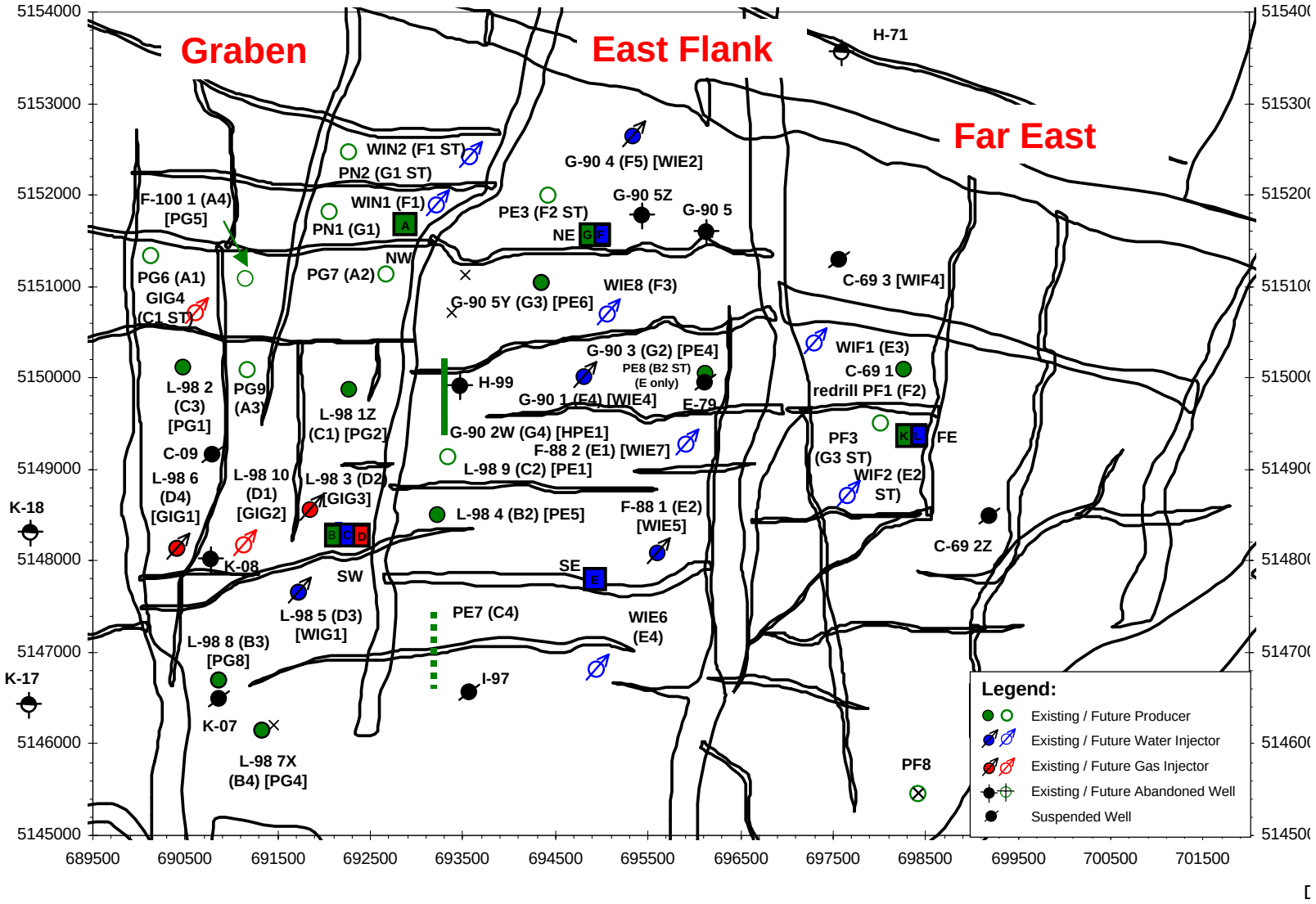


Figure 2. Terra Nova Development Site Layout.

2.8 Scheduling

VSP surveys typically occur during the summer season (although they could occur at any time throughout the year) and will continue on an as-needed basis for the life of the Terra Nova Development project.

2.9 Description of Activities

During the life of the Terra Nova Development, Petro-Canada intends to conduct VSP activities at its wells at Terra Nova (see Figure 2) on an as-needed basis. In the current program with the *Henry Goodrich*, there are six more wells to be drilled. This is the current base case scenario and may change as wells are drilled (J. Evans, Petro-Canada, pers. comm.). The VSP is used to measure acoustic waves between a well bore and the surface. It differs from surface seismic in that it has higher resolution and can provide wave fields *in situ*. This permits calibration of surface seismic data and provides "images" within the vicinity of the well bore that could otherwise not be defined by surface seismic data.

A VSP can be regarded as an extension of a 'checkshot survey'. Typically, the same source and downhole receivers are used for both types of survey. The difference is in the higher spatial sampling and longer recording time for VSPs versus checkshots. Acquisition times are dependent on the type of VSP and acquisition tool but they normally vary between 8-36 hours per well.

2.9.1 Checkshots

A checkshot can be defined as measurement of travel time between the surface and a given depth. This is achieved by placement of a downhole geophone that records direct arrivals, at defined depths in a well. A hydrophone monitors the signature and timing of the source signal. Several shots are usually acquired at the same level (depth) and stacked in order to improve the signal-to-noise ratio. Checkshots are usually acquired at the tops of significant formations, at the top of the sonic log, above and below the casing shoe and at zones where the borehole is in bad condition.

Sonic logs are calibrated by reference to check shot surveys to correct the velocities obtained by the integration of the sonic interval transit times. The calibrated sonic log may then be used for the translation of surface seismic time into depth and for the generation of synthetic seismograms and for other applications.

2.9.2 ZVSP (Zero-offset VSP)

This is the basic type of VSP that is normally acquired for vertical or near-vertical wells. The source is placed at a fixed distance of between 40 m and 125 m offset from the wellhead. Wherever possible, the source is deployed from the drill rig.

2.9.3 DVSP (Deviated VSP)

This is a variation on the ZVSP above due to deviation of the well trajectory. For this type of VSP, the source is positioned at several (usually between one and three) fixed distances of between 40 m and the maximum horizontal displacement of the well. Wherever possible, the source is deployed from the drill rig. A vessel for the source may be used if the well trajectory is such, that offsets are required that cannot be attained from the rig.

2.9.4 OVSP (Offset VSP)

In addition to a ZVSP or DVSP, a VSP may be acquired in the same well with the source positioned in any direction at fixed distances between 500 m and 2.0 km from the wellhead. In this case, the source would be deployed off a vessel.

2.9.5 Walkaway VSP

For a Walkaway VSP the source is deployed at uniform intervals (between 15 m and 100 m) in particular directions from the wellhead for distances of up to 5.0 km. In the case of a Walkaway VSP only a limited number of receiver levels would be acquired (usually between 8 to 40) and in a particular zone only. The source would be deployed from a vessel in this case.

2.9.6 VSP Method Proposed for Terra Nova

The sound source to be used at Terra Nova will include a four sleeve-gun tuned array comprised of 2x 100 in^3 and 2x 150 in^3 guns for a total volume of 500 in^3. The guns will be charged with nitrogen or compressed air, suspended at a constant depth of four to seven metres, depending on sea-state and operated at 2,000 psi pressure. The 0-to-peak source level is 8.45 Bar-m which converts to 238.5 dB re 1 µPa 0-P @ 1 m; maximum output occurs between 20 and 140 Hz (R. Dugal, Petro-Canada, pers. comm.).

The Terra Nova VSP surveys may range from a zero-offset VSP (i.e., fixed distance from the wellhead) with the source deployed from the rig to a walkaway VSP (uniform intervals up to 5.0 km from the rig). At each well, the survey would be a one-time event potentially occurring as early as July 2006 (and occurring over the life of the project) and extend for eight to 36 hours per survey.

Petro-Canada's preference is to use the Baker Atlas Multi-Level Receiver (MLR) tool as a receiver. The MLR tool is generally deployed with five receivers at a spacing of 15 metres between tools but can also be deployed with up to thirteen receivers if required. The MLR tool can be used in both open hole and cased hole environments. Alternatively, a Slim-Hole Receiver (SHR) tool is available if borehole conditions warrant its use. A normal job using the standard MLR configuration would result in the acquisition of up to 400 levels (R. Dugal, Petro-Canada, pers. comm.).

2.10 Mitigations

Prior to the onset of VSP, the airgun array will be gradually ramped up. The smallest airgun will be activated first and then the volume of the array will be increased gradually over a recommended 20 to 30-min period. An observer aboard the rig with the seismic source will watch for marine mammals and sea turtles 30 min prior to ramp-up. If a marine mammal or sea turtle is sighted within 500 m of the array then ramp-up will not commence until the animal has moved beyond the 500 m zone. The observers will watch for marine mammals and sea turtles when the airgun array is active and note the location and behaviour of these animals. Any dead or distressed marine mammals or turtles will be reported immediately to the C-NLOPB and DFO.

3.0 Valued Ecosystem Components (VECs)

The VECs considered in this EA include

- Commercial fish and fisheries
- Seabirds
- Marine mammals
- Species at risk

3.1 Commercial Fisheries/DFO and Industry Surveys

The Terra Nova Development occurs in NAFO Unit Area (UA) 3Lt. This update focuses on any new information or changes since the completion of recent EAs for the area (LGL 2004a,b; LGL 2005, LGL 2006).

3.1.1 Data Sources

This update is based on an analysis of 2005 DFO catch and effort data (LGL 2006). The DFO catch and effort data utilized are from DFO Newfoundland and Labrador Region and DFO Maritimes Region. They were supplied in digital form by the Statistics Division (NL) and Commercial Data Division (Maritimes) in February 2006.

3.1.2 Domestic Fisheries in 2005

Commercial harvesting in 3Lt in 2005 was very similar to that in 2004. Snow crab accounted for essentially all of the harvest in the vicinity of the Project Area. Spatial and temporal aspects of the crab harvest in 2005 were similar to those observed in 2004. Most of the crab harvested in 3Lt was caught in the eastern part of the UA, east of the project Area. In terms of timing, most 2005 crab harvesting occurred between May and July, just as in 2004. The difference in 2005 was that July was peak harvest time compared to May/June in recent years. This was likely due to the delayed start of the snow crab fishery in 2005. The 3Lex and 3L200 snow crab fisheries closed officially on 31 July 2005, though some of the harvest was not landed until the beginning of August. Snow crabs are harvested in 3Lt using bottom-fished crab pots/traps (fixed gear).

3.1.2.1 Snow Crab

Snow crab (*Chionoecetes opilio*) in the northwest Atlantic occurs over a broad depth range (20 to >400 m). The distribution of this crustacean in waters off Newfoundland and southern Labrador is widespread but the stock structure remains unclear (DFO 2006). While commercial-sized snow crabs (≥95 mm carapace width (CW)) typically occur on mud or mud/sand substrate, smaller snow crabs are often found on harder substrates as well as on the softer ones. Snow crab mating generally occurs during the spring months. Depending on location, female snow crabs carry the fertilized eggs for one to

two years prior to larval hatch. Hatching normally occurs in late spring and summer after which time the larvae remain planktonic for up to three to four months before settling to the benthic habitat (DFO 2006). Snow crab diet includes fish, clams, polychaetes, brittle stars, shrimp, crabs and other crustaceans. Common predators of snow crabs include various ground fish, seals and snow crabs themselves (DFO 2006).

Based on recent DFO multispecies bottom trawl surveys data, fishery logbook data and observer sampling data, there are indications of decline of both exploitable biomass and recruitment in NAFO Divisions 2J3KL. There has also been an apparent contraction of resource within these Divisions during recent years (DFO 2006).

3.1.3 2006 Fisheries

No significant changes in the domestic fisheries in the vicinity of the Project Area are expected in 2006.

3.1.4 DFO Science and Industry Surveys

Fisheries research surveys conducted by DFO, and sometimes by the fishing industry, are important to the commercial fisheries to determine stock status, as well as for scientific investigation. There is some potential for overlap with the DFO research vessel (*R/V Teleost*) survey in 3KL this year. Table 1 provides the relevant 2006 DFO research survey schedule plan for Newfoundland and Labrador Region as of 2 June 2006 (J. Tillman, DFO St. John's, pers. comm.). Effects on DFO research are unlikely but the Proponents will communicate with DFO on this issue.

FFAWU biologists have recently 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 typically takes place in September.

3.2 Avifauna in Terra Nova Development Area

The avifauna community of the Terra Nova Development Area is composed mainly of true pelagic species. The area lies on the eastern Grand Banks just inside two hundred nautical mile limit. This is beyond the range of most species not fully adapted for prolonged periods on the open sea. Even most members of the Laridae family (gulls) do not range as far off shore as the Terra Nova Development Area. The main species groups that occur in the Project Area are Procellariidae (fulmars and shearwaters), Hydrobatidae (storm-petrels), Sulidae (gannets), Phalaropodinae (phalaropes), Laridae (skuas, jaegers, gulls and terns) and Alcidae (auks) (Table 2).

The avifaunal richness of the Grand Banks is demonstrated by the high numbers of seabird colonies on the Avalon Peninsula and the northeast coast of Newfoundland. The nearly five million pairs of seabirds nesting at these colonies use the waters off eastern Newfoundland for feeding and the rearing of young (Table 3). These birds plus their young and non-breeding sub-adults use the Grand Banks for at

Table 1. DFO Science Survey Schedule, Newfoundland and Labrador, 2006.

Scientist	Trawler	Survey Type	Start	End	Days
Stevens	Teleost	Hydroacoustic Calibrations	06-Jun-06	10-Jun-06	5
Pepin	Teleost	IGP-Calanus-Grand Banks	11-Jun-06	23-Jun-06	13
Mowbray	Teleost	IGP-Forage Fish-SE Shoal GB	24-Jun-06	10 Jul-06	17
Colbourne	Teleost	Oceanography	11-Jul-06	28-Jul-06	17
Brodie	Teleost	Multi-species 2J 3KLMNO (and possibly 2H)	03-Oct-06	13-Oct-06	11
			13-Oct-06	24-Oct-06	12
			24-Oct-06	07-Nov-06	15
			07-Nov-06	21-Nov-06	15
			21-Nov-06	05-Dec-06	15
			05-Dec-06	19-Dec-06	15
Brodie	Templeman/Needler	Multi-species 3LNO	10-Jun-06	21-Jun-06	12
Brodie	Templeman/Needler	Multi-species 3LNO	21-Jun-06	30-Jun-06	10
Stevens	Templeman/Needler	Hydroacoustic Calibrations	04-Jul-06	07-Jul-06	4
Payne	Templeman/Needler	Hibernia Environmental Monitoring	10-Jul-06	24-Jul-06	15
Anderson	Templeman/Needler	NSERC/Ecosystem	1-Aug-06	19-Aug-06	19
Pepin	Templeman/Needler	IGP-Calanus-Grand Banks	20-Aug-06	2-Sep-06	14
Brodie	Templeman/Needler	Gear Trials	26-Sep-06	29-Sep-06	4
Brodie	Templeman/Needler	Multi-species – Grand Banks	29-Sep-06	10-Oct-06	12
			10-Oct-06	24-Oct-06	15
			24-Oct-06	7-Nov-06	15
			7-Nov-06	21-Nov-06	15
			21-Nov-06	5-Dec-06	15
			5-Dec-06	19-Dec-06	15

Table 2. Species Occurring in Project Area and Predicted Monthly Abundances.

Common Name	Scientific Name	Monthly Abundance											
		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Procellariidae													
Northern Fulmar	*Fulmarus glacialis*	C	C	C	C	C	C	C	C	C	C	C	C
Greater Shearwater	*Puffinus gravis*					C	C	C	C	C	C	U	
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*				C	C	C	C	C	C	C	S	
Sulidae													
Northern Gannet	*Morus 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		
Parasitic Jaeger	*Stercorarius parasiticus*					S	S	S	S	S	S		
Long-tailed Jaeger	*Stercorarius longicaudus*					S	S	S	S	S			
Herring Gull	*Larus argentatus*	S	S	S	S	S	S	S	S	S	S	S	S
Lesser Black-backed	*Larus fuscus*				VS	VS	VS	VS	VS	VS	VS	VS	
Iceland Gull	*Larus glaucoides*	S	S	S	S						S	S	S
Glaucous Gull	*Larus hyperboreus*	S	S	S	S	S						S	S
Great Black-backed Gull	*Larus marinus*	U	S	S	S	S	VS	VS	S	U	U	U	U
Ivory Gull	*Pagophila eburnea*		VS	VS									
Sabine's Gull	*Xema sabini*					VS	VS	VS	VS	VS			
Black-legged Kittiwake	*Rissa tridactyla*	C	C	C	C	C	S	S	S	S	C	C	C
Arctic Tern	*Sterna paradisaea*					S	S	S	S	S			
Alcidae													
Dovekie	*Alle alle*	U	U	U	U	U	S	VS	VS	VS	U	U	U
Common Murre	*Uria aalge*	S	S	S	S	S	S	S	S	S	S	S	S
Thick-billed Murre	*Uria lomvia*	U	U	U	U	U	S	VS	VS	VS	U	U	U
Atlantic Puffin	*Fratercula arctica*					S	S	S	S	S	S	S	

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

Table 3. Number of Pairs of Seabirds Nesting at Seabird Colonies in Eastern Newfoundland.

Species	Wadham Islands	Funk Island	Cape Freels and Cabot Island	Baccalieu Island	Witless Bay Islands	Cape St. Mary's	Middle Lawn Island	Corbin Island	Green Island
Procellariidae									
Northern Fulmar	-	13[a]	-	20[a]	40[a,f]	Present[a]	-	-	-
Manx Shearwater	-	-	-	-	-	-	100[a]	-	-
Hydrobatidae									
Leach's Storm-Petrel	1,038[d]	-	250[a]	3,336,000[a]	621,651[a,f]	-	26,313[a]	100,000[a]	72,000[a]
Sulidae									
Northern Gannet		9,837[b]		1,712[b]	-	6,726[b]	-	-	-
Laridae									
Herring Gull	-	500[a]	-	Present[a]	4,638[a,e]	Present[a]	20[a]	5,000[a]	-
Great Black-backed Gull	Present[d]	100[a]	-	Present[l]	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)

least part of the year. It is thought that migrant seabirds outnumber local breeders on the Grand Banks at all seasons (Lock et al. 1994). Seabirds that nest in Labrador, the Canadian Arctic and Greenland, especially Northern Fulmars, Thick-billed Murres, Dovekies, and Black-legged Kittiwakes migrate through eastern Newfoundland waters or spend the winter there. In addition, millions of marine birds, mostly Greater Shearwaters, migrate from the Southern Hemisphere to spend the summer in eastern Newfoundland waters, especially the Grand Banks.

The Ivory Gull is the only bird listed on *SARA* (Species of Concern on Schedule 1) that might occur in the Study Area in winter or early spring (January-April). The Ivory Gull lives among the pack ice and thus may occur in the Terra Nova Development Area in late winter if and when the pack ice reaches the southern limit for the year. It would likely be a rare and less than annual occurrence in the Terra Nova Development Area.

3.2.1 Seasonal Occurrence and Abundance of Seabirds

Table 2 summaries the abundance status by month for each species expected to occur regularly in the Terra Nova Development Area. Information was derived from Brown (1986), Lock et al. (1994), Baillie et al. (2005), Moulton et al. (2005) and Moulton et al. (2006b). The table uses categories to define a relative abundance of seabirds species observed. Four categories of abundance were used: Common, Uncommon, Scarce and Very Scarce. Common = expected daily in moderate to high numbers,

Uncommon = expected regularly in small numbers, Scarce = a few individuals expected and Very Scarce = very few individuals. Overall world populations a species is taken into consideration for example Greater Shearwater are far more numerous on a world wide scale compared to a predator like the Long-tailed Jaeger.

3.2.1.1 Procellariidae (fulmars and shearwaters)

Northern Fulmar and Greater Shearwater are two of the most abundant species on the Terra Nova Development Area. In the northwest Atlantic Northern Fulmar breeds mainly in the Arctic and Greenland. It is present year around in Newfoundland waters but is more abundant in winter. Greater and Sooty Shearwater breed in the Southern Hemisphere and come to Newfoundland in the summer during their non-breeding season to moult. A significant percentage of the total world population Greater Shearwater migrates to eastern Newfoundland, particularly the Grand Banks for the annual moult in June and July (Lock et al. 1994). Manx Shearwater is a European species with a small population in Atlantic Canada. It is relatively rare on the Terra Nova Development Area.

3.2.1.2 Hydrobatidae (storm-petrels)

Two species of storm-petrel occur in Atlantic Canada. They are absent from Atlantic Canada in winter. Leach's Storm-Petrel is an abundant breeder in eastern Newfoundland (Table 3). It is common in most Newfoundland waters during the summer months and it is the species most commonly associated with stranding on vessel decks. Wilson's Storm-Petrel visits the Northern Hemisphere from May to October

after breeding in the Southern Hemisphere. The Terra Nova Development Area is on the northern limit of its range.

3.2.1.3 Sulidae (gannets)

Northern Gannet

Northern Gannet is the only member of the Sulidae family to occur in Newfoundland. Three of the five major Northern Gannet colonies in North America are located in eastern Newfoundland at Cape St. Mary's, Baccalieu Island and Funk Island (Table 3). Gannets usually feed in shelf waters. Northern Gannet is expected to be a scarce visitor to the Terra Nova Development Area, May to October.

Phalaropodinae (phalaropes)

Red Phalarope and Red-necked Phalarope breed in the Arctic to sub-Arctic in North America and Eurasia. Phalaropes migrate at sea and both species winter at sea in the Southern Hemisphere. The two phalarope species are often difficult to distinguish at sea. Red Phalarope usually outnumbers Red-necked Phalarope in Newfoundland waters (Brown 1986). Phalaropes seek out areas of upwelling and convergence where rich sources of zooplankton are found. Red and Red-necked Phalarope are expected to be very scarce to scarce in the Terra Nova Development Area from May to September.

Stercorariidae (Skuas and Jaegers)

Skuas

The two species of skua known to occur in the northwest Atlantic have been recorded on the Terra Nova Development Area. Great Skua breeds in the Northern Hemisphere in Iceland and northwestern Europe. South Polar Skua breeds in the Southern Hemisphere and migrates to the Northern Hemisphere for the non-breeding season. Skuas are among the most difficult species to identify in the north Atlantic. Both species are expected to be scarce in the Terra Nova Development Area, May to October.

Pomarine, Parasitic and Long-tailed Jaeger are closely related species with similar habits and difficult to separate in the field. All three species of jaeger nest in the sub-Arctic to Arctic in North America and Eurasia and winter at sea in the middle latitudes of the Pacific and Atlantic oceans. Sub-adults usually don't migrate all the way back to the breeding grounds. Some are present in Newfoundland waters all summer. All three species of jaeger are expected to be scarce in the Terra Nova Development Area from May to October.

3.2.1.4 Laridae (Gulls)

Seven species of gull are expected to occur annually in the Terra Nova Development Area. They are Great Black-backed, Herring, Glaucous, Iceland, Lesser Black-backed, and Sabine's Gull and Black-legged Kittiwake. Great Black-backed Gull and Herring Gull are land based gulls breeding in

Newfoundland. Small portions of the overall population live at sea during the non-breeding season. Great Black-backed Gull was fourth in abundance of all birds recorded from fixed platforms on the Grand Banks, 1999-2002 (Baillie et al. 2005). Glaucous Gull and Iceland Gull breed in the low Arctic and include Newfoundland as part of their wintering grounds. They occur regularly offshore in small numbers during the winter. Black-legged Kittiwake breeds at seabird colonies in eastern Newfoundland and Arctic Canada and winters at sea (Table 3). It is common most of the year on the Grand Banks. Sabine's Gull (May-September) and Lesser Black-backed Gull (April to November) are regular in very small numbers.

Ivory Gull

Ivory Gull, listed as 'Special Concern' on Schedule 1 of *SARA*, might occasionally occur in the Terra Nova Development Area when pack ice reaches the annual southern extremity in February and March. See Section 13: Species at Risk for additional information.

3.2.1.5 Sterninae (Terns)

The Arctic Tern is only tern species expected in the Terra Nova Development Area. In the eastern North America, the breeding range extends from the Arctic south to Massachusetts. Arctic Terns migrate and winter at sea in the Southern Hemisphere. Arctic Tern is expected to be scarce in the Terra Nova Development Area, May to September.

Alcidae (Auks)

Four species of auks are expected in the Terra Nova Development Area: (1) Dovekie, (2) Common Murre, (3) Thick-billed Murre and (4) Atlantic Puffin. Dovekie and Thick-billed Murre are most numerous in Newfoundland waters during the winter and migration periods. Common Murre and Atlantic Puffin are abundant breeders in Newfoundland but winter mostly south of the Terra Nova Development Area.

Dovekie breeds in the North Atlantic, mainly in Greenland and east to Nova Zemlya, Jan Mayen and Franz Josef Land in northern Russia. Dovekie is an abundant bird with a world population estimated at 30 million (Brown 1986). It winters at sea south to 35°N. A large percentage of the Greenland breeding Dovekies winter in the western Atlantic, mainly off Newfoundland (Brown 1986). Dovekie is expected to be uncommon to occasionally common in fall, winter and spring in the Terra Nova Development Area.

Thick-billed Murre breeds in the sub-Arctic to Arctic regions of North America and Eurasia. In Atlantic Canada, it breeds as far south as Newfoundland. In the western Atlantic, Thick-billed Murre winters in open water within its breeding range and south to New Jersey. Thick-billed Murre is the "winter murre" in eastern Newfoundland. The sources of Thick-billed Murres in Newfoundland are the breeding grounds in the eastern Arctic and Greenland where two million plus pairs breed (Brown 1986, Lock et

al. 1994). Relatively small numbers (~2,000) breed in eastern Newfoundland (Table 3). Thick-billed Murre is expected to be uncommon to occasionally common fall, winter and spring in the Terra Nova Development Area.

Common Murre breeds in the north Pacific and north Atlantic. In the northwest Atlantic, it winters from southern Newfoundland south to Massachusetts. Nearly a half million pairs of Common Murres breed in eastern Newfoundland (Table 3). The maximum distance Common Murres are known to forage from breeding sites is 200 km, placing the Terra Nova Development Area beyond the reach of Newfoundland breeding colonies birds during the breeding season May to July. Common Murre is probably scarce on the Terra Nova Development Area throughout the year.

The Atlantic Puffin breeds in the north Atlantic in Maine, Newfoundland and Labrador, Greenland, Iceland and northwest Europe. In North America, it winters off southern Newfoundland and southern Nova Scotia. About 12 million pairs of Atlantic Puffins breed in the North Atlantic (Brown 1986). About 320,000 pairs nest in Atlantic Canada, mostly in eastern Newfoundland (Table 3). Atlantic Puffin is probably a scarce visitor to the Terra Nova Development Area, May to November.

3.3 Marine Mammals and Sea Turtles

3.3.1 Marine Mammals

At least 20 species of marine mammals may occur in the Project Area including 16 species of cetaceans (whales and dolphins) and three species of phocids (seals) (Husky 2000) (Table 4). Additional marine mammal species may occur rarely. Most marine mammals are seasonal inhabitants, the waters of the Grand Banks and surrounding areas being important feeding grounds for many of them. Recent marine mammal monitoring programs from seismic vessels in the Jeanne d'Arc and Orphan basins provide new information for the area. A marine mammal monitoring program was conducted from 3 October to 6 November 2005 during Husky's seismic program in the Jeanne d'Arc Basin, just north of the Project Area (see "Seismic Area" in Figure 3; Lang et al. in prep.). In the Orphan Basin, marine mammal monitoring was conducted from seismic vessels during the summers of 2004 and 2005 on behalf of Chevron Canada Limited (Moulton et al. 2005, 2006b).

Population estimates and feeding information of many of the marine mammal species that occur within the Project Area are provided in Tables 5 and 6, respectively.

3.3.1.1 Baleen Whales (Mysticetes)

The five species of baleen whales that may occur in the Project Area include the blue, fin, sei, humpback and minke whale (Table 4). It is possible, but highly unlikely, that a North Atlantic right whale may occur in the Project Area. Although nearly all of these species experienced depletion due to whaling, it is likely that many are experiencing some recovery (Best 1993).

Table 4. Marine Mammals Likely to Occur in the Project Area.

Common Name	Scientific Name	COSEWIC Status (*SARA* listing/status)
Baleen Whales	**Mysticetes**	
Blue Whale	*Balaenoptera musculus*	Endangered (Schedule 1)
Fin Whale	*Balaenoptera physalus*	Special Concern (No status; under consideration for addition to Schedule 1)
Sei Whale	*Balaenoptera borealis*	Data Deficient (No status)
Humpback Whale	*Megaptera novaeangliae*	Not At Risk (No status)
Minke Whale	*Balaenoptera acutorostrata*	Not At Risk (No status)
North Atlantic Right Whale	*Eubalaena glacialis*	Endangered (Schedule 1)
Toothed Whales	**Odontocetes**	
Sperm Whale	*Physeter macrocephalus*	Not At Risk (No status)
Northern Bottlenose Whale	*Hyperoodon ampullatus*	Endangered—Scotian Shelf Population (Schedule 1); Not At Risk—Davis Strait Population (No status)
Sowerby's Beaked Whale	*Mesoplodon bidens*	Special Concern (Schedule 3)
Bottlenose Dolphin	*Tursiops truncatus*	Not assessed (No status)
Killer Whale	*Orcinus orca*	Data Deficient (No status)
Long-finned Pilot Whale	*Globicephala melas*	Not assessed (No status)
Short-beaked Common Dolphin	*Delphinus delphis*	Not assessed (No status)
Atlantic White-sided Dolphin	*Lagenorhynchus acutus*	Not assessed (No status)
White-beaked Dolphin	*Lagenorhynchus albirostris*	Not assessed (No status)
Risso's Dolphin	*Grampus griseus*	Not At Risk (No status)
Striped Dolphin	*Stenella coeruleoalba*	Not assessed (No status)
Harbour Porpoise	*Phocoena phocoena*	Special Concern (No schedule or status; referred back to COSEWIC)
True Seals	**Phocids**	
Grey Seal	*Halichoerus grypus*	Not assessed (No status)
Harp Seal	*Phoca groenlandica*	Not assessed (No status)
Hooded Seal	*Cystophora cristata*	Not assessed (No status)

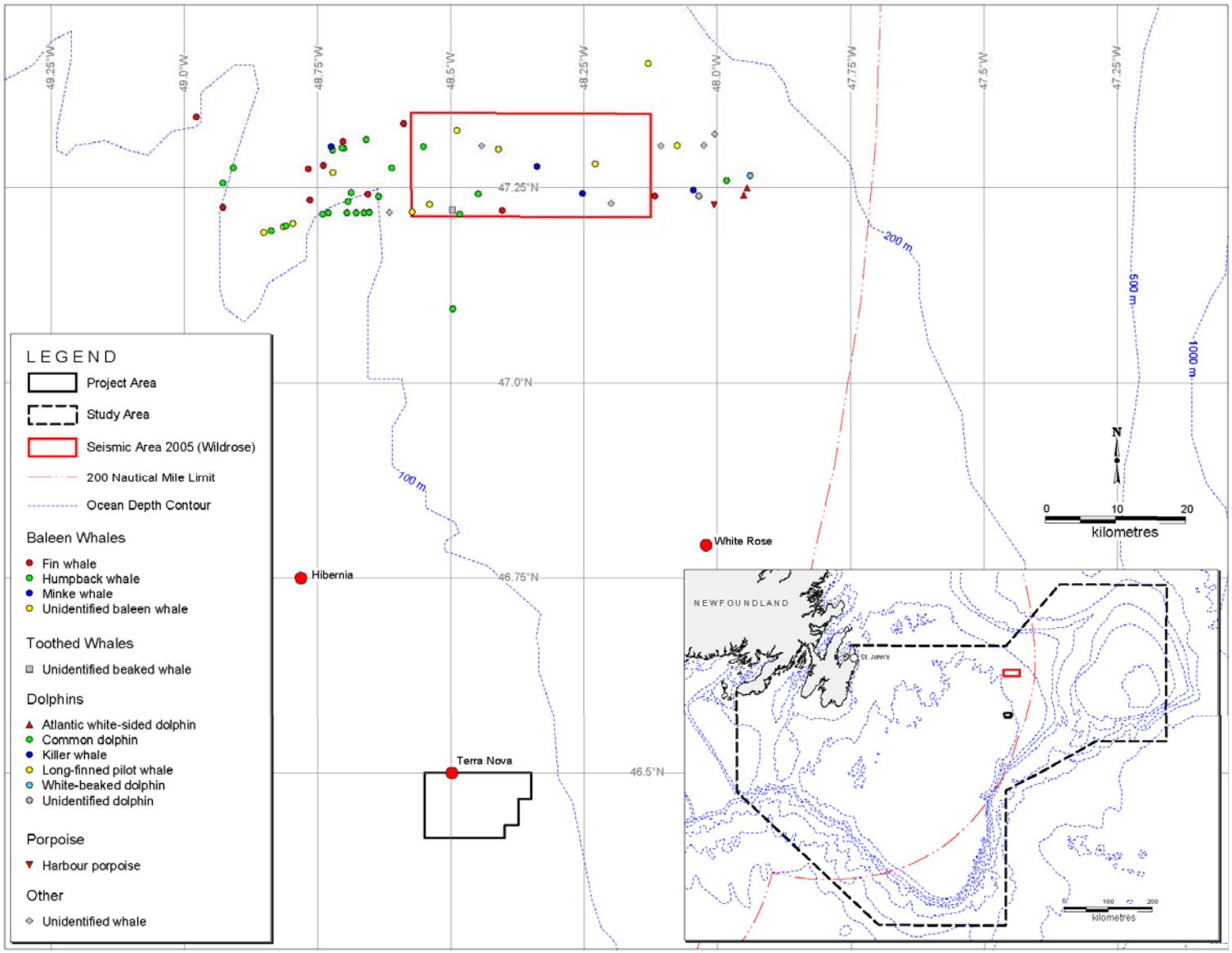


Figure 3. Marine Mammal Sightings made from the MV *Western Neptune* during Husky's Seismic Monitoring Program in the Jeanne d'Arc Basin During October and November 2005 (Lang et al. in prep.). (Note that there was no survey effort at the Terra Nova site.)

Table 5. Population Estimates of Marine Mammals that Occur in the Study Area (updated from Buchanan et al. (2004)).

Species	Northwest Atlantic (NW) Population Size	Population Occurring in the Study Area		
	Estimated Number	Stock	Estimated Number	Source of Updated Information
Baleen Whales				
Blue Whale	308 [a]	NW Atlantic	Unknown	Waring et al. (2004: Appendix III)
Fin Whale	2814 [b]	Can. E. Coast	Unknown	Waring et al. (2004)
Sei Whale	Unknown	Nova Scotia	Unknown	COSEWIC (2004); Waring et al. (2004)
Humpback Whale	5505 (11,570 in North Atlantic)	NF/Labrador	1,700-3,200	Whitehead (1982); Katona and Beard (1990); Baird (2003)
Minke Whale	4018 [c]	Can. E. Coast	Unknown	Waring et al. (2004)
North Atlantic Right Whale	322	NW Atlantic	Unknown	Krauss et al. (2001)
Toothed Whales				
Sperm Whale	4702 [d]	North Atlantic	Unknown	Reeves and Whitehead (1997); Waring et al. (2004)
Northern Bottlenose Whale	Tens of thousands?	North Atlantic	Unknown	Reeves et al. (1993); Waring et al. (2004)
Sowerby's Beaked Whale	Unknown			Katona et al. (1993)
Common Bottlenose Dolphin (offshore stock)	29,774	NW Atlantic	Unknown	Waring et al. (2004)
Risso's Dolphin	30,000	US East Coast	Unknown	Reeves et al. (2003)
Killer Whale	Unavailable		Unknown	Lien et al. (1988); Waring et al. (2004)
Long-finned Pilot Whale	14,524	NW Atlantic	Abundant	Nelson and Lien (1996); Waring et al. (2004)
Short-beaked (Common) Dolphin	30,768	NW Atlantic	Unknown	Katona et al. (1993); Waring et al. (2004)
Atlantic White-sided Dolphin	51,640 [e]	NW Atlantic	Unknown	Palka et al. (1997); Waring et al. (2004)
White-beaked Dolphin	Unknown	NW Atlantic	Unknown	Waring et al. (2004)
Harbour Porpoise	Unknown	Newfoundland	Unknown	Wang et al. (1996); COSEWIC (2004); Waring et al. (2004)
True Seals				
Harp Seal	5.2 (±1.2) million	NW Atlantic	Unknown	DFO (2000)
Hooded Seal	626, 600	NW Atlantic	Unknown	Hammill and Stenson (2000)
Grey Seal	173,500	NW Atlantic	Unknown	Hammill and Stenson (2000)

[a] Based on surveys from the Gulf of St. Lawrence. This estimate deemed unsuitable for abundance estimation.
[b] Based on surveys from George's Bank to the mouth of the Gulf of St. Lawrence.
[c] Based on surveys from George's Bank to the mouth of the Gulf of St. Lawrence plus a survey in the Gulf of St. Lawrence.
[d] Based on surveys from Florida to the Gulf of St. Lawrence.
[e] Gulf of Maine Stock.

Table 6. Summary of Marine Mammal Prey that Occur in the Study Area.

Species	Prey	Source of Updated Information
Baleen Whales		
Humpback Whale	Fish (predominantly capelin), euphausiids	Piatt et al. (1989)
Blue Whale	Euphausiids	
Fin Whale	Fish (predominantly capelin), euphausiids	Piatt et al. (1989)
Sei Whale	Copepods, euphausiids, some fish	
Minke Whale	Fish (predominantly capelin), squid, euphausiids	Piatt et al. (1989)
North Atlantic Right Whale	Euphausiids and other crustaceans	
Toothed Whales		
Sperm Whale	Cephalopods, fish	Reeves and Whitehead (1997)
Northern Bottlenose Whale	Primarily squid, also fish	
Sowerby's Beaked Whale	Squid, some fish	Pitman (2002)
Bottlenose Dolphin	Squid, fish (mackerel, butterfish)	Gaskin (1992a)
Killer Whale	Herring, squid, seals, dolphins, other whales	Lien et al. (1988)
Long-finned Pilot Whale	Short-finned squid, northern cod, amphipods	Nelson and Lien (1996)
Short-beaked (Common) Dolphin	Squid, fish	Katona et al. (1993)
Atlantic White-sided Dolphin	Schooling fish (sand lance, herring), hake, squid	Palka et al. (1997)
White-beaked Dolphin	Fish (cod, capelin, herring), squid	Hai et al. (1996)
Risso's Dolphin	Squid	Reeves et al. (2003)
Harbour Porpoise	Schooling fish (capelin, cod, herring, mackerel)	
True Seals		
Harp Seal	Fish (capelin, cod, halibut, sand lance), crustaceans	Lawson and Stenson (1995); Lawson et al. (1998); Wallace and Lawson (1997); Hammill and Stenson (2000).
Hooded Seal	Fish (Greenland halibut, redfish, Arctic and Atlantic cod, herring), squid, shrimp, molluscs	Ross (1993)
Grey Seal	Fish (herring, cod, hake, pollock), squid, shrimp	Benoit and Bowen (1990); Hammill et al. (1995)

Source: Mobil (1985) with updates where indicated.

Humpback Whale.—The humpback whale has a cosmopolitan distribution. Its migrations between high-latitude summering grounds and low-latitude wintering grounds are reasonably well known (Winn and Reichley 1985). It is by far the most common baleen whale in Newfoundland waters. About 900 humpbacks are thought to use the Southeast Shoal of the Grand Banks as a summer feeding area, where their primary prey is capelin (Whitehead and Glass 1985). Thirteen humpbacks were sighted offshore on the Grand banks during the offshore supply vessel survey in 1999; most of these sightings were in September (Wiese and Montevecchi 1999). Humpbacks were fairly common in the Jeanne d'Arc Basin during marine mammal monitoring of Husky's seismic program to the north of the Project Area (Lang et al. in prep.). There was a total of 27 sightings (35 individuals) in 237 hours of observation during the program, which was conducted during October and early November 2005. Humpback whales were also observed during the summers of 2004 and 2005 in and near the Orphan Basin (Moulton et al. 2005; 2006b).

Recent research on humpbacks suggests genetic as well as spatial segregation between feeding areas within the North Atlantic (Valsecchi et al. 1997). The entire North Atlantic population is estimated at approximately 10,600 individuals (Smith et al. 1999), the northwest Atlantic population at 5,505 individuals (Katona and Beard 1990) and the Newfoundland/Labrador population at 1,700 to 3,200 (Whitehead 1982).

Humpback whales occur relatively commonly within the Study Area, in both shallow (<400 m) and deep (>400 m) areas. In terms of the number of sighting events recorded in the DFO database (DFO 2003c), humpback whales ranked first in Divisions 3K, 3L (inside and outside the EEZ) and 3M, particularly in the portion of Division 3L inside of the EEZ.

The western North Atlantic and North Pacific populations of humpback whale were singly designated by COSEWIC as 'threatened' in April 1982. In April 1985, they were split into separate populations, at which time the western North Atlantic population was designated as 'special concern'. In May 2003, this population was re-examined and subsequently de-listed (i.e., considered 'not at risk').

Blue Whale.—This species is considered Endangered by COSEWIC and is listed as such on Schedule 1 of SARA. More information is found in Section 4 of this report.

Fin Whale.—The fin whale is commonly found on the Grand Banks during summer months (Piatt et al. 1989). Eight fin whales, including two calves, were sighted on the Grand Banks in August 1999, during an offshore supply vessel survey (Wiese and Montevecchi 1999). This species is associated with the presence of capelin, their predominant prey item in these waters (Piatt et al. 1989; Whitehead and Carscadden 1985).

Recent genetic studies indicate that fin whale populations that summer in Nova Scotia, Newfoundland, and Iceland may be genetically distinct from each other (Arnason 1995). The number of fin whales in the northwest Atlantic was recently estimated at approximately 2,800 (Waring et al. 2004). This is lower than estimates from previous reports, but supports the idea that fin whale numbers are decreasing off Newfoundland (Whitehead and Carscadden 1985).

According to the DFO cetacean sightings database, these common visitors to the Study Area have been sighted most often inside the EEZ in both Divisions 3K and 3L, particularly 3L. Fin whale sightings have occurred in both the shallower (<400 m) and deeper (>400 m) areas of the Study Area. During Husky Energy's seismic program in the autumn of 2005 there were ten sightings of fin whales (16 individuals) in 237 observation hours in Jeanne d'Arc Basin (Figure 3; Lang et al. in prep.). The fin whale was regularly observed in the deeper waters of the Orphan Basin during the summers of 2004 and 2005 (Moulton et al. 2005; 2006b).

The fin whale is considered a species of 'special concern' by COSEWIC and is being considered for addition to Schedule 1 of SARA.

Sei Whale.—The sei whale has a cosmopolitan distribution, and prefers temperate oceanic waters (Gambell 1985). Sei whales are known for their high mobility and unpredictable appearances (Reeves et al. 1998). Incursions into nearshore waters of the Gulf of Maine, associated with high copepod densities, are well documented (Payne et al. 1990; Schilling et al. 1992).

No reliable population estimates are available for sei whales. A 1970s estimate for the Nova Scotia stock suggested a minimum population of 870 individuals (Mitchell and Chapman 1977). This population was, until recently, only thought to range as far as the Grand Banks. Based on the DFO cetacean sightings database, no sei whale sightings have been reported in the larger Study Area since 1980. (Fin and sei whales are often hard to distinguish; this could partially explain the low number of reported sei whale sightings.) However, their range is currently known to extend well north of the Study Area. Several sei whales were identified in the Orphan Basin during the summers of 2004 and 2005 (Moulton et al. 2005; 2006b). These observations are the first documented sightings of sei whales in the area since 1980 (Buchanan et al. 2004). In 2004, there were six confirmed sightings consisting of nine individuals which accounted for 13.0% of all baleen whale sightings (11.4% of total baleen whale individuals). In 2005, there were 15 sightings (24 individuals) of sei whales in the Orphan Basin (13.7% of total baleen whale individuals). Sei whales are still considered uncommon in the Project Area. The Atlantic population of the sei whale is considered by COSEWIC as 'data deficient' (COSEWIC 2006).

Minke Whale.—Another baleen whale commonly found on the Grand Banks in summer is the minke whale (Piatt et al. 1989). Eight individuals were sighted along the near-shore half of an offshore supply vessel survey in August and September 1999 (Wiese and Montevecchi 1999). Like the fin whale, the minke whale is associated with the presence of capelin, their predominant prey item in these waters (Piatt et al. 1989; Whitehead and Carscadden 1985). The size of the northwest Atlantic population of minke whales is not well known, but the best available estimate is ~4000 individuals (Waring et al. 2004).

Minke whales commonly occur within the Study Area. Most of the reported sightings (based on the Regional Area defined in Husky 2000) in the DFO database (DFO 2003c) have occurred in Divisions 3K and 3L, inside the EEZ in areas with water depths <400 m. The minke whale was sighted in relatively lower numbers than humpback, fin and sei whales during the 2004 and 2005 monitoring programs in the Orphan Basin (Moulton et al. 2005; 2006b). In the Orphan Basin, minke whales were sighted in water depths ranging from 2208-2452 m. During Husky's 2005 seismic program in Jeanne d'Arc Basin, four individuals of this species were sighted in ELs 1066, 1067 and 1089 in depths of 112 to 164 m (Lang et al. in prep.).

North Atlantic Right Whale.—The North Atlantic right whale is a slow-moving whale prone to collisions with ships. It feeds on krill and other crustaceans. The right whales is among the most endangered whales and today it is distributed only in the northwestern Atlantic and numbers about 300 individuals. Off Atlantic Canada, right whales typically concentrate in the Bay of Fundy and off southwestern Nova Scotia. However, some right whales are known to occur off Iceland and it is possible (although highly unlikely) that may occur in the Project Area. This species is designated endangered by COSEWIC and is listed with this designation on Schedule 1 of the *SARA*.

3.3.1.2 Toothed Whales (Odontocetes)

Eleven species of toothed whales are found in the Study Area (Table 4). These species range from the largest living toothed whale, the sperm whale (at approximately 18 m for an adult male (Reeves and Whitehead 1997)) to one of the smallest whales, the harbour porpoise (at approximately 1.6 m for an average adult (Gaskin 1992b)). Most of these marine mammals occur seasonally in the Study Area and little is known regarding their distribution and population size in these waters. The Scotian Shelf population of the northern bottlenose whale is a priority species under *SARA* due to its 'endangered' designation. However, the Davis Strait population of northern bottlenose whales is not considered at risk by COSEWIC (2006).

Sperm Whale.—Sperm whales have an extensive worldwide distribution (Rice 1989). This species routinely dives to depths of hundreds of metres and may occasionally dive to more than 3,000 m. They apparently are capable of remaining submerged for longer than two hours, but most dives probably last a half-hour or less (Rice 1989). The diet of sperm whales is dominated by mesopelagic and benthic squids and fishes (Reeves and Whitehead 1997).

Population numbers of sperm whales are not known for the NW Atlantic. Reeves and Whitehead (1997) caution that previous population estimates for this species are suspect given their long-distance movements and lack of any clear stock structure. There is evidence that stock delineation in this species may be dependent on the time scale of the measure used, further complicating reliable population estimation (Dufault et al. 1999). The few sightings of sperm whales reported in the DFO cetacean sightings database occurred in Division 3K, beyond the 400 m isobath. Sperm whales are known to feed in deep water and it is possible that they occur regularly beyond the continental shelf. Sperm whales were observed north of the Study Area in the Orphan Basin. There were five sightings in early July 2004 in water depths of 2600-2900 m (Moulton et al. 2005) and 32 sightings in June to October 2005 in water depths of 803-2547 m (Moulton et al. 2006b).

Sperm whales have previously been reported to be associated with areas of high plankton productivity and upwelling, presumably because the squid upon which they feed are in turn feeding on the zooplankton (Cushing 1969 *in* Griffin 1999). If sperm whale occur in or near the Project Area, it is likely that they would be males because females usually do not venture north of 40 degrees latitude (Griffin 1999; Whitehead 2003). Another relevant point is that they may not be highly concentrated as males tend to be more dispersed than females (S. Dufault, LGL, pers. comm.). On the East Coast to the south of Newfoundland, warm-core rings and Gulf Stream fronts have been identified as areas of concentration for sperm whales (Griffin 1999).

Sperm whales are considered 'not at risk' by COSEWIC.

Northern Bottlenose Whale. —Northern bottlenose whales are found only in the North Atlantic, with a total population that may be in the tens of thousands (Reeves et al. 1993). Only a few individuals have been sighted on the Grand Banks. Similar to sperm whales, bottlenose whales can dive for periods well in excess of one hour, and their dives can reach depths of more than 1,000 m. They live primarily in

deep canyon and slope areas, where they prey on squid and deep-sea fishes. They are rarely found in waters less than 500 m deep (Gowans 2002).

The Study Area is within the known range of the northern bottlenose whale. This whale's life history is poorly known and most records from Newfoundland are based on carcasses washed ashore. Water depths in the Study Area do not exceed 500 m, and typically range between 100-200 m. Few bottlenose whales are expected to occur on the relatively shallow Grand Banks. Several bottlenose whales were observed during seismic monitoring programs in Orphan Basin in 2004 and 2005 but all in water depths >1000 m (Moulton et al. 2005; 2006b). None were sighted during the Husky monitoring program in the relatively shallow water of Jeanne d'Arc Basin during the autumn of 2005 (Lang et al. in prep.).

The northern bottlenose whale that inhabits the Scotian Shelf is considered as 'endangered' by COSEWIC whereas the Davis Strait population is considered 'not at risk' (COSEWIC 2006). This species occurs in Newfoundland and Labrador waters but is unknown to what population they belong. It is unlikely that sightings of northern bottlenose whales in the Orphan Basin would be from the Scotian Shelf population as these whales are known to spend most of their time in the Gully, Haldimand and Shortland canyons on the Scotian Slope and their home ranges are thought to be a few hundred kilometers or less (Wimmer and Whitehead 2004).

Sowerby's Beaked Whale.—This beaked whale is also known as the North Sea beaked whale because its distribution appears to be centered there, based on numbers of strandings. In the 1980s, two mass strandings were recorded on the northeast coast of Newfoundland. One involved three animals and the other involved six (Katona et al. 1993). The Study Area lies within the known range of the Sowerby's beaked whale. This beaked whale is also a deep-sea diver that occurs mainly in areas where water depth is 1,000 m or more. As is the case with the northern bottlenose whale, the life history of the Sowerby's beaked whale is not well understood and most Newfoundland records of it involve carcasses washed ashore. There was one sighting (four individuals) of Sowerby's beaked whale in the Orphan Basin in September 2005 in a water depth of 2534 m (Moulton et. al. 2006b). Water depths in the Project Area do not exceed 500 m, and typically range between 100-200 m. Few Sowerby's beaked whales are expected to occur on the relatively shallow Grand Banks. They are considered of 'special concern' by *SARA* (Schedule 3). A single beaked whale was recorded during the Husky seismic program in 2005 in Jeanne d'Arc Basin (Lang et al. in prep.). This whale lacked the prominent melon of the northern bottlenose whale suggesting that it was a Sowerby's or other species of beaked whale. It was seen north of the Project Area in the southwest corner of EL 1067 in 128 m of water (Lang et al. in prep.).

Bottlenose Dolphin.—A north-south migration has been assumed to occur along the east coast of North America, with bottlenose dolphins moving into higher-latitude areas in summer and fall, then moving farther south (or possibly just offshore) for the winter (Selzer and Payne 1988; Gowans and Whitehead 1995). The northern limit of this species range in the summer is likely the Flemish Cap (Gaskin 1992a). It is considered 'not at risk' by COSEWIC. No bottlenose dolphins were identified during the Chevron monitoring program in Orphan Basin in 2004 and there was one sighting (15 individuals) in 2005 (Moulton et al. 2005; 2006b). No bottlenose dolphins were identified during the Husky monitoring program in Jeanne d'Arc Basin in October and November 2005 (Lang et al. in prep.).

Risso's Dolphin.—Risso's dolphin is widely distributed in tropical and warm temperate oceans (Reeves et al. 2003). It is usually found over deep water (>300 m) where they feed almost exclusively on squid. They are abundant worldwide but are probably rare in the in and near the Project Area (Reeves et al. 2003).

Killer Whale. —The killer whale is a year-round resident that is thought to occur in relatively small numbers in the Study Area (Lien et al. 1988). Three killer whales were sighted within 20 km of the White Rose area on August 24, 1999 (Wiese and Montevecchi 1999). On a global basis, killer whales are not endangered. There are no population estimates for the northwest Atlantic. No killer whales were identified during the Chevron Canada Limited monitoring program in Orphan Basin in 2004 and 2005 (Moulton et al. 2005; 2006b). Similarly, no killer whales were sighted in Jeanne d'Arc Basin during Husky's seismic program in the autumn of 2005, although a group was sighted about 100 nmi northeast of the Avalon Peninsula (Lang et al. in prep.).

Long-finned Pilot Whale.—The most common toothed whale in the Study Area and also one of the only year-round residents is the long-finned pilot whale (also known as the Atlantic pilot whale). This species is considered abundant in the Grand Banks area from July through December. However, none were sighted during a recent offshore supply vessel survey (Wiese and Montevecchi 1999). This species was the most abundant marine mammal encountered in the Orphan Basin during the summer of 2004 and 2005(Moulton et al. 2005; 2006b). The northwest Atlantic population probably numbers between 4,000 and 12,000 individuals (Nelson and Lien 1996).

It is a common belief that long-finned pilot whales in the northwest Atlantic prey mainly on short-finned squid in summer. However, this statement is based largely on evidence from inshore waters of Newfoundland (Sergeant 1962), and other evidence suggests that they also prey on a variety of fish species, as well as additional species of cephalopods (especially long-finned squid, *Loligo pealei*) at other times and in other areas (Waring et al. 1990; Overholtz and Waring 1991; Desportes and Mouritsen 1993; Nelson and Lien 1996; Gannon et al. 1997).

Most of the Survey Area (and adjacent areas) pilot whale sightings found in the DFO database (3K, 3L and 3M) were reported in areas where water depth <400 m. It is considered 'not at risk' by COSEWIC.

Short-beaked Common Dolphin.—The short-beaked common dolphin's western North Atlantic range extends from Venezuela and the Gulf of Mexico to Newfoundland. These dolphins occur rather commonly at sea off Newfoundland, usually in groups ranging from 50 to 200 individuals. Most of the population in US waters is located south of Georges Bank in areas where water depth ranges between 100 and 200 m although they do occur out the 2,000 isobath. Short-beaked common dolphins eat a variety of fishes and squids (Katona et al. 1993).

Considering the water depth ranges in areas where this cetacean has been sighted in US waters, short-beaked dolphins could occur in the Project Area. This species was not observed during the 2004 CCL monitoring program in the Orphan Basin (Moulton et al. 2005) but there were nine sightings (88 individuals) in and near Orphan Basin in 2005 (Moulton et al. 2006b). One group of 15 individuals was

sighted in EL 1089 during the autumn 2005 Husky monitoring program in Jeanne d'Arc Basin (Lang et al. in prep.).

Atlantic White-Sided Dolphin.—There are three stocks of Atlantic white-sided dolphins in the northwest Atlantic: Gulf of Maine, Gulf of St. Lawrence, and Labrador Sea. The combined northwest Atlantic population probably numbers 27,000 individuals (Palka et al. 1997). The number of white-sided dolphins in the Study Area is unknown. There were seven sightings of 250 individuals on the Grand Banks in August to September 1999, including several sightings within approximately 30 km of the White Rose site, during an offshore supply vessel surveys (Wiese and Montevecchi 1999). The most easterly recorded sighting for individuals from the northwest Atlantic population occurred on the Flemish Cap (Gaskin 1992c).

Few sightings of this dolphin within the Study Area are recorded in the DFO cetacean sightings database. The sightings that are recorded occurred both inside and outside the 400 m isobath. There were four sightings totaling 70 individuals in the Orphan Basin during the summer of 2004 (Moulton et al. 2005) and 18 sightings (304 individuals) in 2005 (Moulton et al. 2006b). During the Husky monitoring program in October and November 2005, two groups (25 individuals) were sighted to the north of the Project Area in EL 1089 in Jeanne d'Arc Basin (Lang et al. in prep.).

White-beaked Dolphin.—The white-beaked dolphin tends to be a coastal, cool-water species (Reeves et al. 1999). This species seems to remain at relatively high latitudes throughout the fall and winter (Lien et al. 1997), but the nature of their seasonal movements is uncertain. During the summer, approximately 3,500 white-beaked dolphins occur off southern Labrador (Alling and Whitehead 1987). This species was regularly sighted during the 1980-81 Hibernia surveys, primarily during summer (Mobil 1985). There was one sighting totaling five individuals in the Orphan Basin during the summer of 2004 (Moulton et al. 2005) and six sightings (52 individuals) during the summer of 2005 (Moulton et al. 2006b). One group of eight individuals was sighted in Jeanne d'Arc Basin in EL 1089 in 181 m of water during the Husky monitoring program in autumn 2005 (Lang et al. in prep.). There is no reliable population estimate for the northwest Atlantic and the abundance of this species in the Study Area is unknown. The total North Atlantic population may range from high tens of thousands to low hundreds of thousands (Reeves et al. 1999). Ice entrapment is not uncommon in the bays of southern Newfoundland in years when pack ice is heavy (Hai et al. 1996).

Harbour Porpoise. —The harbour porpoise is widely distributed throughout temperate waters, but its population size in Newfoundland waters is unknown (Gaskin 1992b). Harbour porpoises that occur in Newfoundland waters are believed to belong to a separate stock from those in the Gulf of St. Lawrence and Bay of Fundy/Gulf of Maine regions. This is supported by differences in organochlorine contaminant levels, which are lower in Newfoundland animals (Westgate and Tolley 1999), and by differences in mitochondrial DNA haplotype frequencies (Wang et al. 1996). The northwest Atlantic population of harbour porpoise was designated by COSEWIC as 'threatened' in April 1990 but in May 2003, it was downlisted to 'special concern'. Harbour porpoises may occur in the Project Area. Two members of this species were observed north of the Project Area on 7 October 2005 in EL 1089 in a water depth of 165 m during the Husky monitoring program (Lang et al. in prep.).

3.3.1.3 True Seals (Phocids)

Three species of true seals may occur in the waters of the Study Area (Table 4). Populations of harp, hooded, and grey seals in Canada are thought to be increasing (Waring et al. 2004). Because of their potential to interact with commercial fisheries, reasonable population estimates for the northwest Atlantic are now available for most seal species. The main diet of seals consists of fish (including capelin, cod, halibut and sand lance) and invertebrates such as squid and shrimp (Table 6), with considerable seasonal, geographic and interannual variation in diet (Hammill et al. 1995; Lawson and Stenson 1995; Wallace and Lawson 1997). Other seal species (harbour, bearded, and ringed seals) may occur occasionally.

Harp Seal.—Harp seals whelp in the spring in the Gulf of St. Lawrence and in an area known as the 'Front' off southern Labrador and northeastern Newfoundland (Sergeant 1991; DFO 2000). The main whelping patch for the northwest Atlantic breeding stock of harp seal is well north of the Study Area. In heavy ice years, it is likely harp seal whelping herds extend into the Regional Area defined in Husky (2000). Individuals from these two areas spend the summer in the Arctic and then migrate south in the autumn. Surveys conducted during the early 1990s suggested that offshore waters on the northern edge of the Grand Banks in NAFO fishing area 3L were an important over-wintering area for some animals during those years (Stenson and Kavanagh 1994). Sighting effort from these surveys within the Regional Area was low, but harp seals were present in low numbers. Similarly, data from satellite transmitters deployed on harp seals suggest that the Grand Banks is an important wintering area for some seals (Stenson and Sjare 1997). It is possible that more harp seals are occurring south of this area in recent years because there has been an apparent change in their distribution. There has been a documented increase in the extralimital occurrences (south of normal range) of harp seals in the northern Gulf of Maine (McAlpine et al. 1999), which may also be occurring in the Grand Banks area. This southward expansion may be related to the increase in the harp seal population or the recent changes in ocean ecology that may be affecting their foraging success (McAlpine et al. 1999). The total population estimate of harp seals in the northwest Atlantic is currently 5.2 (±1.2) million (DFO 2000).

The diet of harp seals foraging off Newfoundland and Labrador appears to vary considerably with age, season, year and location. On the Grand Banks and Labrador Shelf, capelin predominates, followed by sand lance, Greenland halibut and other pleuronectids (Wallace and Lawson 1997; Lawson et al. 1998). Recent "historical" data on the diet of harp seals greater than a year old from northeast Newfoundland, indicates that there was a shift in prey from capelin in 1982 to Arctic cod in 1986 and beyond, while Atlantic cod remained relatively unimportant throughout this period. Harp seals collected from nearshore waters forage intensively on a variety of fish and invertebrate species, although most of the biomass is derived from relatively few species, particularly Arctic cod, capelin, Atlantic cod, Atlantic herring and some decapod crustaceans. A recent consumption model estimates that harp seals consume less Atlantic cod than once believed as seals apparently spend more time offshore than previously thought (Hammill and Stenson 2000).

Hooded Seal.—Like the harp seal, the hooded seal is a North Atlantic endemic species that reproduces on the spring pack ice of the Gulf of St. Lawrence and along the Labrador coast, and then migrates

northward to the sub-Arctic and Arctic to feed during the summer (Lydersen and Kovacs 1999). Data collected from satellite transmitters deployed on hooded seals in the Gulf of St. Lawrence indicate that some females feed near the Flemish Cap after breeding while migrating to Greenland waters (G.B. Stenson, unpubl. data). Tagged males migrating to Greenland in early summer were recorded along the Grand Banks shelf edge near the Flemish Pass. It appears that males spend little time foraging in this area (G.B. Stenson, unpubl. data). Little is known regarding their winter distribution, although it is believed that the majority of seals remain offshore; they have been seen feeding off the Grand Banks in February. Surveys in the early 1990s suggested that, as was the case for harp seals, the offshore waters on the northern edge of the Grand Banks also might be an important over-wintering area for hooded seals (Stenson and Kavanagh 1994). Hooded seal sightings in the Regional Area (defined in Husky 2000) during these surveys were less frequent than harp seal sightings. The number of visitors to the Study Area is unknown. However, these numbers may be increasing as hooded seals are apparently expanding their southern range of occurrence (McAlpine et al. 1999) and population numbers are increasing. Hooded seals increased from 470,000 individuals in 1990 to ~627,000 in 1996 (Hammill and Stenson 2000).

Hooded seals consume a variety of prey. In nearshore areas of Newfoundland, prey (in decreasing order of total wet weight) includes: Greenland halibut, redfish, Arctic cod, Atlantic herring and capelin. Relatively small amounts of squid (*Gonatus* spp.) and Atlantic cod were also found (Ross 1993). Data from offshore areas are limited, but suggest that similar prey species are consumed (J.W. Lawson and G.B. Stenson, unpubl. data).

Grey Seal.—Grey seals that might occur in the Study Area are likely migrants from the Sable Island and Gulf of St. Lawrence breeding populations. This species occurs in the Regional Area year-round, but most commonly in July and August (Stenson 1994). The Sable Island and Gulf of St. Lawrence breeding areas account for essentially all of the pup production in the northwest Atlantic, which increased exponentially between 1977 and 1989 (Stobo and Zwanenburg 1990). The eastern Canadian population of grey seals was estimated at 173,500 in 1996 (Hammill and Stenson 2000). The number that migrates into the Study Area is unknown, but is believed to be low.

Grey seals are less tied to coastal and island rookeries than are harbour seals. They travel long distances, one individual having been tracked over a distance of 2,100 km (McConnell et al. 1999). The food of grey seals in the western North Atlantic includes at least 40 species, some of which are commercially important (for example, Atlantic cod, herring, and capelin) (Benoit and Bowen 1990; Hammill et al. 1995; Hammill and Stenson 2000).

3.3.2 Sea Turtles

Sea turtles are probably not common in the Study Area but are important to consider because of their threatened or endangered status, both nationally and internationally.

Three species of sea turtles may occur in the Study Area: (1) the leatherback, (2) the loggerhead, and (3) the Kemp's ridley (Ernst et al. 1994). However, little can be said to qualify, much less quantify, the degrees of occurrence of these three sea turtle species within the Study Area due to lack of information. No sea turtles were sighted during monitoring of seismic exploration of Jeanne d'Arc Basin to north by Husky in October and early November 2005 (Lang et al. in prep.). The leatherback turtle is listed as endangered by COSEWIC (2006) and by the United States National Marine Fisheries Service (NMFS) and Fish and Wildlife Service (FWS) (Plotkin 1995). Due to its risk designation by COSEWIC, the leatherback turtle is considered a priority species under *SARA*. The Kemp's ridley is also listed as endangered and the loggerhead turtle is listed as threatened by NMFS and FWS (Plotkin 1995).

3.3.2.1 Leatherback

This species is considered Endangered by COSEWIC and is listed as such on Schedule 1 of *SARA*. More information is found in Section 4 of this report.

3.3.2.2 Loggerhead Turtle

This species is the most abundant sea turtle in North American waters (Ernst et al. 1994; Plotkin 1995). The loggerhead turtle winters in the south, but some individuals migrate north into the Canadian Atlantic with the Gulf Stream in summer (Cook 1984). An estimate of the population size in the Study Area is unavailable; however, loggerheads are thought to occur in these waters during summer and fall. Loggerheads found in Canadian waters are generally smaller than those found in coastal US waters, indicating that they are younger animals (Witzell 1999).

Loggerhead turtles apparently dwell in both coastal and offshore waters but generally associate with convergence zones, drift lines and downwellings (Carr 1986). Continental shelf waters are believed to be important because they contain known loggerhead prey like crabs, molluscs, sea pens and various gelatinous organisms (Payne et al. 1984). Loggerheads also eat algae and vascular plants (Ernst et al. 1994). Data from the US pelagic longline fishery observer program have added to the knowledge of loggerhead distribution off Newfoundland (Witzell 1999). Seventy percent of loggerheads (936 captures) caught incidentally by this fishery between 1992 and 1995 from the Caribbean to Labrador were captured in waters on and east of the 200 m isobath off the Grand Banks. Animals were caught in this region during all months from June to November, with a peak in captures during September. Within these waters, loggerhead captures corresponded closely with fishing effort, both clustered near the 200 m isobath where oceanographic features concentrate prey species for both the turtles and the swordfish and tuna that are the targets of the longline fishers.

The loggerhead turtle may achieve sexual maturity at an age of 30 to 50 years and one of the largest breeding aggregations is found on the central Atlantic coast of Florida (Magnuson et al. 1990). In fact, 90 percent of females nesting in the Atlantic do so in the southeastern US in what appear to be demographically independent groups (based on mitochondrial DNA haplotype distributions) (Encalada et al. 1998). Most females nest from three to five times in a season and average clutch sizes are between 95 to 150 eggs per nest (LeBuff 1990). It is unlikely that loggerhead sea turtles will occur in the Study

Area. No loggerhead sea turtles were sighted during CCL's 2004 monitoring program in the Orphan Basin (Moulton et al. 2005).

3.3.2.3 Kemp's Ridley Turtle

Kemp's ridleys are the smallest (40 to 50-kg) and rarest of all sea turtles within the Newfoundland area (Cook 1984). These turtles apparently prefer shallow water and while adults rarely range beyond the Gulf of Mexico, juveniles have been sighted along the southeast coast of Newfoundland near St. Mary's Bay and along southern Nova Scotia (Ernst et al. 1994). However, the number of Kemp's ridley turtles that may visit the Study Area is unknown, but likely low. They apparently prefer shallow water and feed primarily on crabs, but occasionally they eat molluscs, fish, shrimp and vegetation (Shaver 1991).

This species has a very restricted nesting range, with 95 percent of nests laid along a 60 km stretch of beach in Rancho Nuevo, Mexico. The number of females nesting there declined from as many as 40,000 over 50 years ago to approximately 700 in the late 1980s, but saw a steady increase in the 1990s as a result of conservation measures (Marquez et al. 1999). It is unknown how long this species lives or at what age it reaches sexual maturity. More than half of the adult females nest every year between April and August (NRC 1990). They lay an average of 3.1 clutches per season, with an average of 103 eggs per clutch (Rostal 1991). After a 48 to 65-day incubation period, eggs hatch and hatchlings head for the sea (Mager 1985). Both eggs and hatchlings are very vulnerable to predators like ghost crabs, coyotes and hawks (Plotkin 1995).

3.4 Sensitive Habitats and Times

Most important fishery areas are concentrated at more than 25 km distant from Terra Nova. As indicated in the following section, a number of *SARA*-listed and COSEWIC-listed species may occur in the Terra Nova area on more than a sporadic or 'stray' basis. These species are discussed in more detail below.

4.0 Species at Risk

The following subsections provide an overview of species listed on SARA and/or considered at risk by COSEWIC. Emphasis is given to those species listed as Endangered or Threatened on Schedule 1 of SARA. Only those species listed as threatened or endangered on Schedule I have special legal protection under SARA in terms of recovery strategies, penalties to be incurred for harming or killing individuals of the species, or destroying critical habitat. It is not Petro-Canada's intention to contravene the prohibitions of SARA. Status of species that may occur at Terra Nova, at least sporadically, are shown in Table 7.

Petro-Canada will apply adaptive management measures to deal with any changes to Schedule 1 of *SARA*. Each year prior to commencement of the drilling season, Petro-Canada will consult with DFO and Environment Canada regarding any listing changes of Schedule 1 species, releases of Recovery Strategy Plans, and possible mitigation measures as they relate to Species at Risk.

Species profiles for those species most likely to be encountered in the Terra Nova area are provided below.

4.1 Wolffishes

In the northwest Atlantic, there are three wolffish species (*Anarhichus* spp.) distributed from Davis Strait to Maine. Kulka et al. (2004) examined changes in distribution and habitat associations of three species of wolffish on the Grand Banks and Labrador Shelf using data collected during DFO RV surveys in the spring and fall between 1971 and 2003. The three wolffish species are at the center of their distributions, reaching highest density and covering the largest area on the northeast Newfoundland and Labrador Shelf. On the Shelf, they distribute over a wide range of depths (25 to 1400 m) with the northern wolffish exhibiting the widest distribution of the three species, and the Atlantic or striped wolffish exhibiting the narrowest. Kulka et al. (2004) demonstrated the importance of water temperature to wolffish habitat. All three wolffish species appear to be associated with an extremely narrow range of bottom water temperature (1.5 to 4.5 ºC). These fish appear to avoid areas where water temperature <0 ºC. Kulka et al. (2004) also discussed the relationship between the three wolffish species and sediment type. They reported that Atlantic wolffish and spotted wolffish were widely distributed on various sediment types while northern wolffish appear to prefer areas with sediments consisting of sand/shell hash, gravely sand and/or rock. Atlantic wolffish occurring in near-shore areas appear to avoid areas where there is potential for the substrate to get stirred up (e.g., mud). The distributions of both northern and spotted wolffish indicated by 1995-2003 trawl data are concentrated towards the Shelf edge. Kulka et al. (2004) did not establish a clear link to survival or the proximal causes of change in habitat but did demonstrate that thermal conditions appear to affect wolffish population abundance. Note that wolffish are solitary, territorial fish that build nests on the ocean bottom. The abundances of spotted and striped wolffish have been increasing slowly for several years.

Table 7. *SARA* and COSEWIC Listed Species Potentially Occurring in the Jeanne d'Arc Basin Area (updated June 2006).

Species	SARA Status	COSEWIC Status (date of most recent status report)	Comments
Atlantic Salmon (*Salmo salar*) (Bay of Fundy)	Schedule 1: Endangered	Endangered (April 2006)	Some strays are possible. Mostly in NB, NS but also in broader area of Atlantic Ocean.
Atlantic cod (*Gadus morhua*) (NL population)	Schedule 3: Special Concern	Endangered (May 2003)	High likelihood of occurrence.
Porbeagle shark (*Lamna nasus*)	*No status; under consideration for addition to Schedule 1*	Endangered (May 2004)	Moderate likelihood of occurrence.
White shark (*Carcharodon carcharias*)	*Not on SARA website.*	Endangered (April 2006)	Low likelihood of occurrence.
Northern wolffish (*Anarhichas denticulatus*)	Schedule 1: Threatened	Threatened (May 2001)	Moderate likelihood of occurrence.
Spotted wolffish (*Anarhichas minor*)	Schedule 1: Threatened	Threatened (May 2001)	Moderate likelihood of occurrence.
Shortfin Mako Shark (*Isurus oxyrinchus*)	*Not on SARA website.*	Threatened (April 2006)	Moderate likelihood of occurrence.
Cusk (*Brosme brosme*)	*No schedule or status.*	Threatened (May 2003)	Low likelihood of occurrence.
Atlantic Wolffish (*Anarhichas lupus*)	Schedule 1: Special Concern	Special Concern (November 2000)	Moderate likelihood of occurrence.
American eel (*Anguilla rostrata*)	*Not on SARA website.*	Special Concern (April 2006)	Low likelihood of occurrence.
Blue shark (*Prionace glauca*)	*Not on SARA website.*	Special Concern (April 2006)	Moderate likelihood of occurrence.
Ivory Gull (*Pagophila eburnea*)	Schedule 1: Special Concern	Endangered (April 2006)	Extremely unlikely to occur in the Project Area during June to December as this species is associated with ice.
Blue Whale (*Balaenoptera musculus*)	Schedule 1: Endangered	Endangered (May 2002)	Very uncommon; more likely to be encountered in the Gulf of St. Lawrence and south coast of Newfoundland than the Jeanne d'Arc Basin.
North Atlantic Right Whale (*Eubalaena glacialis*)	Schedule 1: Endangered	Endangered (May 2003)	Extremely rare, highly unlikely to occur in Project Area. Predominantly occur in and near Bay of Fundy in Canadian waters.
Fin Whale (*Balaenoptera physalus*)	*No status; under consideration for addition to Schedule 1*	Special Concern (May 2005)	Likely abundant within the Project Area.
Sowerby's Beaked Whale (*Mesoplodon bidens*)	Schedule 3: Special Concern	Special Concern (April 1989)	Unlikely to occur in the Project Area.
Harbour porpoise (*Phocena phocena*)	*No schedule or status; refered back to COSEWIC*	Special Concern (April 2006)	Likely to occur within the Project Area.
Leatherback Sea Turtle (*Dermochelys coriacea*)	Schedule 1: Endangered	Endangered (May 2001)	Likely very uncommon; potentially associated more with the slope of the banks than the shelf.

Striped wolffish in Newfoundland waters spawn in September and the early juvenile stage remains close to the spawning location. Spotted wolffish are thought to spawn in late autumn or early winter. On the Grand Banks where the survey takes place, wolffish young-of-the-year (YOY) are more abundant in the northern part of the surveyed area (i.e., more in 3K than in 3L) (Simpson and Kulka 2002). The juvenile stages of all three wolffish species appear to be semi-pelagic.

The spotted wolffish and striped wolffish are regarded as commercial species in Newfoundland waters while the northern wolffish is not (Simpson and Kulka 2002). The spotted and northern wolffish occur in deep water (>475 m) where water temperatures normally range between 3 and 4ºC. They are thought to spawn during the late fall/early winter months. Wolffishes typically feed on a variety of benthic invertebrates and various fish.

The Department of Fisheries and Oceans is presently preparing a 'Wolffish Recovery Plan' but this document has not yet been published (J. Simms, DFO biologist, pers. comm.). D. W. Kulka of DFO is the Chair of the 'Wolffish Recovery Team" and author of the "Wolffish Recovery Plan'. Both the northern wolffish and spotted wolffish are incidentally captured in fisheries directed at other commercial species, particularly Greenland halibut and snow crab. Incidental capture in the commercial fishery is considered the dominant source of human induced mortality for these two wolffish species. Permitting, education regarding live release, and gear modification have been identified as the key issues in ensuring the survival of these fish (DFO 2004a; Simpson and Kulka 2003). DFO (2004a) conducted a workshop on northern and spotted wolffish designed to describe conditions that would allow human activity to occur without affecting recovery of the species. It was decided that recent levels of mortality (2000-2002) do not impair the ability of these two wolffish species to recover. It was noted that the greatest threat to these fish is the commercial fishery. Since many of the fisheries that result in incidental catches of northern and spotted wolffish are expected to decline over the next few years, mortality of these fish should also decline. DFO (2004a) also concluded that offshore oil and gas activities will result in negligible effects on wolfish.

4.2 Atlantic Cod (Newfoundland and Labrador Population)

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

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

Historically, many of the northern cod migrated between overwintering areas in deep water near the shelf break and feeding areas in the shallower waters both on the plateau of Grand Bank and along the coasts of Labrador and eastern Newfoundland. Some cod remained in the inshore deep water during the winter. For centuries, several nations harvested cod while they were in the shallower inshore waters, first with hook and line and later with nets that eventually evolved into the highly effective Newfoundland cod trap. The deep waters, both inshore and offshore, remained refugia until the 1950s when longliners and bottom trawlers joined the fishery. European bottom trawlers initially exploited the outerbanks cod in summer and autumn but eventually extended the fishing to winter and early spring when the cod were highly aggregated. At the same time as offshore cod landings increased dramatically, the longliners fishing deep inshore waters introduced synthetic gillnets to the fishery.

The number and individual size of the fish declined through the 1960s and 1970s. Fishing effort by the expanding Canadian trawler fleet increased dramatically following Canada's extension of jurisdiction to 200 miles in 1977. The total allowable catch doubled between 1978 and 1984 due to an overestimation of stock size during this period. The stock was finally closed to Canadian fishing in July 1992 due to its decline (Lilly et al. 2001).

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

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

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

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

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

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

4.3 Sharks

Porbeagle sharks are large, cold-temperate pelagic fish that are known to occur over a depth range of surface to 715 m. The highly migratory porbeagle tends to be most abundant on continental offshore fishing banks but is also found far from land in ocean basins and occasionally inshore (Scott and Scott 1988; DFO 2005a,b; SAUP 2006).

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

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

The known depth range of occurrence of the migratory shortfin shark is 0 to 740 m., although it is usually found in surface waters down to about 150 m. While typically oceanic, the shortfin mako is sometimes found close inshore (Scott and Scott 1988).

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

4.4 Other Fish

Cusk (*Brosme brosme*) are solitary, slow-swimming groundfish that occur on both sides of the North Atlantic. In Canadian waters, this species is most common in the Gulf of Maine, Gulf of St. Lawrence and the southwestern Scotian Shelf although its range is indicated for the entire Grand Banks (Scott and Scott 1988). Although most common within a depth range of 128 to 144-m, some have been caught as deep as 600 m. The diet of cusk is not well documented because their stomachs usually evert when they are brought to the surface. Studies have shown that in European waters, cusk feed on crab, molluscs, krill, cod, and halibut. Their diet is presumed to be the same in Canadian waters (Scott and Scott 1988). An allowable harm assessment for cusk in Atlantic Canada was recently prepared by DFO (DFO 2004b).

It is known that this catadromous fish spawns at sea but few specifics relating to the movements of adults and larvae at sea are understood (Scott and Scott 1988). It is speculated that adult American eels spawn in the Sargasso Sea, located south of Bermuda and east of the Bahamas but migration corridors between the Sargasso Sea and the Atlantic Canadian coast are not defined. Although unlikely, adult and/or larval American eels could occur on the Grand Bank, the adults in late summer/fall and the larvae in spring.

4.5 Ivory Gull

Ivory Gull (*Pagophila eburnea*) breeds in high Arctic Canada, Greenland and northern Eurasian. It winters among the sea ice within its breeding range and slightly farther south. The southern-most extent of its range is the northwestern Atlantic where it reaches northern Newfoundland waters (Haney and MacDonald 1995). Ivory Gull often feed from the wing over water, dip feeding for small fish and invertebrates on the surface. They occasionally plunge-dive so that the entire body may be submerged momentarily. They also swim and pick at the surface of the water and walk on ice to scavenge animal remains.

Ivory Gull is classified as a species of 'Special Concern' under *SARA* (www.speciesatrisk.gc.ca). This is likely to change to 'Endangered' because COSEWIC upgraded the status to 'Endangered' in April 2006 (P. Thomas, CWS, pers. comm.) It is rare on a global scale with fewer than 14,000 pairs. The Canadian Arctic supports a significant but declining population of Ivory Gull. The Canadian breeding population was estimated at 2,400 individuals in the early 1980s (Thomas and MacDonald 1987). Extensive surveys of historic breeding sites and adjacent breeding habitat in 2002 and 2003 and interviews with

Inuit residents indicate the breeding population in Canada has declined by 80% (Gilchrist and Mallory 2005). Reasons for the apparent decline of the Canadian breeding population are uncertain. Given the high position of Ivory Gull in the food chain of the high Arctic, there are concerns that a decline in the breeding population could signify changes in the delicate web of Arctic life.

The winter range of the Ivory Gull in the Northwest Atlantic is among sea ice from the Davis Strait south to about 50º to the Labrador Sea (Orr and Parsons, 1982 *in* Haney and MacDonald 1995), extending south in pack ice to the northeast coast of Newfoundland (Brown 1986; McLaren et al. 1983). Very little published information exists on Ivory Gull at sea off eastern Newfoundland. In 1981, an aerial survey route of Petro-Canada's OLABS Program centered about Funk Island (N49° 45' W53°11') resulted in several Ivory Gull sightings. There were four sightings ranging from 1-5 individuals on the February survey and four sightings ranging from 1-5 individuals on the March survey (McLaren et al. 1983). These sightings are about 450 km northwest of the northern Grand Banks. Ivory Gulls have been documented on the northeast Avalon Peninsula at roughly the same latitude as the Project Area. Winter storms occurring in January to April storms very occasionally bring small numbers of Ivory Gulls to the St. John's area (B. Mactavish, unpubl. data). Ivory Gulls (21 in total) have been reported by environmental monitors from drill platforms on the northeast Grand Banks in 1999-2002; these observations should be treated with caution as most individuals were reported during ice-free periods (Baillie et al. 2005). There is a possibility that Ivory Gulls were confused with Iceland Gull (*Larus glaucoides*), which are relatively more abundant and whose presence is not necessarily correlated with the presence of ice, because at a distance Ivory and Iceland Gulls can be easily confused given their similar white colouration and long wing shape.

The thirty-year median of ice concentration shows ice extending into the northern edge of the Grand Banks east to 48°W in late February to late March. The presence of sea ice does not does not imply that Ivory Gulls will be present. The overall density of Ivory Gull on the pack ice in the Northwest Atlantic is extremely low. The presence of sea ice is the condition most favourable for Ivory Gull occurrence. Ivory Gull may occasionally occur in the small numbers in the Project Area when pack ice reaches the northern Grand Banks in late winter (February to April). Ivory Gull would be extremely unlikely to occur in the Project Area during the typical period when VSP surveys will be conducted.

4.6 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 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 Petro-Canada Project Area (see Figure 4) based upon available data provided by DFO. The closest sighting was made in June 1993, approximately 250 km south of the Project Area. Based upon the DFO sighting database, most sightings of blue whales in Newfoundland have occurred near the coast, which may, in part, be related to the lack of dedicated marine mammal surveys in offshore waters. Blue whales were regularly sighted in offshore waters (~100-3000 m deep) of the Laurentian sub-basin area during a recent seismic monitoring program in June to September 2005. In fact, blue whales were the most frequently sighted baleen whale species. Sighting rate of blue whales was highest in water depths ranging from 2000-2500 m (Moulton et al. 2006a). However, no blue whales were sighted in the deep waters of the Orphan Basin during seismic monitoring programs conducted during the summers of 2004 (Moulton et al. 2005) and 2005 (Moulton et al. 2006b). No blue whales were sighted during a seismic monitoring program in the Jeanne d'Arc Basin in October and November 2005 (Lang et al. in prep.); baleen whales are typically less abundant on the Grand Banks in late fall vs. summer. It is possible that blue whales may occur in the Jeanne d'Arc Basin but numbers are expected to be low.

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).

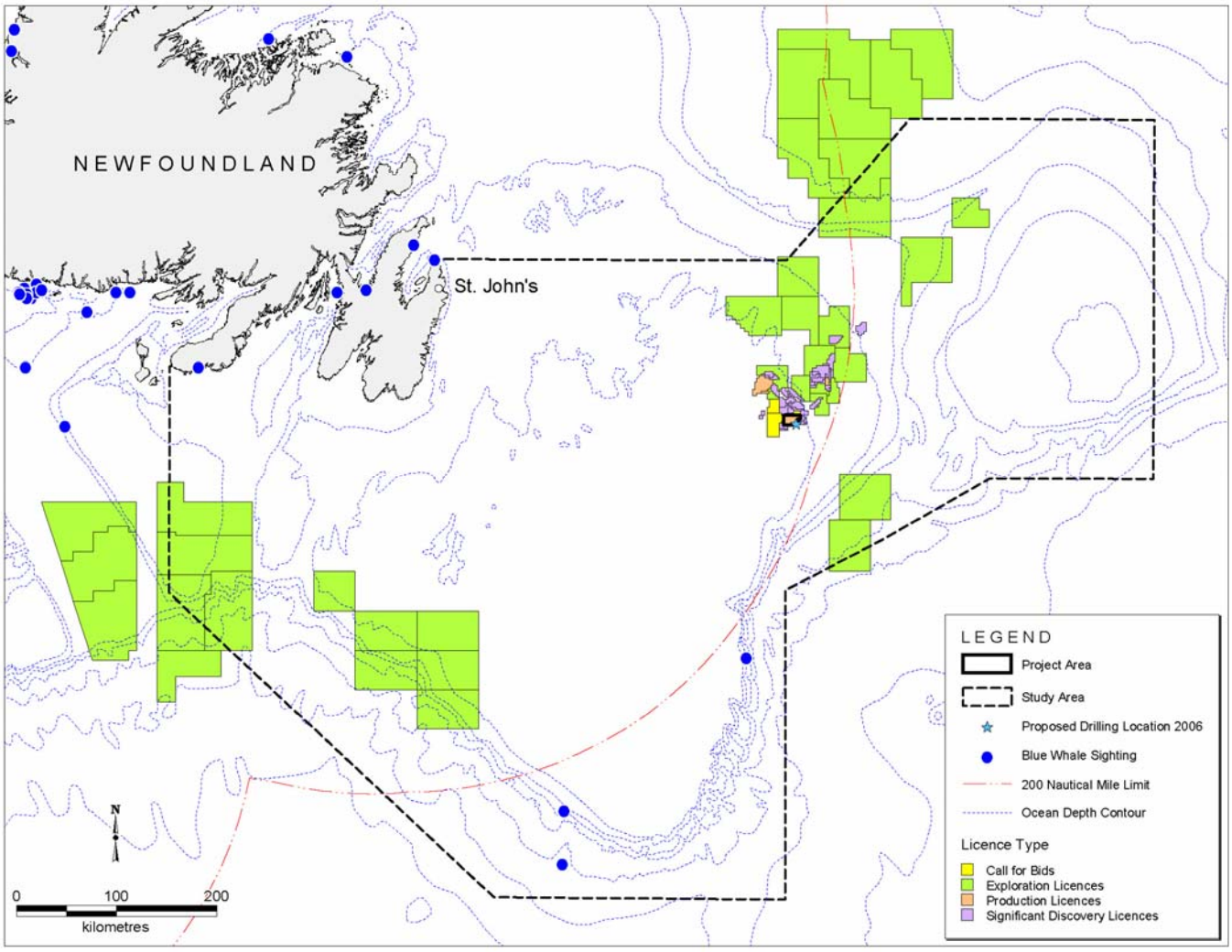


Figure 4. Location of Blue Whale Sightings Relative to Petro-Canada's Project and Study Areas (data from DFO marine mammal database).

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).

4.7 Leatherback Sea Turtle

The leatherback is the largest living turtle (2.2 m in length and over 900-kg (Morgan 1989)) and it also may be the most widely distributed reptile, as it ranges throughout the Atlantic, Pacific, and Indian oceans and into the Mediterranean Sea (Ernst et al. 1994). Adults engage in routine migrations between temperate and tropical waters, presumably to optimize both foraging and nesting opportunities. Leatherbacks are less genetically diverse than other sea turtle species and may have less-rigid homing instincts (Dutton et al. 1999).

The worldwide population of leatherbacks is currently estimated at between 26,000 and 43,000 (Dutton et al. 1999). The current population is thought to be declining as major nesting colonies have declined in the last 20 years, although an increase in leatherbacks nesting in Florida has been reported in the last few years (Dutton et al. 1999). Despite its patchy worldwide distribution and in contrast to other sea turtles, adult leatherbacks are regularly sighted in the waters off Nova Scotia and Newfoundland from June to October (with peak abundance in August), where they likely come to feed on jellyfish, their primary prey (Bleakney 1965; Cook 1981; 1984). The scattered nature of the data make estimating the number of turtles in the Canadian Atlantic difficult. However, the North Atlantic Leatherback Turtle Working Group (NALTWG), created in 1997, is currently conducting research on the distribution and abundance of the leatherback. More leatherbacks visit waters near the Study Area than was once believed.

Leatherbacks, both adults and juveniles, undergo annual migrations that include areas off southern Newfoundland (James et al. 2005). The analysis of satellite telemetry, morphometric and fishing entanglement data identified areas of high-use habitat of leatherbacks in Northwest Atlantic waters. It was shown that leatherbacks do not migrate along specific routes but that they utilize broad areas of the Atlantic. Leatherback sea turtles did exhibit foraging site fidelity to shelf and slope waters off Canada and the northeastern United States (James et al. 2005). Satellite-tagged leatherbacks (caught off Cape Breton) mostly occurred well southwest of the Project Area during June to October (although some southward migrations did not begin until December; James et al. 2005). It is possible that leatherbacks may occur in the Project Area. However, to date, no sea turtles have been reported in the near the Terra Nova Development by observers on various platforms (U. Williams, Petro-Canada, pers. comm.). Also, no leatherbacks were sighted during Chevron's seismic monitoring program in the Orphan Basin in 2004 and 2005 and during Husky's seismic monitoring program in Jeanne d'Arc Basin in fall 2005 (Moulton et al. 2005, 2006b; Lang et al. in prep.).

Data from the US pelagic longline fishery observer program have also added to the knowledge of leatherback distribution off Newfoundland (Witzell 1999). Nearly half of the leatherbacks (593 captures) caught incidentally by this fishery between 1992 and 1995 from the Caribbean to Labrador were captured in waters on and east of the 200 m isobath off the Grand Banks (Witzell 1999). Animals were caught in this region during all months from June to November, with the bulk of captures from July to September. Not surprisingly, leatherback captures within these waters corresponded closely with fishing effort, both clustered near the 200 m isobath.

The apparent common northerly occurrence of this species compared to other sea turtles may be attributed to an ability to maintain body temperatures of 25ºC in sea water as much as 18ºC cooler. An adult was even observed by fishermen in Trinity Bay, Newfoundland swimming amongst ice (Goff and Lien 1988). Twenty leatherbacks were reported off Newfoundland between 1976 to 1985, 14 were entangled in fishing gear (Goff and Lien 1988).

Little is known about the biology of the leatherback. It nests from April through November in the tropics along sandy beaches. Females deposit an average of five to seven nests per year, with clutch size averages varying geographically (Plotkin 1995). Nothing is known about the behaviour or survivorship

of post-hatchlings. Loss of nesting habitat due to development and erosion, predation by animals, and poaching of adults and eggs for consumption inhibit the recovery of this species. Ingestion of plastic materials, which leatherbacks presumably mistake for jellyfish is common and can be fatal. The loss of individuals (primarily through net entanglement) in the Canadian Atlantic is not known to critically contribute to population decline (Cook 1981).

5.0 Effects Assessment

5.1 Methodology

The methodology of this effects assessment and definitions are consistent with all of the EAs conducted for Petro-Canada and Husky since 1996 (e.g., Petro-Canada 1996a,b; Husky 2000, 2001; LGL 2003,2004).

5.2 Scoping

Scoping for the effects assessment was conducted by reviewing the results of the Terra Nova EIS (Petro-Canada 1996 a,b, 1997), the White Rose Comprehensive Study and Supplement (Husky 2000, 2001), the Jeanne d'Arc Basin exploratory drilling EA (Husky 2002), relevant seismic EAs (e.g., Davis et al 1998; Moulton et al. 2003) and the Woodstock VSP EA (LGL 2003).

Given the reduced duration, much smaller area covered and lower number of shotpoints, as well as the smaller seismic source compared to surface-towed seismic surveys, any impacts from VSP surveys would be much less relative to full-scale 2-D or 3-D seismic surveys. For example, Petro-Canada's VSP source array will have a total volume of 500 cu in whereas a typical 3-D array may total 3,000 to 4,900 cu in (A. Kaderali, pers. comm.).

Documents such as Davis et al. (1998), Moulton et al. (2003), and Lawson et al. (2000) provide a good overview of the effects of seismic noise on Valued Ecosystem Components (VECs), including marine mammals and fish, typically considered in offshore EAs for Atlantic Canada. Also, the Husky EA (Husky 2002) included a discussion of cumulative impacts from seismic surveys on the Grand Banks. These documents did not predict any significant impacts on VECs from full-scale seismic surveys provided certain mitigation and monitoring measures were in place (see below), particularly for marine mammals, which are known to be sensitive to underwater noise.

As noted above ('Important Biological Resources'), there have been no significant changes in the biological resources of the Study Area since the Terra Nova EIS (Petro-Canada 1996 a,b, 1997), the White Rose EA (Husky 2000) or the Jeanne d'Arc Basin exploratory drilling EA (Husky 2002) were prepared although the nature of the fishery has changed somewhat since the Terra Nova EIS. There do not appear to be any unique biological features at Terra Nova. Snow crab are, by far, the most important commercial species in 3Lt, the NAFO Unit Area that contains Terra Nova, and this fishery is pursued offshore of Terra Nova in deeper water. The recent study by LGL Limited on the effects of seismic airguns on snow crab found no physical or behavioural effects on commercial-size snow crab, including no effect on catchability in commercial crab traps (Christian et al. 2003). The received sounds in that study were simulating full scale seismic surveys and were probably stronger and covered a larger area than typical VSP surveys, particularly zero-offset ones.

The Terra Nova area does not appear to be critical spawning habitat for the *SARA*-listed species such as Atlantic cod nor does it appear to provide critical spawning or nesting habitat for northern or spotted wolfish. All of these important life functions occur in deeper water (probably in much deeper water in the case of wolfish), offshore of Terra Nova. Small numbers of planktonic cod eggs or larvae could be exposed to potentially damaging sound energy (see Davis et al. 1998) if they happen to occur within a few metres of the airguns and if the timing of the VSP activities coincides with their peak numbers in the water column (probably spring).

Petro-Canada intends to enforce a 1,000-m safety zone for marine mammals as a precautionary measure; this safety zone should be outside the zone of potential effects for marine mammals as other jurisdictions (e.g., US Minerals Management Service in the Gulf of Mexico or the JNCC in UK waters) use a 500-m safety buffer for seismic surveys (MMS 2003; Stone 2003).

Petro-Canada will implement mitigation and monitoring during VSP activities. This will minimize any impacts on VECs. No significant impacts are predicted for VECs from VSP activities as magnitude will be low, geographic extent of adverse effects will be 1-10 km^2 or less, duration will be <1 month, and any effects will be reversible, at least at the population level (Husky 2003).

6.0 Mitigations and Follow-up

Prior to the onset of VSP, the airgun array will be gradually ramped up. The smallest airgun will be fired first and then the volume of the array will be increased gradually over a recommended 20 to 30-min period. An observer aboard the rig with the seismic source will watch for marine mammals and sea turtles 30-min prior to ramp-up. If a marine mammal or sea turtle is sighted within 500 m of the array, then ramp-up will not commence until the animal has moved beyond the 500 m zone. The observers will watch for marine mammals and sea turtles hen the airgun array is active and note the location and behaviour of these animals. Any dead or distressed marine mammal or turtle will be reported immediately to the C-NLOPB and DFO. A monitoring report will be submitted to the C-NLOPB.

7.0 Significance of Residual Effects

The environment will have negligible effect on the Project because VSP programs are small scale and will be done in the ice-free season during good weather conditions.

The VSP activities may occur throughout the life of the Terra Nova Project. However, given that mitigations (e.g., ramp-ups and observers) will be used, VSP programs are usually of lower power than typical 2D or 3D programs, of very limited geographic extents (a few square kilometres), of very short durations (typically 36 hours or less), no significant adverse effects (including any possible cumulative effects) are predicted from VSP activities at Terra Nova (see Table 8).

Table 8. Significance of Effects on VECs.

VEC	Significance Rating	Level of Confidence in Prediction
Fish and Fish Habitat	Not significant	High
Seabirds	Not significant	High
Marine Mammals	Not significant	High
SARA Species	Not significant	High
Fisheries	Not significant	High

8.0 Conclusions

Given the present state of knowledge the following conclusions can be drawn:

- There are no recorded unusually large concentrations of species sensitive to sound, or 'species at risk' under *SARA*, in the Terra Nova area.
- The geographic extent, magnitude and duration of the VSP activities will all be less than standard 2-D or 3-D seismic surveys.
- Conservative mitigations will be employed.
- Provided that points '1' and '2' are the case, VSP activities at Terra Nova should not result in any significant effects on marine populations in the area.

9.0 References Cited

Alling, A.K. and H.P. Whitehead. 1987. A preliminary study of the status of White-beaked Dolphins, *Lagenorhynchus albirostris*, and other small cetaceans off the coast of Labrador. Canadian Field-Naturalist. 101: 131-135.

Baillie, S.M., G.J. Robertson, F.K. Wiese and U.P. Williams. 2005. Seabird data collected by the Grand Banks offshore hydrocarbon industry 1999-2002: results, limitations and suggestions for improvement, . Canadian Wildlife Service Technical Report Series No.434. Atlantic Region.

Benoit, D. and W. D. Bowen. 1990. Seasonal and geographic variation in the diet of grey seals (*Halichoerus grypus*) in eastern Canada. Can. Bull. J. Fish. Aquat. Sci. 222:215-226.

Best, P.B. 1993. Increase rates in severely depleted stocks of baleen whales. ICES J. Mar. Sci. 50:169-186.

Bleakney, J.S. 1965. Reports of marine turtles from New England and Eastern Canada. Can. Field-Nat. 79: 120-128.

Brander, K.M. 1994. Patterns of distribution, spawning, and growth in North Atlantic cod: the utility of inter-regional comparisons. ICES J. Mar. Sci. Symp. 198: 406-413.

Brown, R.G.B. 1986. Revised atlas of eastern Canadian seabirds. 1. Shipboard surveys. Canadian Wildlife Service, Ottawa. 111 p.

Buchanan, R.A., J. Christian, V. Moulton and B. Mactavish. 2004. Orphan 3-D Seismic Program, 2004-2006 environmental assessment. LGL Report No. SA799. Prepared for Chevron Canada Resources and ExxonMobil. 209 p. + App.

Cairns, D.K., W.A. Montevecchi and W. Threlfall. 1989. Researcher's guide to Newfoundland seabird colonies. Second edition. Memorial University of Newfoundland Occasional Papers in Biology, No. 14. 43 p.

Campana, S., L. Marks, W. Joyce, and S. Harley. 2001. Analytical assessment of the porbeagle shark (*Lamna nasus*) population in the northwest Atlantic, with estimates of long-term sustainable yield. DFO Can. Sci. Advis. Sec. Stock Status Report 2001/067.

Canning and Pitt Associates, Inc. 2002. Husky Energy Lewis Hill & Grand Bank Geophysical Surveys (Fugro-Jacques Ltd), Commercial Fisheries Assessment. 25 p.

Carr, A. 1986. Rips, FADS, and Little Loggerheads. BioScience 36: 92-100.

Chardine, J.W. 2000. Census of Northern Gannet colonies in the Atlantic Region in 1999. Canadian Wildlife Service Technical Report Series No. 361. Atlantic Region.

Chardine, J.W., G.J. Robertson, P.C. Ryan and B. Turner. 2003. Abundance and distribution of Common Murres breeding at Funk Island, Newfoundland 1972 and 2000. Canadian Wildlife Service Technical Report Series No. 404. Atlantic Region.

Christian, J.C., A. Matthieu, D. White, and R.A. Buchanan. 2003. Effects of seismic energy on snow crab (*Chionoecetes opilio*). Presentation at Offshore Oil and Gas Environmental Effects Monitoring Workshop: Approaches and Technologies. 26-30 May, 2003. Bedford Institute of Oceanography, Dartmouth, Nova Scotia.

C-NOPB and C-NSOPB. 2003. Joint guidelines respecting data acquisition and reporting for well, pool and field evaluations in the Newfoundland and Nova Scotia offshore area. June 2003. Canada-Newfoundland Offshore Petroleum Board, St. John's, NL; Canada-Nova Scotia Offshore Petroleum Board, Halifax, NS. 46 p.

Cook, F.R. 1981. Status report on the Leatherback Turtle *Dermochelys coriacea* in Canada. Committee on the Status of Endangered Wildlife in Canada. 17 p.

Cook, F.R. 1984. Introduction to Canadian Amphibians and Reptiles. National Museum of Natural Sciences, National Museums of Canada, Ottawa, ON. 200 p.

COSEWIC. 2002. COSEWIC assessment and update status report on the Blue Whale *Balaenoptera musculus* in Canada. Committee on the Status of Endangered Wildlife in Canada. Ottawa. vi + 32 p.

COSEWIC. 2006. Database of species assessed by COSEWIC. http://www.cosewic.gc.ca/eng/sct1/searchform_e.cfm

Davis, R.A., D.H. Thomson and C.I. Malme. 1998. Environmental assessment of seismic exploration on the Scotian Shelf. TA2205. Rep. by LGL Limited, King City, ON, for Mobil Oil Properties Ltd., Shell Canada Ltd., Imperial Oil Ltd. and Canada/Nova Scotia Offshore Petroleum Board, Halifax, NS. 181 p.

Desportes, G. and R. Mouritsen. 1993. Preliminary results on the diet of Long-finned Pilot Whales off the Faroe Islands. Rep. Int. Whal. Comm. (Special Issue 14): 305-324.

DeYoung, B. and G.A. Rose. 1993. On recruitment and distribution of Atlantic cod (*Gadus morhua*) off Newfoundland. Can. J. Fish. Aquat. Sci. 50: 2729-2741.

DFO. 2000. Northwest Atlantic Harp Seals. DFO Science Stock Status Report E1-01 (2000).

DFO. 2004a. Proceedings of Species at Risk Atlantic Zonal Assessment Process-Determination of allowable harm for spotted and northern wolfish, May 7, 2004, St. John's, Newfoundland and Labrador. Can. Sci. Advis. Secret. Proc. Ser. 2004/028.

DFO. 2004b. Allowable harm assessment for cusk in Atlantic Canada. DFO Can. Sci. Advis. Sec. Stock Status Report 2004/044.

DFO. 2005a. Recovery assessment report on NAFO Subareas 3-6 porbeagle shark. DFO Can. Sci. Advis. Sec. Sci. Advis. Report 2005/043.

DFO. 2005b. Stock assessment report on NAFO Subareas 3-6 porbeagle shark. DFO Can. Sci. Advis. Sec. Sci. Advis. Report 2005/044.

DFO. 2006. Assessment of Newfoundland and Labrador snow crab. DFO Can. Sci. Advis. Sec. Sci. Advis. Rep. 2006/006.

Dufault, S., H. Whitehead and M. Dillon. 1999. An examination on the current knowledge on the stock structure of Sperm Whales (*Physeter macrocephalus*) worldwide. J.Cetacean Res. Manage. 1: 1-10.

Dutton, P.H., B.W. Bowen, D.W. Owens, A. Barragan and S.K. Davis. 1999. Global phylogeography of the Leatherback Turtle (*Dermochelys coriacea*). J. Zool. (London) 248: 397-409.

Encalada, S.E., K.A. Bjorndal, A.B. Bolten, J.C. Zurita, B. Schroeder, E. Possardt, C.J. Sears and B.W. Bowen. 1998. Population structure of Loggerhead Turtle (*Caretta caretta*) nesting colonies in the Atlantic and Mediterranean as inferred from mitochondrial DNA control region sequences. Mar. Biol. 130: 567-575.

Ernst, C.H., R.W. Barbour and J.E. Lovich (eds.). 1994. Turtles of the United States and Canada. Smithsonian Institution Press, Washington, DC. 578 p.

Falk-Petersen, I-B, T.K. Hansen, R. Fieler, and L.M. Sunde. 1999. Cultivation of the spotted wolffish *Anarhichas minor* (Olafsen) – a new candidate for cold-water fish farming. Aquaculture Res. 30: 711-718.

Gambell, R. 1985. Sei Whale *Balaenoptera borealis* lesson, 1828. p. 155-170. *In:* S.H. Ridgway and R. Harrison (eds.), Handbook of Marine Mammals. Volume 3. Academic Press, London.

Gannon, D.P., A.J. Read, J.E. Craddock and J.G. Mead. 1997. Stomach contents of Long-finned Pilot Whales (*Globicephala melas*) stranded on the U.S. mid-Atlantic Coast. Mar. Mamm. Sci. 13: 405-418.

Gaskin, D.E. 1992a. Status of the Common Dolphin, *Delphinus delphis*, in Canada. Can.Field-Nat. 106: 55-63.

Gaskin, D.E. 1992b. Status of the Harbour Porpoise, *Phocoena phocoena*, in Canada. Can. Field-Nat. 106: 36-54.

Gaskin, D.E. 1992c. Status of the Atlantic White-sided Dolphin, *Lagenorhynchus acutus*, in Canada. Can. Field-Nat. 106: 64-72.

Gilchrist, G.H and M.L. Mallory. 2005. Declines in abundance and distribution of the Ivory Gull (*Pagophila eburnea*) in Arctic Canada. Biological Conservation 121:303-309.

Goff, G.P. and J. Lien. 1988. Atlantic Leatherback Turtle, *Dermochelys coriacea*, in cold water off Newfoundland and Labrador, Can. Field-Nat. 102: 1-5.

Gowans, S. 2002. Bottlenose whales. Pages 128-129 *In*: W. F. Perrin, B. Würsig and J. G. M. Thewissen, eds. Encyclopedia of Marine Mammals. Academic Press, San Diego.

Gowans, S. and H. Whitehead. 1995. Distribution and habitat partitioning by small Odontocetes in the Gully, a submarine canyon on the Scotian Shelf. Can. J. Zool. 3: 1599-1608.

Griffin, R.B., 1999. Sperm whale distributions and community ecology associated with a warm-core ring off Georges Bank. Mar. Mamm. Sci. 15, 33-51.

Hai, D.J., J. Lien, D. Nelson and K. Curren. 1996. A contribution to the biology of the White-beaked dolphin, *Lagenorhynchus albirostris*, in waters off Newfoundland. Can. Field-Nat. 110: 278-287.

Hammill, M.O. and G.B. Stenson. 2000. Estimated prey consumption by Harp Seals (*Phoca groenlandica*), Hooded Seals (*Cystophora cristata*), and Grey Seals (*Halichoerus grypus*) in Atlantic Canada. J. Northwest Fish. Sci..26:1-23.

Hammill, M.O., M.S. Ryg and B. Mohn. 1995. Consumption of cod by the Northwest Atlantic Grey

Seal in Eastern Canada. p. 337-349. *In:* A.S. Blix, L. Walloe and O. Ulltang (eds.), Whales, seals, fish and man. Proceedings of the International Symposium on the Biology of Marine Mammals in the North East Atlantic. Developments in Marine Biology 4.

Haney, J.C. and S.D. MacDonald. 1995. Ivory Gull *Pagophila eburnean*. *In*: The birds of North America, No. 175, ed. A. Poole and F. Gill. The Academy of Natural Sciences of Philadelphia and American Ornithologists' Union, Washington, DC. 21 p.

Husky. 2000. White Rose Oilfield Comprehensive Study. Submitted by Husky Oil Operations Limited, St. John's, NL.

Husky. 2001. White Rose Oilfield Comprehensive Study Supplemental Report. Responses by Husky Oil Operations Limited to comments from Canada-Newfoundland Offshore Petroleum Board, Dept. Fisheries and Oceans, Environment Canada, Natural Resources Canada, and Canadian Environmental Assessment Agency. 265 p. + App.

Husky. 2002. Husky Jeanne d'Arc Basin Exploration Drilling Program project description and environmental assessment. Prepared by LGL Limited, Oceans Ltd., Provincial Airlines Ltd. and SL Ross Ltd. for Husky Oil Operations Limited, St. John's, NL. 179 p.

Husky. 2003. White Rose Addendum: vertical seismic profiling project description and environmental assessment. Prepared by LGL Limited for Husky Oil Operations Limited, St. John's, NL. 17 p.

Hutchings, J.A. 1996. Spatial and temporal variation in the density of northern cod and a review of hypotheses for the stock's collapse. Can. J. Fish. Aquat. Sci. 53: 943-962.

Hutchings, J.A. and R.A. Myers. 1994. Timing of cod reproduction: interannual variability and the influence of temperature. Mar. Ecol. Prog. Ser. 108: 21-31.

James, M.C., S.A. Eckert, and R.A. Myers. 2005. Migratory and reproductive movements of male leatherback turtles (*Dermochelys coriacea*). Mar. Biol. 147: 845-853.

Katona, S.K. and J.A. Beard. 1990. Population size, migration and feeding aggregation of the Humpback Whale (*Megaptera novaeangliae*) in the Western North Atlantic Ocean. Rep. Int.Whal. Comm. (Spec. Iss. 12): 295-305.

Katona, S.K., V. Rough, and D.T. Richardson. 1993. A Field Guide to Whales, Porpoises and Seals from Cape Cod to Newfoundland. Smithsonian Institution Press, Washington, USA. 316 p.

Kawamura, A. (1980) A review of food of balaenopterid whales *in* Scientific Reports of the Whales Research Institute 32 : Page(s) 155-197

Keats, D.W., G.R. South, and D.H. Steele. 1985. Reproduction and egg guarding by Atlantic wolffish (*Anarhichas lupus*: Anarhichadidae) and ocean pout (*Macrozoarces americanus*: Zoarcidae) in Newfoundland (Canada) waters. Can. J. Zool. 63(11): 2565-2568.

Kime, D.E. and H. Tveiten. 2002. Unusual motility characteristics of sperm of the spotted wolffish. J. Fish Biol. 61: 1549-1559.

Kulka, D.W., N.C. Antle, and J.M. Simms. 2003. Spatial analysis of 18 demersal species in relation to petroleum licence areas on the Grand Bank (1980-2000). Can. Tech. Rep. Fish. Aquat. Sci. No. 2473. 202 p.

Kulka, D.W, M.R. Simpson, and R.G. Hooper. 2004. Changes in distribution and habitat associations of wolffish (Anarhichidae) in the Grand Banks and Labrador Shelf. DFO Can. Sci. Advis. Sec. Res. Doc. 2004/113.

Lawson, J.W. and G.B. Stenson. 1995. Historic variation in the diet of Harp Seals (*Phoca groenlandica*) in the Northwest Atlantic. p. 261-269. *In:* A.S. Blix, L. Walloe and O. Ulltang (eds.), Whales, seals, fish and man. Proceedings of the International Symposium on the Biology of Marine Mammals in the North East Atlantic. Developments in Marine Biology 4.

Lawson, J.W., J.T. Anderson, E.L. Dalley and G.B. Stenson. 1998. Selective foraging by Harp Seals *Phoca groenlandica* in nearshore and offshore waters of Newfoundland, 1993 and 1994. Mar. Ecol. Prog. Ser. 163: 1-10.

Lawson, J.W., R.A. Davis, W.J. Richardson and C.I. Malme. 2000. Assessment of Noise Issues Relevant to Key Cetacean Species (Northern Bottlenose and Sperm Whales) in the Sable Gully Area of Interest. Report prepared by LGL Ltd. Environmental Research Associates and Charles I. Malme Eng. and Sci. Services for Oceans Act Coordination Office, Maritimes Region, Fisheries and Oceans Canada. LGL Report TA2446-2.

LeBuff, C.R., Jr. 1990. The Loggerhead Turtle in the Eastern Gulf of Mexico. Caretta Research, Inc.,Sanibel, FL. 216 p.

LGL. 2003. Husky Jeanne d'Arc Basin Exploration Drilling Program Project Description and Environmental Assessment Addendum for Vertical Seismic Profile Activities. Report by LGL Limited for Husky Oil Operations Limited, St. John's. 6 p.

LGL. 2004a. Vertical seismic profiling environmental assessment Terra Nova Development. Rep. by LGL Limited, St. John's, NL for Petro-Canada, St. John's, NL.

LGL. 2004b. Wellsite geohazard survey environmental assessment Terra Nova Development. Rep. by LGL Limited, St. John's, NL for Petro-Canada, St. John's, NL.

LGL. 2005. Wellsite geohazard survey, 2005 environmental assessment Terra Nova Development. Rep. by LGL Limited, St. John's, NL for Petro-Canada, St. John's, NL.

LGL. 2006. Husky delineation/exploration drilling program for Jeanne d'Arc Area environmental assessment update. Rep. by LGL Limited, St. John's, NL for Husky Oil Operations Limited, St. John's, NL.

Lien, J., G.B. Stenson and P.W. Jones. 1988. Killer Whales (*Orcinus orca*) in waters off Newfoundland and Labrador, 1978-1986. Rit Fiskideildar. 11: 194-201.

Lien, J., G. B. Stenson, and P. W. Jones. 1990. A natural trap for blue whales *Balaenoptera musculus*: Sightings and ice entrapments in Newfoundland (1979- 1988). Manu. Mar. Mamm. Sci..

Lien, J., D. Nelson and J.D. Hai. 1997. Status of the White-beaked Dolphin, *Lagenorhynchus albirostris*, in Canada. Report for the Committee on the Status of Endangered Wildlife in Canada.

Lilly, G.R., P.A. Shelton, J. Brattey, N.G. Cadigan, B.P. Healey, E.F. Murphy, and D.E. Stansbury. 2001. An assessment of the cod stock in NAFO Divisions 2J and 3KL. Canadian Science Advisory Secretariat Research Document 2001/044. 149 p.

Lock, A.R., R.G.B. Brown and S.H. Gerriets. 1994. Gazetteer of marine birds in Atlantic Canada. An atlas of seabird vulnerability to oil pollution. Canadian Wildlife Service, Environmental Conservation Branch, Environment Canada, Atlantic Region. 137 p.

Lomond, T.M., D.C. Schneider and D.A. Methven. 1998. Transition from pelagic to benthic prey for age 0-1 Atlantic cod, Gadus morhua. Fish. Bull. 96: 908-911.

Lydersen, C. and K.M. Kovacs. 1999. Behaviour and energetics of ice-breeding, North Atlantic phocid seals during the lactation period. Mar. Ecol. Prog. Ser.. 187: 265-281.

Mager, A.M., Jr. 1985. Five-year status reviews of sea turtles listed under the Endangered Species Act of 1973. U.S. Dept. Commerce, NOAA, National Marine Fisheries Service, St. Petersburg. FL. 90 p.

Magnuson, J., K. Bjorndal, W. DuPaul, G. Graham, D. Owens, C. Peterson, P. Pritchard, J. Richardson, G. Saul and C. West. 1990. Decline of Sea Turtles: Causes and Prevention. National Academy Press, Washington, DC.

Mansfield, A. W. 1985. Status of the blue whale, *Balaenoptera musculus*, in Canada. Can. Field-Nat. 99(3): 417-420.

Marquez, R., J. Diaz, M. Sanchez, P. Burchfield, A. Leo, M. Carrasco, J. Pena, C. Jimenez and R. Bravo. 1999. Results of the Kemp's ridley nesting beach conservation efforts in Mexico. Marine Turtle Newsletter 85: 2-4.

McAlpine, D.F., P.T. Stevick and L.D. Murison. 1999. Increase in extralimital occurrences of icebreeding seals in the northern Gulf of Maine region: more seals or fewer fish? Mar. Mamm. Sci. 15: 906-911.

McLaren, P.L., R.E. Harris and I.R. Kirkham. 1983. Distribution of marine birds in the southern Labrador Sea, April 1981-April 1982. Offshore Labrador Biological Studies Program (OLABS). LGL Limited Report for Petro-Canada Exploration Inc., Calgary, Alberta. 252 p + App.

Mitchell, E. and D.G. Chapman. 1977. Preliminary assessment of stocks of northwest Atlantic Sei Whales (*Balaenoptera borealis*). Rep. Int. Whal. Comm. (Spec. Iss. 1): 117-120.

MMS. 2003. Implementation of seismic survey mitigation measures and protected species observer program. US Dept. Interior, Minerals Management Service, Gulf of Mexico OCS Region. NTL 2003-G08 Effective June 5, 2003. 10 p.

Mobil 1985. Hibernia Development Project, Environmental Impact Statement. Volume IIIa: Biophysical Assessment. Mobil Oil Canada, Ltd. (Operator), Gulf Canada Resources Inc., Petro- Canada Inc., Chevron Canada Resources Ltd., and Columbia Gas Development of Canada Ltd. 258 p.

Morgan, P.J. 1989. Occurrence of Leatherback Turtles (*Dermochelys coriacea*) in the British Islands in 1988 with reference to a record specimen. p. 119-120. *In:* S.A. Eckert, K.L. Eckert, and T.H. Richardson (Compilers), Proceedings of the Ninth Annual Conference on Sea Turtle Conservation and Biology. NOAA Tech. Memo. NMFS-SEFC-232. U.S. Dept. Commerce, Miami FL. 305 p.

Morgan, M.J., E.M. DeBlois, and G.A. Rose. 1997. An observation on the reaction of Atlantic cod (*Gadus morhua*) in a spawning shoal to bottom trawling. Can. J. Fish. Aquat. Sci. 54(Suppl.): 217-223.

Moulton, V.D. and W.J. Richardson. 2000. A review of sea turtles and seismic noise. LGL Report for British Petroleum. 12 p.

Moulton, V.D., B.D. Mactavish and R.A. Buchanan. 2006a. Marine mammal and seabird monitoring of ConocoPhillips' 3-D seismic program in the Laurentian Sub-basin, 2005. LGL Rep. SA849. Rep. by LGL Limited, St. John's, NL, for ConocoPhillips Canada Resources Corporation, Calgary, AB. *In prep*.

Moulton, V.D., B.D. Mactavish, R.E. Harris and R.A. Buchanan. 2006b. Marine mammal and seabird monitoring of Chevron Canada Limited's 3-D seismic program on the Orphan Basin, 2005. LGL Rep. SA843. Rep. by LGL

Limited, St. John's, NL, for Chevron Canada Limited, Calgary, AB, ExxonMobil Canada Ltd., St. John's, NL, and Imperial Oil Resources Ventures Ltd., Calgary, AB. 109 p. + appendices.

Moulton, V.D., B.D. Mactavish and R.A. Buchanan. 2005. Marine mammal and seabird monitoring of Chevron Canada Resources' 3-D seismic program on the Orphan Basin, 2004. LGL Rep. SA817. Rep. by LGL Limited, St. John's, NL, for Chevron Canada Resources, Calgary, AB, ExxonMobil Canada Ltd., St. John's, NL, and Imperial Oil Resources Ventures Ltd., Calgary, AB. 90 p. + appendices.

Myers, R.A., G. Mertz, and C.A. Bishop. 1993. Cod spawning in relation to physical and biological cycles of the northern North-west Atlantic. Fish. Oceanogr. 2: 154-165.

Nelson, D. and J. Lien. 1996. The status of the Long-finned Pilot Whale, *Globicephala melas*, in Canada. Can. Field-Nat.. 110: 511-524.

Ollerhead, L.M.N., M.J. Morgan, D.A. Scruton, and B. Marrie. 2004. Mapping spawning times and locations for 10 commercially important fish species found on the Grand Banks of Newfoundland. Can. Tech. Rep. Fish. Aquat. Sci. 2522: iv + 45 p.

Orr, C.D. and J.L. Parsons. 1982. Ivory Gulls *Pagophila eburnea* and ice-edges in Davis Strait and the Labrador Sea. Can. Field-Nat. 96:323-328.

Overholtz, W.J. and G.T. Waring. 1991. Diet composition of Pilot Whales *Globicephala* spp. and Common Dolphins *Delphinus delphis* in the mid-Atlantic Bight during spring 1989. U.S. Fish. Bull. 89: 723-728.

Palka, D., A. Read and C. Potter. 1997. Summary of knowledge of White-sided Dolphins (*Lagenorhynchus acutus*) from US and Canadian Atlantic Waters. Rep. Int. Whal. Comm.ission 47: 729-734.

Payne, P.M., L.A. Selzer and A.R. Knowlton. 1984. Distribution and density of cetaceans, marine turtles and seabirds in the shelf waters of the Northeastern United States, June 1980-December 1983, based on shipboard observations. Final Rep., Contr. NA-81-FA-C-00023. Rep. From Manomet Bird Observ., Manomet, MA, for Nat. Mar. Fish. Serv., Northeast Fish. Cent., Woods Hole, MA. 264 p.

Payne, P.M., D.N. Wiley, S.B. Young, S. Pittman, P.J. Clapham and J.W. Jossi. 1990. Recent fluctuations in the abundance of baleen whales in the Southern Gulf of Maine in relation to changes in selected prey. U.S. Fish. Bull. 88: 687-696.

Petro-Canada. 1996a. Development Application Terra Nova Development Environmental Impact Statement. Prepared by Petro-Canada on behalf of Terra Nova Proponents: Petro-Canada, Mobil Oil Canada Properties, Husky Oil Operations Limited, Murphy Oil Company Ltd., and Mosbacher Operating Limited.

Petro-Canada. 1996b. Development Application Terra Nova Development Supplement A to the Application. Prepared by Petro-Canada on behalf of Terra Nova Proponents: Petro-Canada, Mobil Oil Canada Properties, Husky Oil Operations Limited, Murphy Oil Company Ltd., and Mosbacher Operating Limited. 82 p.

Petro-Canada. 1997. Development Application Terra Nova Development Supplement B to the Application. Prepared by Petro-Canada on behalf of Terra Nova Proponents: Petro-Canada, Mobil Oil Canada Properties, Husky Oil Operations Limited, Murphy Oil Company Ltd., and Mosbacher Operating Limited. 84 p. + App.

Petro-Canada. 1998. Terra Nova baseline environmental characterization data report. Prepared by Petro-Canada on behalf of Terra Nova Proponents: Petro-Canada, Mobil Oil Canada Properties, Husky Oil Operations Limited, Murphy Oil Company Ltd., and Mosbacher Operating Limited.

Piatt, J.F., D.A. Methven, A.E. Burger, R.L. McLagan, V. Mercer and E. Creelman. 1989. Baleen whales and their prey in a coastal environment. Can. J. Zool. 67: 1523-1530.

Plotkin, P.T. (ed.). 1995. National Marine Fisheries Service and U.S. Fish and Wildlife Service status reviews for sea turtles listed under the Endangered Species Act of 1973. National Marine Fisheries Service, Silver Spring, Maryland. 139 p.

Reeves, R.R., E. Mitchell and H. Whitehead. 1993. Status of the Northern Bottlenose Whale, *Hyperoodon ampullatus*. Can. Field-Nat. 107: 491-509.

Reeves, R. and H. Whitehead. 1997. Status of the Sperm Whale, *Physeter macrocephalus*, in Canada. Can. Field-Nat. 111: 293-307.

Reeves, R.R., P.J. Clapham, R.L Brownell, Jr. and G.K. Silber 1998. Recovery plan for the blue whale (*Balaenoptera musculus*). Office of Protected Resources, NMFS, NOAA, Silver Spring, Maryland.

Reeves, R., C. Smeenk, C.C. Kinze, R.L. Brownell Jr. and J. Lien. 1999. White-beaked Dolphin *Lagenorhynchus albirostris* Gray, 1846. p. 1-30. *In:* S.H. Ridgway and R. Harrison (eds.), Handbook of Marine Mammals Volume 6, the Second Book of Dolphins and Porpoises. Academic Press, San Diego, CA. 486 p.

Reeves, R.R., Smith, B.D., Crespo, E.A. and di Sciara, G.N. (compilers) 2003. *Dolphins, Whales and Porpoises: 2002-2010 Conservation Action Plan for the World's Cetaceans*. IUCN/SSC Cetacean Specialist Group. IUCN, Gland, Switzerland and Cambridge, UK.

Rice, D.W. 1989. Sperm whale *Physeter macrocephalus* Linnaeus, 1758. p. 177-233 *In* S. H. Ridgway, and R. Harrison, eds. Handbook of Marine Mammals, Volume 4. Academic Press, London, U.K. 442 p.

Robertson, G.J. and R.D. Elliot. 2002. Changes in seabird populations breeding on Small Island, Wadham Islands, Newfoundland. Canadian Wildlife Service Technical Report Series No.381. Atlantic Region.

Robertson, G.J., D. Fifield, M. Massaro and J.W. Chardine. 2001. Changes in nesting-habitat use of large gulls breeding in Witless Bay, Newfoundland. Can. J. Zool. 79:2159-2167.

Robertson, G.J., S.I. Wilhelm and P.A. Taylor. 2004. Population size and trends of seabirds breeding on Gull and Great Islands, Witless Bay Islands Ecological Reserve, Newfoundland, up to 2003. Canadian Wildlife Service Technical Report Series No. 418. Atlantic Region.

Rodway, M.S., H.M. Regehr and J.W. Chardine. 2003. Status of the largest breeding concentration of Atlantic Puffins. *Fratercula arctica*, in North America. Can. Field Nat. 117: 70-75.

Rose, G.A. 1993. Cod spawning on a migration highway in the northwest Atlantic. Nature 366: 458-461.

Rostal, D.C. 1991. The reproductive behavior and physiology of the Kemp.s ridley Sea Turtle, *Lepidochelys kempi* (Garman, 1880). Ph.D. Dissertation, Texas A&M University, College Station, TX.

SAUP 2006 [Sea Around Us Project website; http://saup.fisheries.ubc.ca/]

Schilling, M.R., I. Seipt, M.T. Weinrich, S.E. Frohock, A.E. Kuhlberg and P.J. Clapham. 1992. Behavior of individually-identified Sei Whales *Balaenoptera borealis* during an episodic influx into the southern Gulf of Maine in 1986. U.S. Fish. Bull. 90: 749-755.

Scott, W.B. and M.G. Scott. 1988. Atlantic Fishes of Canada. Can. Bull. Fish. Aquat. Sci. 219: 731 p.

Sergeant, D.E. 1962. The biology of the Pilot or Pothead Whale *Globicephala melaena* (Traill) in Newfoundland waters. Bulletin of the Fisheries Research Board of Canada 132: 1-84.

Sears, R. 2002. The Blue Whale, Encyclopedia of Marine Mammals, edited by William F. Perrin, Bernd Wursig, J. G. M. Thewissen. San Diego, CA, Academic Press. 1414 p.

Sears, R. and J. Calambokidis. 2002, Status of the Blue Whale (Balaenoptera musculus) in Canada, Report to the committee on the Status of Endangered Wildlife in canada, Canadian Wildlife Service, Ottawa. 2002.

Selzer, L.A. and P.M. Payne. 1988. The distribution of White-sided (*Lagenorhynchus acutus*) and Common Dolphins (*Delphinus delphis*) vs. environmental features of the continental shelf of the northeastern United States. Mar. Mamm. Sci. 4: 141-153.

Sergeant, D.E. 1991. Harp Seals, man and ice. Can. Spec. Pub. Fish. Aquat. Sci. 114: 153 p.

Shaver, D.J. 1991. Feeding ecology of wild and headstarted Kemp.s ridley Sea Turtles in south Texas waters. J.Herpetol. 25: 327-334.

Sigurjonsson, J. and T. Gunnlaugsson. 1990. Recent trends in abundance of blue (*Balaenoptera musculus*) and humpback whales (*Megaptera novaeangliae*) off west and southwest Iceland, with a note on occurrence of other cetacean species. Rep. int. Whal. Commn. 40: 537-551.

Simard, Y., and D. Lavoie. 1999. The rich krill aggregation of the Saguenay - St. Lawrence Marine Park: Hydroacoustic and geostatistical biomass estimates, structure, variability, and significance for whales. Can. J. Fish. Aquat. Sci.. 56:1182-1197.

Simpson, M.R. and D.W. Kulka. 2002. Status of three wolffish species (*Anarhichas lupus, A. minor*, and *A. denticulatus*) in Newfoundland waters (NAFO Divisions 2GHJ3KLNOP). Canadian Science Advisory Secretariat Research Document 2002/078.

Simpson, M.R. and D.W. Kulka. 2003. Formulation of an incidental harm permit strategy for wolffish species (Anarhichadidae). Can. Sci. Advis. Sec. Res. Doc. 2003/047.

Smith, T.D., J. Allen, P.J. Clapham, P.S. Hammond, S. Katona, F. Larsen, J. Lien, D. Mattila, P.J. Palsboll, J. Sigurjonsson, P.T. Stevick and N. Oien. 1999. An ocean-basin-wide mark-recapture study of the North Atlantic Humpback Whale (*Megaptera novaeangliae*). Mar. Mamm. Sci. 15: 1-32.

Stenson, G.B. 1994. The status of pinnipeds in the Newfoundland region. Northwest Atlantic Fisheries Organization, Scientific Council Studies 21: 115-119.

Stenson, G.B. and D.J. Kavanagh. 1994. Distribution of Harp and Hooded Seals in offshore waters of Newfoundland. Northwest Atlantic Fisheries Organization, Scientific Council Studies 21:121-142.

Stenson, G.B., J. Lien, J. Lawson and R. Seton. 2003. Ice entrapments of blue whales in southwest Newfoundland: 1868-1992. p. 15-16 in V. Lesage and M.O. Hammill (eds.), Proceedings of the workshop on the development of research priorities for the northwest Atlantic blue whale population, 20-21 November 2002. DFO Can. Sci. Advis. Sec. Proceed. Ser. 2003/031.

Stenson, G.B. and B. Sjare. 1997. Seasonal distribution of Harp Seals, *Phoca groenlandica*, in the Northwest Atlantic. ICES. C.M. 1997/10 p.

Stobo, W.T. and C.T. Zwanenburg. 1990. Grey Seal (*Halichoerus grypus*) pup production on Sable Island and estimates of recent production in the Northwest Atlantic. p. 171-184. *In:* W.D. Bowen (ed.), Population biology of sealworm (*Pseudoterranova decipiens*) in relation to its intermediate and seal hosts. Can. Bull. Fish. Aquat. Sci. 222 p.

Stone, C.J. 2003. The effects of seismic activity on marine mammals in UK waters, 1998-2000. Joint Nature Conservation Committee. JNCC Report No. 323. 78 p.

Templeman, W. 1966. Marine resources of Newfoundland. Bull. Fish. Res. Board Can. 154: 170 p.

Templeman, W. 1986a. Spotted forms of the northern wolffish (*Anarhichas denticulatus*) in the Northwest Atlantic. J. Northw. Atl. Fish. Sci. 7: 77-80.

Templeman, W. 1986b. Contribution to the biology of the spotted wolffish (*Anarhichas minor*) in the Northwest Atlantic. J. Northw. Atl. Fish. Sci. 7: 47-55.

Templeman, W.T. 1979. Migrations and intermingling of stocks of Atlantic cod, *Gadus morhua*, of the Newfoundland and adjacent areas from tagging in 1962-66. ICNAF (Int. Comm. Northwest Atl. Fish.) Res. Bull. 14: 5-50.

Thomas, V.G. and S.D. MacDonald. 1987. The breeding distribution and current population status of the Ivory Gull in Canada. Arctic 40:211-218.

Valsecchi, E., P. Palsboll, P. Hale, D. Glockner-Ferrari, M. Ferrari, P. Clapham, F. Larsen, D. Mattila, R. Sears, J. Sigurjonsson, M. Brown, P. Corkeron and B. Amos. 1997. Microsatellite genetic distances between oceanic populations of the Humpback Whale (*Megaptera novaeangliae*). Molec. Biol. Evol. 14: 355-362.

Vázquez, A. 2002. Results from bottom trawl survey on Flemish Cap of July 2001. NAFO SCR Doc. 01/12. 8 p.

Wallace, S.D. and J.W. Lawson. 1997. A review of stomach contents of Harp Seals (*Phoca groenlandica*) from the Northwest Atlantic: an update. International Marine Mammal Association 97-01.

Wang, J.Y., D.E. Gaskin and B.N. White. 1996. Mitochondrial DNA analysis of Harbour Porpoise, *Phocoena phocoena,* subpopulations in North American waters. Can. J. Fish. Aquat. Sci. 53: 1632-1645.

Waring, G.T., P. Gerrior, P.M. Payne, B.L. Parry and J.R. Nicolas. 1990. Incidental take of marine mammals in foreign fishery activities off the northeast United States, 1977-1988. U.S. Fish.Bull. 88: 347-360.

Waring, G., R. Pace, J. Quintal, C. Fairfield and K. Maze-Foley. 2004. U.S. Atlantic and Gulf of Mexico Marine Mammal Stock Assessments – 2003. NOAA Tech. Mem. NMFS-NE-182. 269 pp.

Westgate, A.J. and K.A. Tolley. 1999. Geographical differences in organochlorine contaminants in Harbour Porpoises *Phocoena phocoena* from the western North Atlantic. Mar. Ecol. Prog. Ser. 177: 255-268.

Wimmer, T., and Whitehead, H. 2004. Movements and distribution of northern bottlenose whales, *Hyperoodon ampullatus*, on the Scotian Slope and in adjacent waters. Can. J. Zool. **82**: 1782–1794.

Witzell, W.N. 1999. Distribution and relative abundance of sea turtles caught incidentally by the U.S. pelagic longline fleet in the western North Atlantic Ocean, 1992-1995. U.S. Fisheries Bulletin 97: 200-211.

Whitehead, H. 1982. Populations of Humpback Whales in the Northwest Atlantic. Rep. Int. Whal. Comm. 32: 345-353.

Whitehead, H. 2003. *Sperm whales: social evolution in the ocean.* Chicago, IL: University of Chicago Press

Whitehead, H., and C. Glass. 1985. The Significance of the Southeast Shoal of the Grand Bank to Humpback Whales and Other Cetacean Species. Can. J. Zool. 63:2617-2685.

Whitehead, H. and J.E. Carscadden. 1985. Predicting inshore whale abundance - whales and capelin off the Newfoundland coast. Can. J. Fish. Aquat. Sci. 42: 976-981.

Wiese, F. K. and W.A. Montevecchi. 1999. Marine bird and mammal surveys on the Newfoundland Grand Bank from offshore supply vessels. Contract Report Prepared for Husky Oil. 23 p. + App.

Winn, H.E., and N.E. Reichley. 1985. Humpback whale *Megaptera novaeangliae* (Borowski, 1781). 241-272 in S.H. Ridgway and R. Harrison, eds. Handbook of marine mammals, Volume 3 The sirenians and baleen whales. Academic Press.

Witzell, W.N. 1999. Distribution and relative abundance of sea turtles caught incidentally by the U.S. pelagic longline fleet in the western North Atlantic Ocean, 1992-1995. U.S. Fish. Bull. 97: 200-211.

Yochem, P.K. and Leatherwood, S. (1985). Blue whale Balaenoptera musculus (Linnaeus 1758). *In*: Handbook of Marine Mammals, Volume 3, The Sirenians and Baleen Whales'. (Eds S.H. Ridgway and R. Harrison.) pp. 193-240. (Academic Press: London.)

Personal Communication

Dugal, R.	Petro-Canada, St. John's, NL.
Evans, J.	Petro-Canada, St. John's, NL
Kaderali, A.	Husky Oil Operations, St. John's, NL.
Mactavish, B.	LGL Limited, St. John's, NL.
McIntyre, J.	C-NLOPB, St. John's, NL.
Thomas, P.	CWS
Williams, U.	Petro-Canada, St. John's, NL