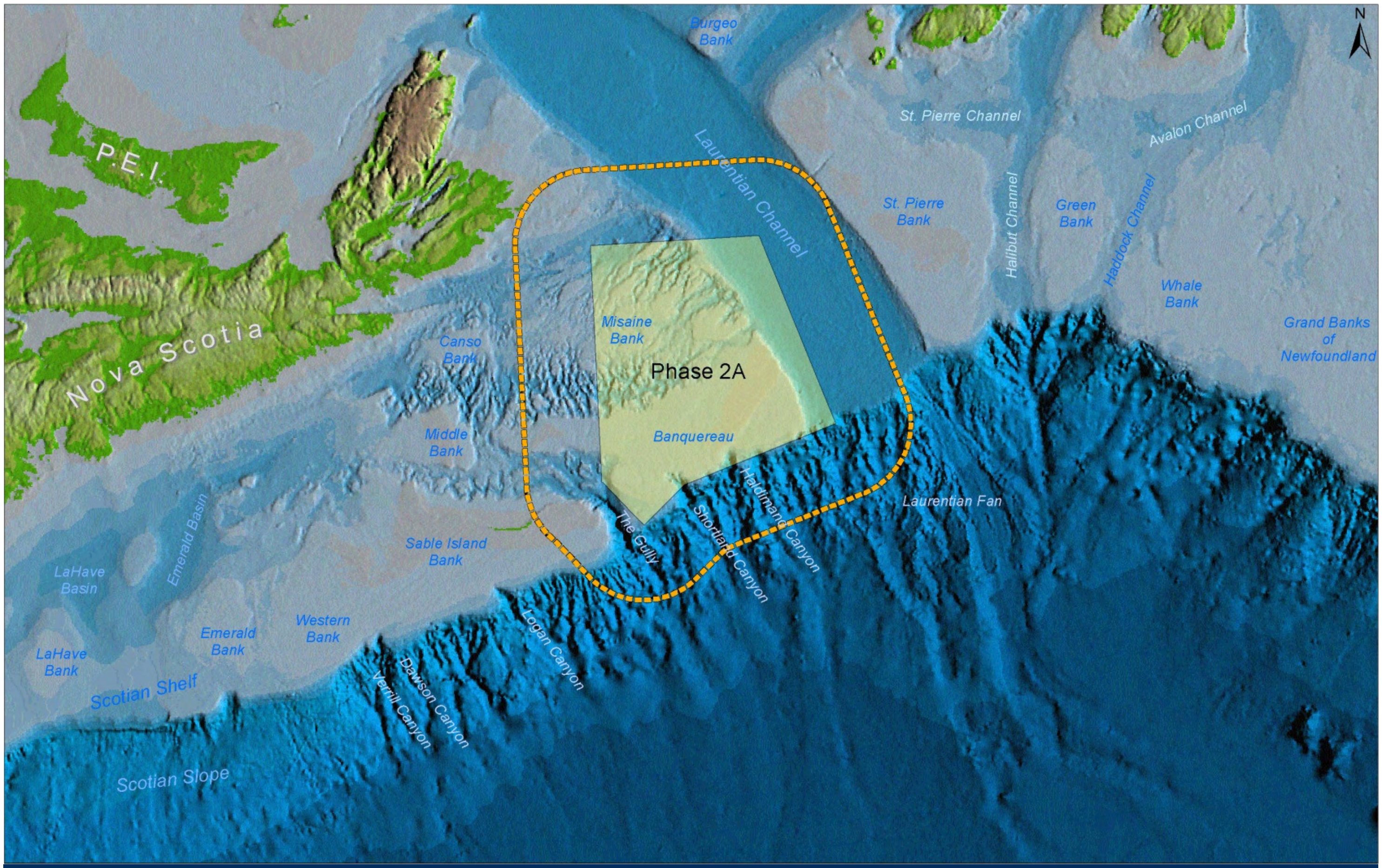
CNSOPB CANADA-NOVA SCOTIA OFFSHORE PETROLEUM BOARD

Final Report



STRATEGIC ENVIRONMENTAL ASSESSMENT FOR OFFSHORE PETROLEUM EXPLORATION ACTIVITIES

Misaine and Banquereau Banks (Phase 2A)

Prepared for:

CANADA-NOVA SCOTIA OFFSHORE PETROLEUM BOARD

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Executive Summary

This report is a Strategic Environmental Assessment (SEA) of potential petroleum exploration activities on the Eastern Scotian Shelf – Misaine and Banquereau Banks. This SEA examines potential environmental effects that may be associated with the potential issuance of future exploration rights granted by the Canada-Nova Scotia Offshore Petroleum Board (CNSOPB) on the Misaine and Banquereau Banks and discusses general restrictive or mitigative measures that should be considered during an exploration program application. The SEA is not intended to replace project-specific environmental assessments (EAs) which would be required for any proposed exploration program; rather it is intended to support and facilitate future project-specific EAs.

The scope of exploration activities considered in the SEA includes geophysical survey activities (*e.g.*, seismic programs), geohazard surveys, geotechnical surveys, exploratory and delineation drilling, vertical seismic profiling, well abandonment, and vessel and helicopter traffic. Routine and accidental events were considered.

The “Project Area” considered for the SEA included the potential area within which exploration rights could be issued by the CNSOPB. This Project Area excludes the Gully Marine Protected Area (MPA). A larger “Study Area” was established as a buffer around the Project Area recognizing a potential zone of influence of environmental effects from activities that could occur within the Project Area. Although the Project Area is predominantly on the Misaine and Banquereau Banks, the larger Study Area extends into the Laurentian Channel and into the deeper waters on the Scotian Slope where the Gully and several other submarine canyons exist.

There are several fish, marine mammal, sea turtle and bird species with special conservation status known to occur within the Study Area, including the endangered blue whale, North Atlantic right whale, Northern bottlenose whale, leatherback turtle, Piping Plover, and Roseate Tern. Special Areas within the SEA Study Area include an *Oceans Act* Marine Protected Area (MPA) and Areas of Interest (AOIs), *Species at Risk Act* Critical Habitat areas, *Fisheries Act* closure areas (*e.g.*, coral conservation areas), and Ecologically and Biologically Significant Areas (EBSAs). Sable Island National Park Reserve is located just west of the Study Area.

The Study Area is heavily fished, particularly on the banks, with invertebrate fisheries (particularly surf clams, snow crab and shrimp) being the dominant fisheries. Other ocean uses in and around the Study Area include commercial shipping, scientific research, military activity and offshore petroleum activity.

In recognition of the existing environment features, potential exploration activities, key relevant legislation and guidelines, and stakeholder interests, the scope of the SEA was established, focusing on the following Valued Environmental Components (VECs):

- Species of Special Status (species listed by the *Species at Risk Act*, Committee on the Status of Endangered Wildlife in Canada (COSEWIC), and migratory birds);
- Special Areas (designated areas of special interest due to ecological/conservation sensitivities); and
- Fisheries (commercial, recreational, and aboriginal fisheries).

For each VEC, the SEA explored potential effects of exploration activities drawing on existing knowledge and literature, recommended mitigation and planning considerations, and discussed data gaps and uncertainties. Adherence to standard regulatory requirements/guidelines, including but not limited to, the Statement of Canadian Practice with Respect to the Mitigation of Seismic Sound in the Marine Environment (SOCP), Offshore Waste Treatment Guidelines, Offshore Chemical Selection Guidelines, and Compensation Guidelines Respecting Damage Relating to Offshore Petroleum Activity, was taken into consideration as standard mitigation. It should be noted however, that in some cases, these requirements would be considered minimum standards and enhanced mitigation may be required (*e.g.*, enhanced mitigation for seismic surveys beyond minimum requirements stated in the SOCP).

Table E.1 provides a high level summary of effects and key mitigation for each VEC (refer to Table 9.1 for full summary of mitigation).

Table E.1 Summary of Key Issues and Mitigation

VEC	Key Issues/Potential Effects	Key Mitigation
Species of Special Status	Noise, traffic, lights, and spills can cause physiological and behavioral effects and change in habitat quality which can affect mortality risk.	• Adherence (at a minimum) to SOCP and other regulatory guidelines • Spill modelling and oil spill response plan (OSRP) • Acoustic modelling • Pre-spud and post-drilling surveys
Special Areas	Noise, traffic, and spills can cause change in habitat quality.	• Adherence (at a minimum) to SOCP and other regulatory guidelines • Spill modelling and OSRP • Pre-spud surveys • Enhanced mitigation and Environmental Effects Monitoring (EEM) may be required within, or adjacent to, Special Areas (*e.g.* Shortland and Haldimand Canyons, St. Anns Bank AOI and Laurentian Channel AOI) • Avoidance of the Gully MPA (seismic and exploratory drilling), Shortland and Haldiman Canyons (exploratory drilling) and the *Lophelia* Coral Conservation Areas (exploration drilling)

Table E.1 Summary of Key Issues and Mitigation

VEC	Key Issues/Potential Effects	Key Mitigation
		• Codes of conduct for work in proximity to Special Areas
Fisheries	Physiological and behavioral effects on fisheries resources may affect catchability; presence of drilling and/or seismic operations can result in loss of access and fisheries gear loss and damage.	• Adherence to SOCP and other regulatory guidelines • Early and ongoing consultation with fisheries • Fisheries Liaison Officer presence on seismic vessels • Coordination of program activities with fishing industry to reduce potential conflict during peak fishing times • Adherence to CNSOPB Compensation Guidelines

Various data gaps and uncertainties exist with respect to the understanding of effects of exploration on marine species. In light of these gaps, a precautionary approach to oil and gas exploration should be taken in the vicinity of sensitive areas and the presence of species of special status. This may mean enhanced mitigation (beyond regulatory compliance) and monitoring until understanding of potential interactions and effects can be improved and appropriate mitigation developed accordingly. Future exploration that may occur in the Study Area offers a potentially valuable platform to conduct further research to address knowledge gaps. Stakeholder consultation will play an important role in mitigating effects on fisheries and other ocean users.

Assuming adherence to applicable standards and regulations and implementation of mitigation and monitoring as recommended, the issuance of exploration rights in the Phase 2A Project Area is not expected to result in unacceptable adverse environmental effects (including cumulative effects) such that populations of species of special status or the integrity of special areas would be compromised. Effects of exploration on fisheries are also not expected to result in unacceptable effects provided the implementation of recommended mitigation and ongoing communication with fishery stakeholders.

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1.0 Introduction

This report is a Strategic Environmental Assessment (SEA) of potential petroleum exploration activities on the Eastern Scotian Shelf – Misaine and Banquereau Banks. SEA incorporates a broad-based approach to environmental assessment (EA) that examines potential environmental effects that may be associated with a plan, program or policy proposal and facilitates environmental management considerations at the earliest stages of exploration planning.

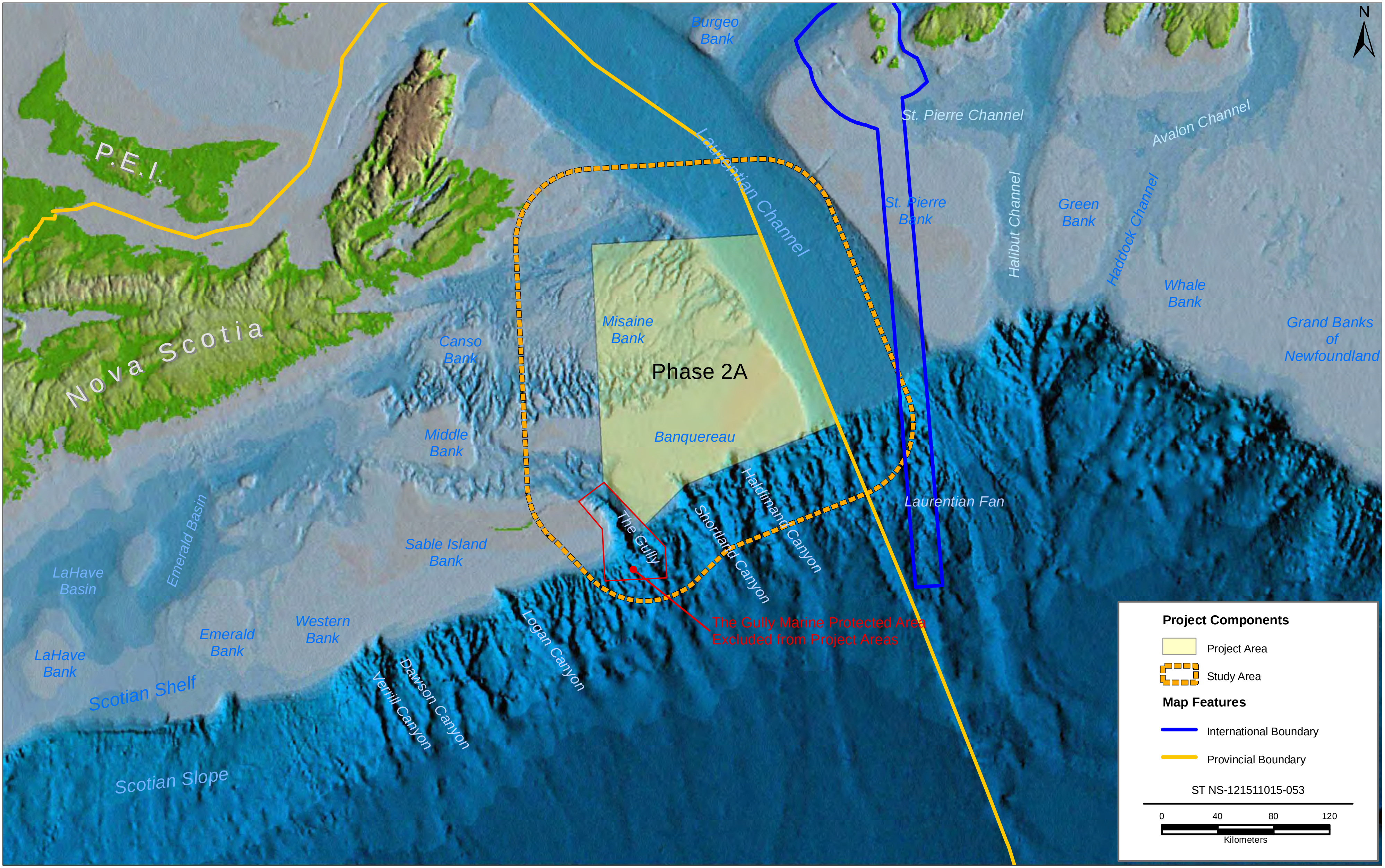
This SEA is intended to assist the Canada-Nova Scotia Offshore Petroleum Board (CNSOPB) in its determination with respect to the potential issuance of future exploration rights within the Misaine and Banquereau Banks SEA area including general restrictive or mitigative measures that should be considered during the exploration program application and program specific environmental assessment process.

Notable features for environmental management consideration within or directly adjacent to the Phase 2A Project Area include the Gully Marine Protected Area (MPA), St. Anns Bank Area of Interest (AOI), the Laurentian Channel AOI, and the Haldimand and Shortland Canyons. Figure 1.1 shows the Assessment Area for Phase 2A which includes the Project Area as defined by the CNSOPB and a larger Study Area which has been delineated in recognition of a potential zone of influence of environmental effects for exploration activities which could potentially occur within the Project Area (refer to Section 4.4 for more information on assessment boundaries).

The SEA:

- defines general exploration activities;
- provides an overview of the existing environment within the Study Area;
- broadly describes potential adverse environmental effects associated with offshore oil and gas exploration;
- highlights relevant knowledge and data gaps; and
- recommends general mitigation measures for offshore petroleum exploration activities.

The SEA therefore identifies key environmental issues for the CNSOPB as well as prospective future operators with interest in the parcels. The SEA is not intended to replace project-specific environmental assessments (EAs) which would be required for any proposed exploration program; rather it is intended to support and facilitate future project-specific EAs. This SEA has been prepared to meet requirements presented in the Scoping Document (Appendix A) which was subject to regulatory and public review. Additional information on the objectives and scope of the SEA is included in Section 4.



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CLIENT:
Canada - Nova Scotia Offshore Petroleum Board

Eastern Scotian Shelf - Misaine and Banquereau Bank Strategic Environmental Assessment

SEA Study Area

FIGURE NO.: 1.1

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2.0 Exploration Activities

Generic descriptions of potential exploration activities to be considered in the SEA are presented in Table 2.1. Consideration of routine emissions and discharges have been guided by the scope of the SEA (refer to Appendix A) assuming compliance with applicable regulations and guidelines including: the Offshore Waste Treatment Guidelines (OWTG) (NEB *et al*. 2010), Nova Scotia Offshore Drilling and Production Regulations (and associated guidelines), Offshore Chemical Selection Guidelines (NEB *et al*. 2009), Compensation Guidelines Respecting Damage Relating to Offshore Petroleum Activity (C-NLOPB and CNSOPB 2002), and Environmental Protection Plan Guidelines (C-NLOPB *et al*. 2011).

Table 2.1 Generic Description of Exploration Activities

Exploration Activity	Details
Geophysical survey activities (2D seismic, 3D seismic, 3D Wide Azimuth (WAZ) seismic)	• Seismic surveys are the first step in oil and gas exploration in which sound waves are used to develop an image of subsurface strata and structure features where hydrocarbons could accumulate and be retained. • Sound waves are typically generated by air guns with reflections from subsurface rock being recorded by hydrophones (streamers) towed behind the survey vessel. • Air guns are typically arranged in arrays of 12-48 guns of various sizes distributed over a horizontal area approximately 20 m inline by 20 m cross line. • An array typically has 3-6 sub arrays called strings with each string being made up of 6-8 air guns. • The array is towed approximately 200 m behind the vessel and suspended by floats at a depth of 3m-10 m. • The hydrophone streamer is also towed behind the vessel (usually 4500-6000 m in length but can be up to 10,000 m in length). • The air guns operate at 2000 psi or 137 bar and fire every 10-15 seconds. • Most of the emitted energy lies within the 10 – 120 Hz range with some energy in the 500 – 1000 Hz range. • In shallow waters (25 m-50 m) air guns can be audible at distances up to 75 km, while in deeper waters they can be audible at distances over 100 km. • Seismic sources for 2D, 3D, and 3D WAZ surveys are directed in the downward position. • Typical zero-to-peak source levels for exploration seismic arrays are 245-260 dB relative to 1 µPa at 1m. • 2D seismic surveying is the simplest and most inexpensive method, typically using one air gun array and one seismic streamer and are used to create 2D slices of the sea bottom with several kilometer distances between each survey line. • 3D seismic surveys use a series of parallel passes through an area with a vessel towing an air gun array with 6-10 seismic streamers at a speed of 5 knots. 3D methods require the operating vessel to transit along closely spaced parallel transects approximately 100-500 m apart. Multiple streamer cables and air gun arrays can produce data sets that can be processed with advanced software to reveal the 3D geometry of the surface at high resolutions. • 3D WAZ seismic surveys are used for more complex geological settings, particularly in basins underlain with salt, like those found in deep water areas of the Nova Scotia offshore. The configuration of the survey can vary; multi-vessel configurations are used where one or two cable vessels are accompanied by up to four additional

Table 2.1 Generic Description of Exploration Activities

Exploration Activity	Details
	vessels towing source arrays only (whereas conventional 3D involves a single vessel towing both a source and receiver array). This type of configuration is more logistically and technically complex, and has a larger survey footprint. Refer to Figure 2.1 for a typical 3D WAZ survey vessel configuration. • 3D WAZ seismic surveys take longer to change survey lines (turn), usually 5 -7 hours, compared to 2-3 hours for typical 3D seismic surveys. • Up to five support vessels may be required to support a 3D WAZ survey as compared to 1-2 support vessels of typical 3D surveys. • Seismic surveys (2D and 3D) typically take 14-30 days to complete. • 3D wide azimuth surveys usually do not take longer than 120 days dependent on the area being surveyed. Source: Hurley 2009; DFO 2011a; Shell 2012; LGL 2012
Geohazard surveys	• Geohazard surveys are used for: o Identification of shallow geological hazards such as slump scars, channels, faulting, shallow gas accumulations, gas hydrates, and shallow trap closure o Acquisition of detailed bathymetry o Identification of surficial geology, boulder till, channel till, slumping, faulting, and gas charged shallow sediments o Determining the nature and characteristics of seafloor sediments o Identification of iceberg scours, morphology of seabed depositional units, seafloor obstruction and bedform indication of seafloor sediment dynamics o Location and identification of seafloor installation, wrecks and cables. • Geohazard surveys are conducted via 2D high resolution (2DHR) digital seismic (low energy) consisting of a small air gun array and a single streamer 1200 m or less in length towed 2-4 m below the surface. • Sidescan sonar and multibeam echo sounders may also be used to acquire seabed images. • If the sidescan sonar and multibeam identify potential debris a proton magnetometer will be used. • Camera systems and sediment samples of the seafloor are typically used to corroborate data. • A seabed imaging system is typically used to obtain high resolution sub-bottom profiles. • A boomer or speaker acoustic source trawled within the water column at approximately 20 to 40 m off the seabed is used to capture a sub bottom image penetrating 40 to 100 m. Source: Corridor Resources Inc. 2010; Hurley 2011
Geotechnical Survey	• Geotechnical sampling can involve a variety of technologies including geotechnical boring (well site locations), vibrocores and cone penetrometer technology (CPT). • Surficial grab sampling and underwater video drop cameras are typically taken at each well site. Source: Hurley 2011; Hurley and Stantec 2010
Exploratory and Delineation Drilling	• Drilling into the geological structure is conducted to identify potential hydrocarbon resources. • In shallow waters (less than 100 m) a jack-up rig is usually used; in deeper waters a drill ship or semi-submersible rig is usually used. • Offshore wells are typically drilled in stages, starting with a large diameter conductor hole (approximately 90 cm) being drilled several hundred meters into the seafloor. Water-based mud (WBM) is used to drill this portion of the well as there is no way to return the drilling muds and cuttings to the drilling unit before the riser is installed. As a result, these muds are released onto the seafloor. • The drill string is removed and a steel casing is run and cemented into place to prevent the wall of the hole from caving in and to prevent the seepage of muds and other fluids.

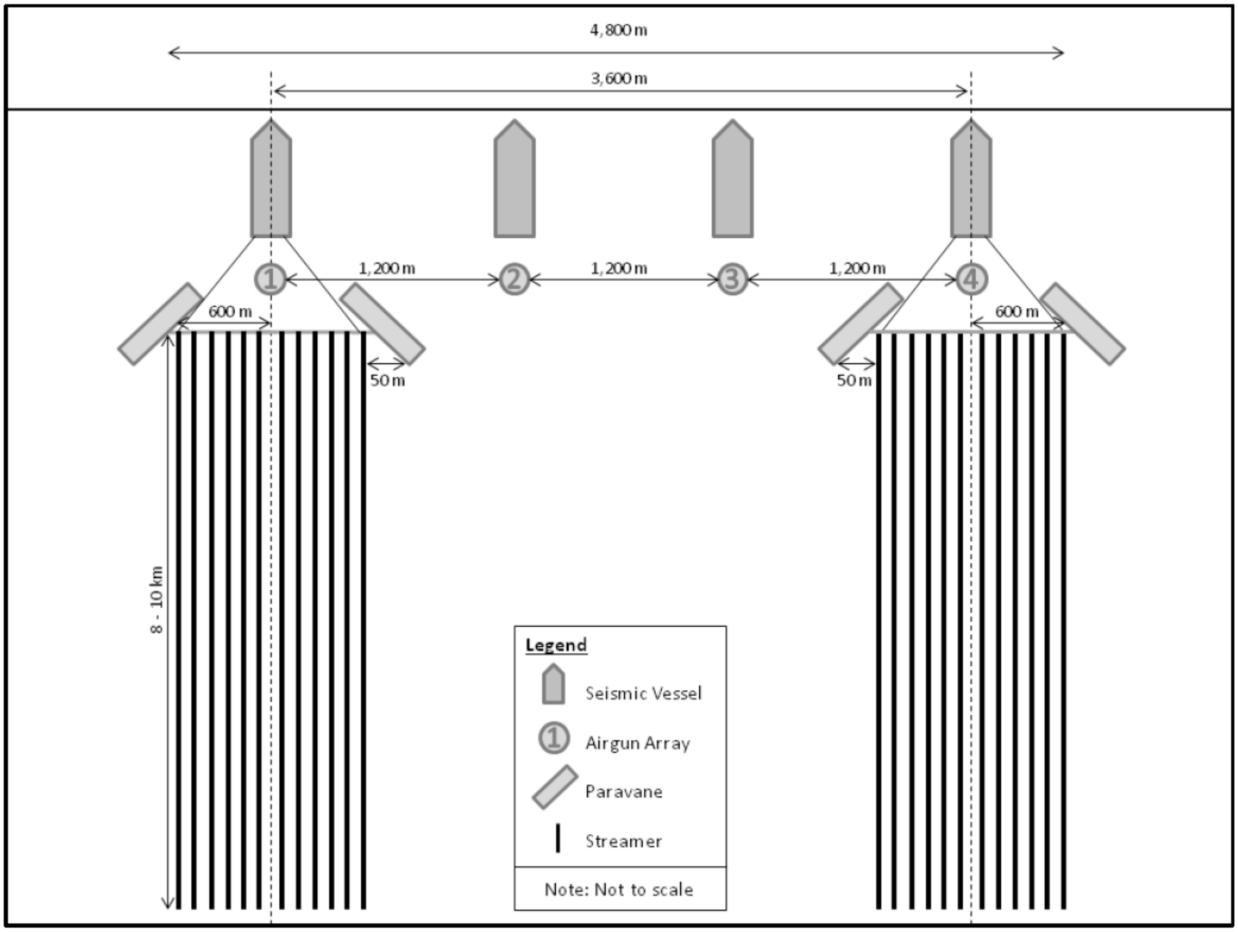
Table 2.1 Generic Description of Exploration Activities

Exploration Activity	Details
	• The casing also ensures that there is adequate pressure integrity to allow a blowout preventer (BOP) and the drilling riser to be installed. The BOP is a system of high pressure valves that prevent water or hydrocarbons from escaping into the environment in the event of an emergency or equipment failure. • The drill bit and string are then lowered through the BOP and into the surface hole. The bit begins drilling at the bottom of the hole, and extra joints are added to the drill string as the drill bit cuts the hole. • When a section of the well is complete, the drill string is pulled out and the sections of the casing are joined together, lowered into the well and cemented into place. • For this portion of the well, the drilling riser connects the casing set at the seafloor up to the drilling unit, which allows the return of cuttings and drilling muds to the surface drilling unit where processing takes place. • Synthetic-based muds (SBMs) may be used in drilling lower well sections if the use of water-based fluids is technically impractical. • SBMs are transported with the cuttings up the riser to the drilling rig for recovery and reuse. Once onboard, the cuttings are removed from the drilling muds in successive separation stages, with some fluids being reconditioned and reused, and spent fluids returned to shore for disposal. • WBM cuttings may specifically be discharged at the drill site provided they are treated prior to discharge to meet Offshore Waste Treatment Guidelines; cuttings containing oil-based mud (OBM) or SBM are collected and returned to shore for disposal. • Levels of radiated drilling noise are dependent on rig type. Jack-up rigs tend to be relatively quiet. Semi-submersible are relatively quiet themselves although dynamic positioning thrusters are a potential source of noise. Drillships tend to be fairly noisy since heavy machinery is situated close to the hull thereby radiating more noise into the marine environment. • Once the exploratory well has been drilled the well is either removed or left in a safe condition for potential future use. • If hydrocarbons are encountered, the size of the oil and/or gas reserves are assessed through drilling of appraisal or delineation wells. • The typical duration of exploratory drilling program ranges from 30-90 days. Source: JWEL 2003; Hurley 2009
Vertical Seismic Profiling	• A vertical seismic profile (VSP), also known as a check-shot survey, is required for all exploration and delineation wells in the Nova Scotia offshore. • A VSP is recorded after the drilling of a well has been completed to obtain accurate “time-to-depth ties”. • This is necessary as seismic data are recorded in time and wells are drilled in meters. • The VSP is taken by placing a string of geophones down the well, with a seismic source suspended from the drilling unit. The seismic source is usually similar to the seismic survey array but is usually smaller with a peak output pressure of 240-250 dB. • Checkshots are recorded every 25 m-100 m. • If significant hydrocarbons are found, the well is then evaluated and tested, which may involve formation flow testing. • The duration of VSP operations is in the order of hours to days. Source: JWEL 2003; Encana 2005
Well Abandonment	• Once drilling and any well testing activities are complete, wells are typically abandoned. • Cement mixtures or mechanical devices are used to plug the well. • The well casing is cut and removed just below the surface of the sea floor and all previously installed equipment is removed. • Wellheads are removed from the seafloor, often using a mechanical casing/wellhead cutting device. If the device fails, operators often use a chemical/directed explosive

Table 2.1 Generic Description of Exploration Activities

Exploration Activity	Details
	method to detach the wellhead. If this method is used the charge is usually set at a minimum of 1m below the sea substrate. • A remotely operated vehicle (ROV) is used to inspect the seabed to ensure that no equipment or obstructions remain in place. Source: JWEL 2003
Vessel and Helicopter Traffic	• During seismic surveys vessel traffic will typically include one seismic vessel, with one or two small chase vessels which are used to look for fishing activity in the area and to prevent gear loss and entanglement. • During 3D WAZ seismic surveys vessel traffic will typically include two seismic vessels with up to an additional four vessels towing source arrays only. • Helicopters may be used for resupply, crew changes, or medical emergencies depending on the length of the seismic survey. • An exploration drilling program would likely require 2-3 supply vessel trips per week with a dedicated stand-by vessel attending the rig throughout drilling operations. • Helicopter flights would be used to transport personnel to and from the drilling rig approximately 4 times per week. • Work boats and helicopters would operate out of a shorebase therefore transit to the Project Area is also considered. • Supply vessels usually range in size from 20 m to 100 m. Source: Thompson *et al.* 2000; Husky 2010

Figure 2.1 Typical 3D WAZ Survey Vessel Configuration



Source: Shell 2012

3.0 Key Characteristics of the Environment

This section provides an overview of key features of the existing environment in the Study Area that could potentially interact with or influence elements of a petroleum exploration program.

3.1 PHYSICAL CHARACTERISTICS

The Scotian Shelf is part of the North American Continental Shelf off of Nova Scotia. The Scotian Shelf is 700 km long and between 125 and 230 km wide. The northeast channel separates the Shelf from the Gulf of Maine to the southwest, while the Laurentian Channel is the natural boundary between Newfoundland and the Shelf to the northeast (DFO 2011a). The Scotian Shelf is a broad continental shelf made up of a number of shallow offshore banks and inner basins. The Eastern Scotian Shelf extends from the Laurentian Channel in the northeast to a line from Halifax south to the shelf break in the southwest, covering an area of approximately 100,000 km^2.

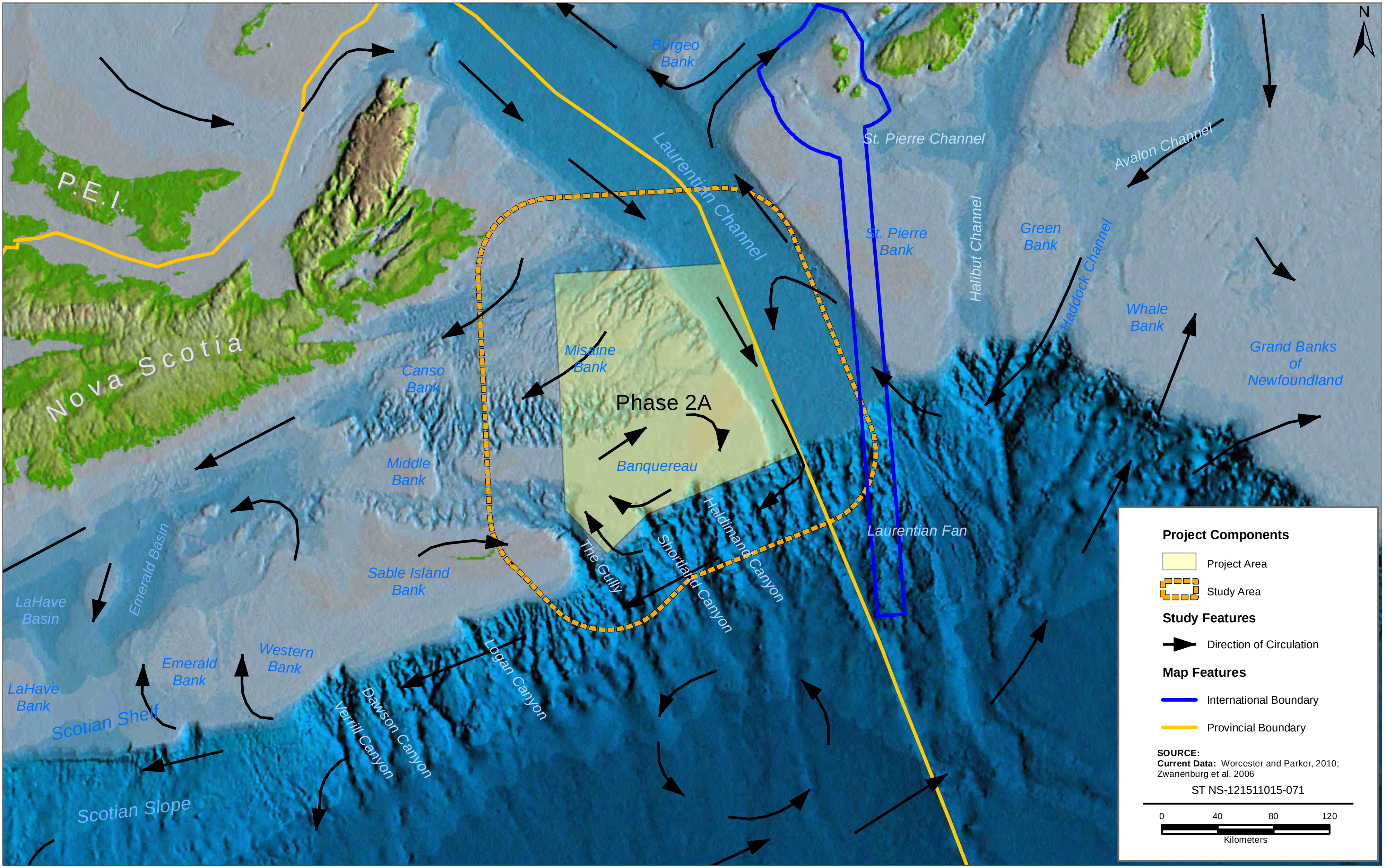
The Scotian Shelf can be divided into the inner, middle, and outer shelf regions. The inner portion of the shelf extends from the coast out to approximately 25 km offshore and is an extension of coastal bedrock (Zwanenberg *et al*. 2006). The eastern portion of the middle shelf is an area of complex topography containing many small-sized banks and basins resulting from repeat glaciation. The outer shelf is a series of relatively flat shallow banks. In the east, Sable Island is an exposed portion of the Sable Island bank, creating a unique feature on the outer shelf regions. Also within the Study Area are Misaine and Banquereau Banks. The average depth of the shelf is approximately 90 m. At the edge of the shelf at the 200 m isobath the continental slope begins as the shelf becomes steeper to a depth of 2000 m. At the depths of 2000 m – 5000 m the slope is more gradual, with this area known as the continental rise.

There are several large submarine canyons that emerge on the outer shelf and continental rise. Some of the major canyons located on the eastern Scotian Shelf include Haldimand Canyon, Shortland Canyon, and the Gully (Zwanenberg *et al.* 2006). At 15 km wide and over 65 km in length, the Gully is the largest canyon on the Scotian Shelf. The size and shape of the Gully influences water transport to and from the Shelf (DFO 2011b).

The physical environment on the Scotian Shelf is governed by its close proximity to the meeting place of major currents of the northwest Atlantic and its complex bathymetry. The three major currents influencing the movement of water on the Scotian Shelf are: the Nova Scotia Current; the Shelf Break Current (an extension of the Labrador Current); and the Gulf Stream (Zwanenburg *et al.* 2006). Relatively cool, fresh waters flow from the Gulf of the St. Lawrence through the Cabot Strait. A portion of this water turns at Cape Breton to flow southwest along Nova Scotia’s Atlantic coast, while the rest of the flow continues through the Laurentian Channel to the shelf break. At the shelf break it turns and joins the Shelf Break Current to flow southwest along the shelf edge. The Shelf Break Current is the largest coast transport feeder on the Eastern Scotian Shelf (Han and Loder 2003). The Gulf Stream flows northeastwards, and its warmer, more saline waters mix with the cool Labrador Current waters over the Scotian Slope, forming a mass of water known as slope water (DFO 2011a). This slope water periodically leaks onto the Shelf through channels and canyons. The shelf bottom consists of a series of submarine banks and cross-shelf channels along the outer shelf and basins and troughs along the central shelf which limit and guide the near-bottom flow. The predominant flow of cold, fresh water from the northeast to the southwest results in a general increase in both temperature and salinity as you move closer to the southwest (Zwanenburg *et al.* 2006). This flow is strongest in the winter and weakest in the summer. For an overview of currents on the Scotian Shelf refer to Figure 3.1.

The eastern end of the Scotian Shelf is made up of mostly cold fresh water from the Gulf of St. Lawrence and the Newfoundland Shelf. The water tends to be cold because the Banquereau and Sable Island Banks prevent the mixing of warm saline water from the Gulf Stream. As a result, the water in this area tends to be cold, especially at depth. A dominant oceanographic feature of the eastern Scotian Shelf is the strong southwesterly flow of the Nova Scotia Current, centered between 100 m and 150 m isobaths on the inner shelf. Current speeds are typically in the range of 5-35 cm/s. (Worcester and Parker 2010; Brickman and Drozdowski 2012). Further offshore at the shelf break, the Shelf Break Current produces current speeds ranging from 15 – 55 cm/s (Han and Loder 2003). The strongest current speeds can be found as the water exiting the Laurentian Channel wraps around Banquereau Bank. Here the water makes a sharp southeasterly turn to travel along the shelf edge. Further offshore of the shelf edge, the currents are much weaker and generally travel in a northeasterly direction. In this offshore area, eddies peel off the Gulf Stream and infiltrate the shelf through the valley and canyons of the outer banks (Brickman and Drozdowski 2012).

At the shelf edge, outer marginal water masses collide to form a frontal zone which shifts in location from year to year. At this frontal zone, cold slope water mixes with the warm water at the edge of the outer banks, supplying nutrients and promoting phytoplankton growth (WWF 2009). The eddies, which peel off the Gulf Stream, also rework the benthic environment here, disturbing the seabed and bringing nutrients towards the surface waters. This frontal zone is an area of high primary productivity and is also a location where species are deposited after long voyages north on the Gulf Stream (WWF 2009).



SOURCE:
Current Data: Worcester and Parker, 2010; Zwanenburg et al. 2006

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PREPARED BY: M. Huskins-Shupe	Eastern Scotian Shelf - Misaine and Banquereau Bank Strategic Environmental Assessment	FIGURE NO.: 3.1
REVIEWED BY: C. Shupe		DATE: Dec 07, 2012
CLIENT: Canada - Nova Scotia Offshore Petroleum Board	**Overview of Currents on the Scotian Shelf**	Stantec

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The North Atlantic Oscillation (NOA) is the dominant atmospheric pattern in the North Atlantic Ocean, which is the significant large scale abiotic driver of the Scotian Shelf ecozone (Drinkwater *et al*. 1998; Petrie 2007; Worcester and Parker 2010). The Scotian Shelf is primarily affected by advection. The NOA is a back and forth pattern between a high pressure cell over the Azores in the south east Atlantic and a low pressure cell over Iceland. The NOA index is a measure in the difference in sea level pressure between the two locations in winter. A high index brings increased westerly winds, precipitation, and warmer waters to the Scotian Shelf. The opposite forcing occurs with a low NOA index bringing drier conditions, a decrease in storm conditions, and cooler water temperatures as a result of an increase in influence from the Labrador Current.

Table 3.1 summarizes physical characteristics of the Study Area.

Table 3.1 Overview of Physical Characteristics

Physical Characteristics	
Sea Bed Characteristics	• The middle shelf is characterized by a wide and complex network of valleys, ridges, and small gravel covered banks. • Basins have been smoothed by glaciers and recently filled with the deposition of silt. These basins span across the middle of the Scotian Shelf. In certain areas, boulder covered till ridges protrude through the mud, silt, and pockmarks. • There are several large and shallow banks that are the defining features of eastern shelf and outer banks. These include the Sable Island, Misaine and Banquereau Banks. • Sable Island Bank is characterized by complex fields of sand ridges with average heights of 12 m and widths of 6.4 km. Sable Island is surrounded by a shore face that extends to 20 m in depth. Sand ridges occur on the lower part of the shore face and extend offshore on both sides of the island. The larger and more extensive ridges lie along the south side of the island and in the deeper water to the west. • The shallow outer banks tend to have sand and/or gravel benthic structure, with some areas having an extensive shell bed cover. Storms and currents constantly shape the tops of the banks forming sand into a wide variety of ridges, waves and ripples. • The deeper basins are covered in fine silt and clay interspersed with coarse glacial material. • The Laurentian Channel divides the Scotian Shelf and the Grand Banks. The channel is a deep trough created from a former river valley eroded by glacial ice. The mouth of the channel is mainly sandy mud. The flanks of the channel are covered in old iceberg furrows lined with gravel. • At the Scotian Slope, sand and gravel slump over the shelf edge. Here dramatic exposed sedimentary bedrock cliffs can also be found. On the Scotian rise (slope to the abyssal plain) glacial erosion, sea level rise and fall, and modern erosion has deposited sediments in a wide area seaward of the Scotian Slope. Deep currents and small eddies which peel off from the Gulf Stream continue to disturb the sediments, creating benthic storms and bringing nutrients to the area. • A series of deep canyons (Gully, Shortland, Haldimand Canyons) occur along the outer edges of the Scotian Shelf and extend down the slope. These canyons act as transport areas for sand and provide a transition from the outer shelf to the deep ocean. • Between the canyons the seabed is criss-crossed by furrows and pits created by icebergs in the past. This area continues to erode creating a natural disturbance, which may enhance biological productivity. Source: DFO 2011b; Worcester and Parker 2010; Zwanenburg *et al*. 2006; WWF 2009; Li and King 2007
Climatology	• Climate is strongly influenced by the warm Gulf Stream and the cold Labrador Current • Daily Air Temperature Range: -1.4°C (February) to 17.8°C (August)

Table 3.1 Overview of Physical Characteristics

Physical Characteristics	
	• Extreme Minimum Air Temperatures: -19.4°C (January) to 4.4°C (August) • Extreme Maximum Air Temperatures: 12.8°C (February) to 29.6°C (July) • Average Monthly Precipitation: 95.2 mm (July) to 147.0 mm (November) • Extreme Daily Precipitation: 66.00 mm (April) to 166.1 mm (November) • Average days per year with fog: 127 days. Source: Environment Canada 2012a
Sea Ice and Icebergs	• Ice cover is rare in the offshore of the Scotian Shelf. • Sea ice is generally transported out of the Gulf of St. Lawrence through the Cabot Strait. • Ice can be transported from the Cabot Strait by north westerly winds and ocean currents onto the Eastern Scotian Shelf, although this is very rare. Source: DFO 2011b
Wind	• Average Wind Speeds: 17.5 km/h (September) to 31.5 km/h (January) • Most Common Wind Direction: Southwest (April to September) and West (October to March) • Maximum Hourly Wind Speed: 74km/h (August) to 130 km/h (November) • Maximum Wind Gust Speed: 100km/h (August) to 130 km/h (November) Source: Environment Canada 2012a
Waves	• Monthly mean Hsig (m): 1.3 in (June/July) to 3.4 (January) • Monthly maximum Hsig (m): 4 (June) to 11.8 (March) • 1 - Year return Hmax (m): 14.7 • 100 - year return Hmax (m): 24 Source: Hurley and Stantec 2010
Ocean Currents	• Circulation patterns are governed by the complex seafloor topography and by the influence of three major currents: o Cool, relatively fresh (less saline) Nova Scotian Current derived from the outflow of the Gulf of St. Lawrence flowing along the inner, middle, and outer portions of the shelf o Cold Shelf Break Current (Influenced by Labrador Current from the north) flowing along the shelf edge o Warm, higher saline Gulf Stream flowing northeast over the Scotian Slope and mixing with the Labrador Current, creating “slope water”. • Overall flow is from the Northeast to southwest, with speeds ranging from 5 – 55 cm/s. Currents are stronger in the winter and weaker in the summer. Source: Worcester and Parker 2010; Zwanenberg *et al*. 2006
Water Temperature	• Most variable in the North Atlantic**,** varying with depth and location. • Eastern Scotian Shelf usually cooler than the majority of the Shelf due to the influence of cool water from the north flowing over the Misaine Bank. • Mixing of warm water from the slope is limited by the Sable Island and Banquereau Banks, resulting in cooler waters, especially at depth. • Upper 50 m of water warms in the summer months. • Warmer “slope” water periodically leaks onto the eastern Scotian Shelf through submarine canyons. • The large variability in the coastal waters of the Scotian Shelf has a significant influence on sound propagation. A strong surface layer condition occurs in many areas during July-October when solar heating has a high effect on surface temperatures. The higher temperature near the surface is often associated with lower salinity produced by runoff that floats on top of the dense ocean water. Sound travels faster in warm water than cold resulting in a net downward refraction of horizontally travelling sound waves. This produces more bottom reflections per kilometer and higher transmission loss. • During November – May, the surface waters are normally colder than the water at depth, resulting in an upward refraction or neutral direction. During these conditions when sound waves are not refracted or are refracted upwards, the effect of the bottom

Table 3.1 Overview of Physical Characteristics

Physical Characteristics	
	on transmission loss is reduced. Source: Worcester and Parker 2010; DFO 2011b; Davis *et al.* 1998
Salinity	• Coastal waters : 30-32 parts per thousand (ppt) • Nova Scotian Current: 31-33 ppt • Labrador Current: 34-36 ppt • Gulf Stream 34-36 ppt Source: Worcester and Parker 2010
Stratification	• Increased stratification can inhibit vertical mixing, decreasing nutrient fluxes to surface waters, in turn affecting primary production. • Alternatively increases in stratification can inhibit turbulence and concentrate phytoplankton, thus increasing primary production. • There have been increases in stratification in recent years on the Scotian Shelf. • Strong stratification can inhibit vertical mixing and cause depleted dissolved oxygen levels at depth. • Bottom dissolved oxygen concentration is relatively high within the Study Area on the Sable Island and Banquereau Banks. Source: Worcester and Parker 2010; Zwanenburg *et al*. 2006; DFO 2011b
Seismic Activity	• Earthquakes occur throughout southeastern Canada with five zones of high earthquake activity, with the closest zone being the Laurentian slope zone. • The area is located off Canada's east coast approximately 250 km south of Newfoundland. • In 1929, a 7.2 magnitude earthquake triggered a large underwater landslide in the Atlantic Ocean, triggering a tsunami that killed 27 people on the Burin Peninsula. • Other earthquakes as large as magnitude 5.3 have been recorded in the area. • Earthquakes in this area are generally associated with fault movement in the ocean floor. Source: NRCAN 2011

3.2 BIOLOGICAL CHARACTERISTICS

3.2.1 Plankton

3.2.1.1 Phytoplankton

Phytoplankton are the base of the marine food web and as a result, their production sets an upper limit on the production of all higher trophic levels (Worcester and Parker 2010). Phytoplankton are distinctive among ocean biota in that they derive their energy from sunlight and structural requirements from nutrients in the surrounding water (DFO 2011a). On the Scotian Shelf diatoms and dinoflagellates are the largest and most common phytoplankton. Their abundance is based on the Shelf's complex physical oceanographic features. There is a distinctive cycle to their abundance characterized by widespread spring and fall blooms related to a high concentration of nutrients and sunlight in the water column. Blooms can vary in temporal and spatial scales. Recent trends in the magnitude and duration of the spring bloom on the Scotian Shelf indicate that blooms are beginning earlier now than they did in the 1960s and 1970s and are more intense and longer in duration (Worcester and Parker 2010).

3.2.1.2 Zooplankton

Zooplankton are animals that are unable to maintain their horizontal spatial distribution against the current flow (DFO 2011a). The dynamics and abundance of zooplankton determines, in part, how much energy produced from phytoplankton is transferred to higher tropic levels (fish, mammals, birds) (Worcester and Parker 2010). Zooplankton can be divided into three main categories based on size:

- Microzooplankton (20-200 µm in length), which includes ciliates, tintinnids, and the eggs and larvae of larger taxa;
- Mesozooplankton (0.2-2 mm in length), which includes copepods, larvaceans, pelagic molluscs, and larvae of benthic organisms; and
- Macrozooplankton (> 2mm), which includes larger and gelatinous taxa.

The mesozooplankton on the Scotian Shelf is dominated by copepods. Three species of copepods known as Calanus comprise over 70% of the copepod biomass. *Calanus finmarchicus* appears to be a significant link in the food chain.

The copepod community on the Eastern Scotian Shelf is very diverse with high abundances of *Calanus finmarchicus*, *Pseudocalanus minutus, Centropages typicus* and *Scolecithricella minor.* Other species present are *Acartia longiremis, Calanus glacialis, Calanus hyperboreus, Candacia pachydactyla, Centropages bradyi, Clausocalanus furcatus, Clytemnestra rostrata, Corycaeus speciosus, Paraeuchaeta* (as *Euchaeta*) *norvegica, Paraeuchaeta* (as *Euchaeta*) *tonsa, Gaetanus* sp., *Lucicutia flavicornis, Macrosetella gracilis, Metridia longa, Metridia lucens, Microcalanus pygmaeus, Oithona atlantica, Oithona similis, Oncaea media, Paracalanus parvus, Pleuromamma borealis, Pleuromamma robusta, Scolecithrix danae, Temora longicornis, Temora stylifera, Undinula vulgaris* and unidentified harpacticoids (Locke 2002).

On the Scotian Shelf zooplankton levels have been lower in more recent years than in the 1960s and 1970s, which is the reverse of the recent phytoplankton trend. However they are beginning to recover from the lows observed in the 1990s (DFO 2011a).

3.2.1.3 Ichthyoplankton

Ichthyoplankton are the eggs and larvae of fish and shellfish. Ichthyoplankton, along with other planktonic early life stages of marine animals, are collectively referred to as the meroplankton (NOAA 2007).

One of the major sources of information on zooplankton for the Eastern Nova Scotian Shelf is the Scotian Shelf Ichthyoplankton Program (SSIP), which was conducted from 1976-1982. The outflow of the Gulf of St. Lawrence (Nova Scotia Current) is responsible for maintaining high biomass of ichthyoplankton on the northeast half relative to the southwestern half of the Scotian Shelf during June and October. The current is responsible for maintaining large populations of copepods in the area. High biomasses of various ichthyoplankton communities have been found on the Misaine and Banquereau Banks in May, September and October (Locke 2002).

3.2.2 Algal Communities

Marine plants include both phytoplankton and macrophytic marine algae, with the latter commonly referred to as “seaweeds”. Seaweeds in Nova Scotia can be grouped into three main categories: green algae; red algae; and brown algae.

Green algae need a large amount of light and can generally be found closer to the surface in the intertidal or shallow subtidal areas. Red algae can grow at greater depths and are generally found in the intertidal zone. Brown algae are the dominant seaweeds in Nova Scotia and can also be found in the subtidal zone (DFO 2011b). Table 3.2 provides an overview of marine vegetation.

Table 3.2 Marine Plants

Middle Shelf (Misaine Bank and Basins)	• Phytoplankton is the dominant plant in the region, and is found in the upper mixed layer of the ocean. • Coralline algae form pale to pinkish crusts on rock and gravel surfaces on the banks. • Productivity is generally not as great as nearer to shore or closer to the edge of the continental shelf. • Most productivity occurs during the spring and fall phytoplankton blooms. • The spring bloom typically peaks in late April and the fall bloom peaks from November – December on the Eastern Scotian Shelf. • Occasionally drifting seaweeds can be found, from interactions with slope water and the Gulf Stream further offshore. • The basins of the middle shelf are too deep to sustain plant growth.
Outer Shelf (Banquereau Bank)	• Phytoplankton is the primary marine plant in the region. • Phytoplankton productivity is similar to that found in the middle shelf with spring and fall blooms. • Encrusting algae may occur on hard substrates on the bank. • The outer edge of the shelf has enhanced plant productivity due to the interaction of shelf and slope waters which brings nutrients to the surface. • Occasionally masses of *Sargassum*, can be found floating in this area.

Source: NSM 1997; Li *et al*. 2011, Song *et al*. 2010.

3.2.3 Corals and Sponges

Cold water corals are suspension-feeding invertebrates with delicate appendages which capture food particles from the water column. Cold-water corals do not contain symbiotic algae and as a result, can live in deeper waters without the influence of sunlight. Most corals require a hard substrate to attach to, while some can anchor themselves into soft sediment (DFO 2011b). The *Lophelia* Coral Conservation area and Stone Fence are located within the Study Area on the southeast corner of Banquereau Bank (refer to Section 3.2.7). Table 3.3 summarizes characteristics of cold water corals in the Study Area.

Table 3.3 Cold Water Corals

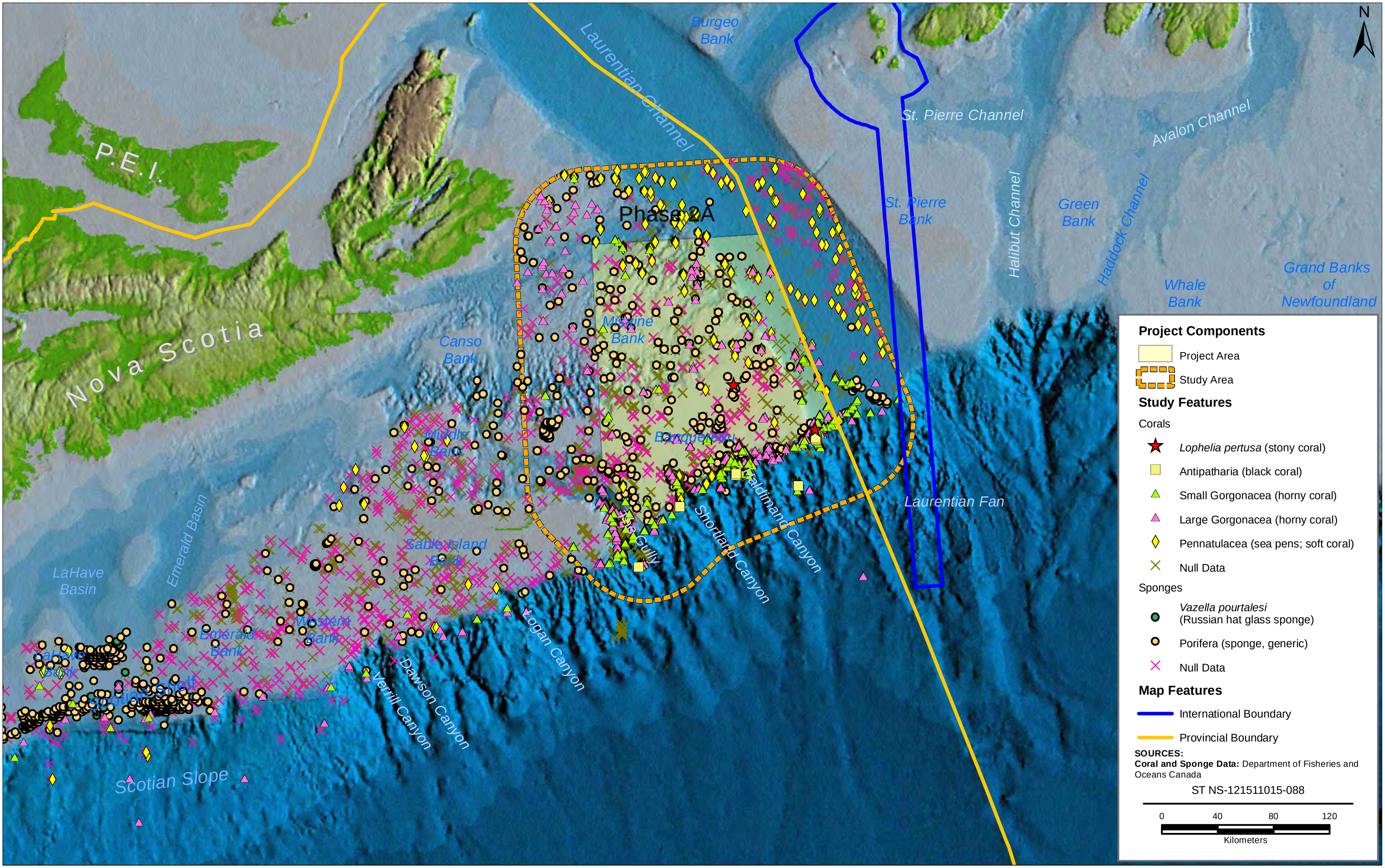
General Characteristics	• Suspension-feeding invertebrates with delicate appendages that capture food particles from the water column. • Do not contain symbiotic algae, and can live at depths without the influence of sunlight. • Most require a hard substrate for attachment; few can anchor into soft sediment. • Occur in many sizes, shapes, with some species forming reef structures. • Slow growing, some maybe over 100 years old. • Two major groups occur on the Scotian Shelf: Hard/Stony corals (*Scleractinia*) and Octocorals, some of which are solitary while others form reefs. • Octocorals include sea pens, sea whips, sea fans, and “soft corals”. • The largest octocorals on the Scotian Shelf are the gorgonian corals which include: bubblegum and seacorn corals. • *Lophelia pertusea*, a species known to build larger reef structures can be found within the Study Area. Source: DFO 2011b; Zwanenburg *et al*. 2006; Kenchington *et al*. 2010; DFO 2006.
Locations within Study Area	• Large gorgonians have only been identified in channels between the banks and in canyons and on the shelf and Laurentian Channel edge. • Sea pens and small gorgonians have been found on soft sediments. • *Lophelia pertusa* can be found in the *Lophelia* Coral Conservation area on the southeast corner of Banquereau Bank. • Black corals can be found on the Shelf edge and slope off Banquereau Bank. • A relatively high concentration of sea pens has been identified in the Laurentian Channel, and in the basins and valleys of Misaine Bank. • There are a few large concentrations of gorgonians near the Gully and on the edge of Sable Island and Banquereau Bank. Source: Kenchington *et al*. 2010; DFO 2006.

Table 3.4 summarizes the general characteristics of Scotian Shelf sponges and potential distribution in the Study Area.

Table 3.4 Sponges

General Characteristics	• Marine invertebrates that attach themselves to bottom substrates. • Filter feeders, which are generally found at depth below 300 m. • Sponges provide substrate and shelter for many other species. Source: DFO 2011b; Kenchington *et al*. 2010
Locations within Study Area	• There are sponge locations within the Study Area on both Banquereau and Misaine Banks, as well as the mouth of the Laurentian Channel. Source: DFO 2011b; Kenchington *et al*. 2010

Figure 3.2 displays known distribution of corals and sponges on the Scotian Shelf (data courtesy of DFO).



SOURCES:
Coral and Sponge Data: Department of Fisheries and Oceans Canada

PREPARED BY:
M. Huskins-Shupe

REVIEWED BY:
C. Shupe

CLIENT:
Canada - Nova Scotia Offshore Petroleum Board

Eastern Scotian Shelf - Misaine and Banquereau Bank Strategic Environmental Assessment

Coral and Sponge Locations

FIGURE NO.:
3.2

DATE:
Dec 07, 2012

Stantec

File Path: V:\1215\active\121510xxx\121511015_cnsopb_sea\geomatics\mapping\mxd\report\Phase2A\ST NS_121511015-088_Coral_Phase2A.mxd

3.2.4 Commercial Fish and Invertebrates

Key commercial fisheries species on the Eastern Scotian Shelf are described in three categories: pelagic fish, groundfish, and invertebrates (*e.g.*, shellfish). Pelagic organisms live in the water column and at the surface and can include highly migratory species such as tuna, swordfish, and sharks. Groundfish spend the majority of their life near the bottom of the ocean and include the gadoids (cod, pollock, and haddock), skates, and flatfishes. Groundfish are a major component of the Scotian Shelf fishery. Invertebrates play an important role in the Scotian Shelf fishery with over 28 species that have commercial value including crustaceans, bivalves, snails, squid, and echinoderms.

Table 3.5 summarizes reproductive times (spawning, hatching, mating) for key commercial fisheries species that are likely to occur in the Study Area.

Table 3.5 Summary of Spawning and Hatching Periods for Principal Commercial Fisheries Species with the Potential to Occur in the Study Area

Common Name	Scientific Namel	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec
Pelagic Species													
Albacore tuna	*Thunnus alalunga*												
Bigeye tuna	*Thunnus obesus*												
Bluefin tuna	*Thunnus thynnus*												
Mako shark	*Isurus oxyrinchus*												
Porbeagle shark	*Lamna nasus*	▨	▨	▨	▨	▨							
Swordfish	*Xiphias gladuis*												
White marlin	*Tetrapturus albidus*												
Groundfish Species													
American plaice	*Hippoglossoides platessoides*				▨	▨	▨	▨					
Atlantic Cod	*Gadus morhua*					▨	■	▨	▨	▨			
Atlantic halibut	*Hippoglossus hippoglossus*		▨	■	▨	▨							
Cusk	*Brosme brosme*					▨	■	▨	▨				
Greysole-Witch flounder	*Glyptocephalus cynoglossus*			▨	▨	▨							
Haddock	*Melanogrammus aeglefinus*			▨	▨	▨							
Monkfish	Lophius spp.						▨	▨	▨	▨			
Pollock	*Pollachius virens*	▨	▨	▨	▨					▨	▨	▨	▨
Redfish (deepwater and Acadian)	*Sebates mentella/ Sebates fasciatus*			▨	▨	▨	▨	▨		▒	▒	▒	▒
Stripped catfish (wolfish)	*Anarchichas lupus*									▨	▨	▨	▨
Turbot-Greenland flounder	*Reinhardtius hippoglossoides*	▨	▨	▨	▨							▨	▨
White hake	*Urophycis tenuis*					▨	▨	▨	▨				
Invertebrate Species													
Cockles	*Cerastoderma edule*					▨	▨	▨	▨				
Northern Shrimp	*Panadalus borealis*	▨	▨	▨	▨					▨	▨	▨	▨
Scallop	Potential for multiple								▨	▨			

Table 3.5 Summary of Spawning and Hatching Periods for Principal Commercial Fisheries Species with the Potential to Occur in the Study Area

Common Name	Scientific Namel	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec
	species								▒	▒			
Sea Cucumber	Class Holothuroidea				▒	▒	▒	▒	▒				
Snow crab	*Chinoecetes opilio*		░	░	▒	▒	▒						
Stimpson's surf clam	*Mactromeris Polynyma*						▒	▒	▒				
Whelks	*Buccinum undatum*	▒	▒			▒	▒	▒	▒	▒	▒	▒	▒

Source: Scott and Scott 1988;Cargnelli *et al*. 1999a; Cargnelli *et al*. 1999b; Campana *et al*. 2003; O'Dea and Haedrich 2000; COSEWIC 2001a; COSWEIC 2001b; DFO 2001, 2003, 2004, 2006a, 2006b;2009a, 2009b, 2009c, 2011f2012

▒	potential spawning and hatching periods
█	peak spawning period anticipated
░	mating period
	Species not mating or spawning in Study Area

The following descriptions of fish and invertebrates focus on species of commercial value.

3.2.4.1 Pelagic Fish

The following table contains common pelagic species of commercial importance that are likely to occur within the Study Area.

Table 3.6 Pelagic Fish of Commercial Value Likely to Occur in Study Area

Common Name	Scientific Name	Distribution
Albacore tuna	*Thunnys alalunga*	Migration routes are still uncertain. Albacore tuna enter Canadian waters in July and remain until November feeding on forage species. Albacore tuna are distributed sparsely along the Scotian Shelf Edge and Slope, with higher numbers further offshore above the abyssal plain.
Atlantic herring	*Clupea harengus*	Common along the coast of Nova Scotia and offshore banks. Known to be present in the northern portions of Sable Island Bank, the Gully trough area, and Banquereau Bank. Recent studies have suggested that there is an offshore spawning population, which spawn during the summer and fall months in the offshore area.
Atlantic mackerel	*Scomber scombrus*	During the winter they occupy moderately deep water, 70-200 m, along the continental shelf from Sable Island Bank to Chesapeake Bay. Migrate over Sable Island bank in the spring and summer months.
Bigeye tuna	*Thunnus obesis*	Young individuals typically inhabit tropical waters while mature individuals migrating to northern latitudes. Mature bigeye tuna enter Canadian waters including the Scotian Shelf in July and remain until November to feed. Bigeye tuna have a similar distribution as the Albacore with a few fish inhabiting waters along the Scotian Shelf Edge and Slope, with higher numbers further offshore.
Black dogfish	*Centroscyllium fabricii*	The black dogfish is a deepwater species found in temperate to boreal waters over the outer continental shelves and slopes of the North Atlantic Ocean. The species has been found along the Scotian Shelf outside of the Project Area.
Bluefin tuna	*Thunnus thynnus*	Bluefin tuna is distributed throughout the North Atlantic, occupying waters up to a depth of 200 m. Adult Bluefin tuna enter Canadian waters, including the Scotian Shelf from June to October. The Bluefin can be found distributed along the edges and slopes of Sable Island Bank.
Blue shark	*Prionace glauce*	The blue shark is a highly migratory species, with its western Atlantic range from Newfoundland to Argentina. The blue shark has been recorded in Canadian waters including the Scotian Shelf most commonly during the summer months. The blue shark mates on the continental shelf during the spring and early summer, moving further offshore afterwards. Blue sharks can be found along the Scotian Shelf Edge and Slope, as well as on the northwest slope of Sable Island Bank and the northeast corner of the Emerald Basin.
Porbeagle shark	*Lamna nasus*	Porbeagle sharks move onto the Scotian Shelf in the early spring. The primary factor affecting distribution is thought to be temperature, with the species typically inhabiting waters between 5-10 °C. Porbeagles can be found in a similar distribution as the blue shark inhabiting the Scotian Shelf Edge and Slope, as well as on the northwest slope of Sable Island Bank and the northeast corner of the Emerald Basin.

Table 3.6 Pelagic Fish of Commercial Value Likely to Occur in Study Area

Common Name	Scientific Name	Distribution
Shortfin mako shark	*Leurus oxyringus*	This species migrates into Canadian waters generally in the later summer and early fall, where they are associated with the warm waters of the Gulf Stream. Shortfin makos inhabit similar water as the blue and Porbeagle sharks including the Scotian Shelf Edge and Slope, as well as on the northwest slope of Sable Island Bank and the northeast corner of the Emerald Basin.
Swordfish	*Xiphias gladuis*	Swordfish migrate into Canadian waters in the summer as part of their annual seasonal movement, following spawning in subtropical and tropical areas. Swordfish are commonly caught along the slope of Sable Island Bank and is one of the most important pelagic commercial fish species in the Study Area. Swordfish can be found along the Scotian Shelf Edge and Slope as well as on the northwest slope of Sable Island Bank and the northeast corner of the Emerald Basin.
White marlin	*Tetrapturus albidus*	In western Atlantic waters, marlin can be found in warm temperate waters and tropical waters. During the summer months marlin migrate into Canadian waters off of Nova Scotia. Marlin can be found along the Scotian Shelf edge and slope.
Yellowfin tuna	*Thunnus albacares*	Yellowfin tuna migrate into Canadian waters, including the Scotian Shelf to feed during the summer months. Yellowfin tuna have similar distributions as the Albacore and Bigeye tunas, sparsely populating the Shelf Edge and Slope with higher numbers further offshore.

Source: Scott and Scott 1988; Campana *et al*. 2003; Maguire and Lester 2012; DFO 2006a; DFO 2011a; DFO 2012
Note: For an in-depth overview of important areas for fish, particularly larval distribution maps, refer to Horsman and Shackell (2009).

3.2.4.2 Groundfish

Table 3.7 summarizes the distribution of groundfish of commercial value likely to occur in the Study Area.

Table 3.7 Groundfish of Commercial Value Likely to Occur in the Study Area

Common Name	Scientific Name	Distribution
Acadian redfish	*Sebastes fasciatus*	Closely associated with the seafloor commonly found inhabiting waters 150 to 300 m in depth along the Scotian Shelf Edge and Slope. Mature individuals expected in to occur in the Study Area from May to October. Spawning occurs in fall. Larvae may be present in water column May to August
American plaice	*Hippoglossoides platessoides*	Closely associated with the seafloor and commonly found in water depths of 100 to 200 m where soft/sandy sediments are present. The maritime population is common to the Scotian Shelf. Within the Study Area American plaice can be found along the Sable Island Bank and slopes.
Atlantic cod	*Gadus morhua*	A demersal gadoid species usually found within 2 m of the seafloor. Atlantic cod can be found from Greenland to Cape Hatteras, and is common in the Study Area on Sable Island, and Banquereau Banks. In 1993 a moratorium on cod fishing was put in place and remains in effect today. Cod remains an important commercial fishery on the southwest Scotian shelf.
Atlantic halibut	*Hippoglossus Hippoglossus*	Atlantic halibut are distributed from north of Labrador to Virginia. On the Scotian Shelf, halibut are most abundant between 200 – 500 m and can be found In deep channels between banks and at the edge

Table 3.7 Groundfish of Commercial Value Likely to Occur in the Study Area

Common Name	Scientific Name	Distribution
		of the continental shelf and can be found within the Study Area. They prefer sand, gravel or clay substrates. The Atlantic halibut is the most important groundfish species within the Study Area.
Haddock	*Melanogrammus aeglefinus*	A demersal gadoid species usually closely associated with the seafloor, preferring broken ground, gravel, pebbles, clay, smooth hard sand, sticky sand of gritty consistency, and shell beds. Haddock can be found from Greenland to Cape Hatteras, and are common in the Study Area on Sable Island, Middle, and Banquereau Banks.
Hagfish	*Myxine glutinosa*	The hagfish can be found from Greenland to the waters off New York. Hagfish prefer to live at depths greater than 30 m and on soft bottoms. As a new fishery in the area Hagfish are becoming an important source of income within the groundfish fishery.
Monkfish	*Lophius americanus*	Monkfish can be found from the Northern Gulf of St. Lawrence to Cape Hatteras. They have been found inhabiting areas up to 800 m in depth, but are most commonly found from 70-100 m. Concentrations of Monkfish can be found on the western portion of Sable Island Bank in the Study Area.
Pollock	*Pollachius virens*	Pollock is a gadoid species found from southern Labrador to Cape Hatteras, with major concentrations on the Scotian Shelf, including areas of Sable Island, and Banquereau Banks.
Turbot – Greenland flounder	Reinhardtius hippoglossoides	The Greenland flounder can be found in water depths ranging from 90-1600 m from western Greenland to the southern edge of the Scotian Slope. Within the Study Area, the species is most common along the Shelf Edge and Slope.
White hake	Urophycis tenuis	White hake can be found on the continental slopes, ranging from southern Labrador and the Grand banks to the Gulf of Maine. The species is common in the Study area along the shelf edges, and the slope of the Laurentian channel
Witch flounder	*Glyptocephalus cynoglossus*	Witch flounder is a deep water boreal flatfish that can be found from Labrador to Georges bank at depths from 50 – 300 m. The species is common in the Study Area along the slopes of the Sable Island Bank.
Yellowtail founder	*Limanda ferruginea*	Yellowtail flounder is a small-mouthed Atlantic flatfish that inhabits relatively shallow waters of the continental shelf from southern Labrador to Chesapeake Bay. High concentrations of the species can be found on Sable Island, and Banquereau Banks.

Source: Scott and Scott 1988; Cargnelli *et al*. 1999a; Cargnelli *et al*. 1999b; DFO 2001, 2006b, 2009b, 2009c 2012.
Note: For an in-depth overview of important areas for fish, particularly larval distribution maps refer to Horsman and Shackell (2009).

3.2.4.3 Invertebrates

Table 3.8 summarizes invertebrate species of commercial value that are known to occur or are common within the Study Area.

Table 3.8 Invertebrates of Commercial Value Likely to Occur in the Study Area

Common Name	Scientific Name	Distribution
Snow crab	*Chionoecetes opilio*	Snow crabs can be found from the Gulf of Maine to Greenland at depths from 1 m to 470 m. The species prefers temperatures in the range of 3-4 °C. Within the Study Area Snow Crab are the most important commercial invertebrate species and can be found in abundance within the valleys and basins separating Banquereau and Misaine Banks.

Table 3.8 Invertebrates of Commercial Value Likely to Occur in the Study Area

Common Name	Scientific Name	Distribution
Atlantic sea scallop	*Placopecten magellanicus*	Atlantic sea scallop can be found from the Gulf of St. Lawrence to Cape Hatteras, North Carolina. The sea scallop is not very common within the Study Area
Iceland sea scallop	*Chlamys islandica*	Iceland Sea Scallop can be found from the Gulf of St. Lawrence to Cape Hatteras, North Carolina. Within the Study Area the Iceland sea scallop is not common.
Sea cucumber	*Class* Holothuroidea	The sea cucumber is a benthic species that can be found worldwide. In the western Atlantic it can be found from Greenland to the northern shores of Cape Cod. They prefer sandy or rocky substrates with strong currents and depths of 30 -300 m or more. There are exploratory sea cucumber fisheries located on Banquereau Bank,
Northern shrimp	*Panadalus borealis*	Northern shrimp is the most abundant shrimp making up 97% of the commercial shrimp catch. The species can be found from New England to Greenland and Baffin bay at depths ranging from 20 -1300m. Northern shrimp prefer soft, muddy ocean bottoms. Within the Study Area, the species can be found in abundance within the valleys and basins separating Banquereau and Missaine Banks.
Propeller clam	Family Hiatellidae	Propeller clam can be found from Cape Cod to the Gulf of St. Lawrence, commonly found buried in sand a few cm deep. The species prefers water temperatures from -1°C – 5.7 °C and salinities ranging from 32.3 psu to 34.2 psu. Within the Study Area the species is sparsely found on Banquereau Bank.
Stimpson’s surf clam (Arctic surf clam)	*Mactromeris Polynyma*	Stimpson’s surf clam, also known as Arctic surf clam, can be found from Baffin Island to Rhode Island living in sandy bottom areas in aggregations called “beds”. The species prefer water temperatures under 15 °C at depths up to 60 m. Within the Study Area the species is prevalent throughout Banquereau Bank.
Cockles	Family Cardiidae	Cockle can be found on at depths up to 500 m, and prefers sandy and muddy substrates. Within the Study area the species is prevalent on the western arm of Banquereau Bank.
Quahog	*Mercenaria mercenaria*	Quahog can be found from Cape Hatteras to the Arctic in fine to medium grain sand bottoms at depths from 4 – 480 m. Within the Study Area the species is prevalent on the western arm of Banquereau Bank.
Whelks	*Buccinum undatum*	In the northwest Atlantic whelk can be found from New Jersey to Labrador. The species is most prominently found in greatest densities on soft sediment at depths of 15- 30 m. Within the Study Area, catches of whelk are limited.

Source: DFO 2002, 2004b, 2007, 2009a, 2012; Government of Newfoundland and Labrador 2003.

3.2.4.4 Fish Species of Special Status

Table 3.8 lists fish species of special status which may be present in the Study Area. Species of special status are those that are listed as endangered, threatened, or special concern either under the *Species at Risk Act* (SARA) or by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC). Populations that are highly unlikely to occur in the Study Area have been excluded (*e.g.*, Atlantic cod Laurentian North population).

Table 3.8 Fish Species of Special Status Potentially Occurring in the Study Area

Common Name	Scientific Name	*SARA* Schedule 1 Status	COSEWIC Designation	Potential Occurrence in Study Area
Northern Wolffish	*Anarhichas denticulatus*	Threatened	Threatened	Low potential for occurrence – Main range is off northeast Newfoundland and across the north Atlantic with some occurrence on the eastern Scotian Shelf off Cape Breton. Most commonly found inhabiting the seafloor in water depths of 100 to 900 m. Non-migratory spawning occurs in the fall. Larvae may be present on the seafloor in fall to early winter.
Spotted Wolffish	*Anarhichas minor*	Threatened	Threatened	Low potential for occurrence – Main range is west of Greenland to the Grand Banks with some occurrence on the eastern Scotian Shelf off Cape Breton. Most commonly found inhabiting the seafloor in water depths of 50 to 600 m. Non-migratory spawning occurs in the summer. Eggs / larvae may be present on the seafloor in summer to fall.
Atlantic (striped) Wolffish	*Anarhichas lupus*	Special Concern	Special Concern	High potential for occurrence – Occurs along the Scotian Shelf with a higher concentration around Brown's Bank, along the edge of the Laurentian Channel and into the Gulf of Maine. Most commonly found inhabiting the seafloor in water depths of 150 to 350 m. Short migrations to spawning grounds in shallow waters during the fall. Eggs / larvae may be present on seafloor in fall to early winter.
White Shark	*Carcharodon carcharias*	Endangered	Endangered	Low potential for occurrence – Rare in north Atlantic Canadian waters (32 records in 132 years), as it is the northern edge of their range. Recorded sightings range from the Bay of Fundy to the Laurentian Channel as well as on the Sable Island Bank. Can range in depth from the surface to 1,300 m, are highly mobile and seasonally migrant.
Acadian Redfish (Atlantic population)	*Sebastes fasciatus*	Not Listed	Threatened	High potential for occurrence - Closely associated with the seafloor commonly found inhabiting waters 150 to 300 m in depth. Can be commonly found along the slopes of Banquereau Bank, and the Laurentian Channel. Spawning occurs in fall. Larvae may be present in water column May to August.
American Eel	*Anguilla rostrata*	Not Listed	Threatened	Low potential for occurrence – Adult American eels migrating from freshwater streams to the Sargasso Sea may pass through the Project Area. Any presence would be transient in nature.

Table 3.8 Fish Species of Special Status Potentially Occurring in the Study Area

Common Name	Scientific Name	*SARA* Schedule 1 Status	COSEWIC Designation	Potential Occurrence in Study Area
American Plaice (Maritime population)	*Hippoglossus platessoides*	Not Listed	Threatened	High potential for occurrence – Population is concentrated in the Gulf of St. Lawrence and on the Scotian Shelf. Closely associated with the seafloor and commonly found in water depths of 100 to 200 m where soft / sandy sediments are present. Spawning occurs in April / May. Larvae may be present in the water column between May and June. Major Spawning area on the Scotian Shelf is on Banquereau Bank.
Atlantic Bluefin Tuna	*Thunnus thynnus*	Not Listed	Endangered	High potential for occurrence – Atlantic bluefin tuna are highly migratory, with long and varied routes and can usually be found in Canadian waters in the summer. Regularly seen on the Scotian Shelf and can be found between the surface and a depth of 200 m. The Bluefin can be found distributed along the edges and slopes of Banquereau Bank.
Atlantic Cod (Laurentian South population)	*Gadus morhua*	Not Listed	Endangered	High potential for occurrence – Benthopelagic species that migrates from the southern Gulf to the waters of the Scotian Shelf off Cape Breton between May to October. Eggs and Larvae may be present in upper water column from May to April.
Atlantic Cod (Southern population)		Not Listed	Endangered	Moderate potential for occurrence – Atlantic Cod from this population inhabit waters from the Bay of Fundy and southern Nova Scotia, including the Scotian Shelf south and west of Halifax, to the southern extent of the Grand Banks.
Atlantic Salmon (Outer bay of Fundy)	*Salmo salar*	Not Listed	Endangered	Low to moderate potential for occurrence – Population extends from the Saint John River westward to the U.S border. Migration patterns to the north Atlantic may cause the population to be present in the project area; any presence will be transient in nature.
Atlantic Salmon (Eastern Cape Breton population)		Not Listed	Endangered	Low potential for occurrence – Population extends from the northern tip of Cape Breton to northeastern Nova Scotia (mainland). Migration to the north Atlantic should not cross the project area.

Table 3.8 Fish Species of Special Status Potentially Occurring in the Study Area

Common Name	Scientific Name	*SARA* Schedule 1 Status	COSEWIC Designation	Potential Occurrence in Study Area
Atlantic Salmon (Nova Scotia Southern Upland population)		Not Listed	Endangered	Low to moderate potential for occurrence – Population extends from northeastern Nova Scotia (mainland) along the Atlantic and Fundy coasts up to Cape Split. Migration between freshwater rivers and the north Atlantic means the population may pass through the project area with an presence being transient in nature.
Atlantic Sturgeon (Maritimes Populations)	*Ancipenser oxyrinchus*	Not Listed	Threatened	Low to moderate potential for occurrence – Population found throughout the coastal waters of the Maritimes and extends out onto the shelf. Concentrated in water depths less than 50 m and highly migratory in nature so any presence in the project area is likely transient.
Basking Shark (Atlantic population)	*Cetorhinus maximus*	Not Listed	Special Concern	Low to moderate potential for occurrence – Found throughout the north Atlantic with concentrations in coastal waters of Newfoundland and near the mouth of the Bay of Fundy. Known presence along the Scotian Shelf and typically only present in Canadian waters during the summer. Have been shown to be sensitive to low frequency (25-200 Hz) pulses.
Blue Shark (Atlantic population)	*Priomace glauca*	Not Listed	Special Concern	Moderate to high potential for occurrence – Commonly found in offshore waters in water depths up to 350 m. Most abundant along the coast of Nova Scotia including the Scotian Shelves and most common during the late summer and fall. Blue sharks can be found along the Scotian Shelf Edge and Slope. Have been shown to be sensitive to low frequency (25-200 Hz) pulses.
Cusk	*Brosme brosme*	Not Listed	Endangered	High potential for occurrence – Commonly found between the Gulf of Maine and southern Scotian Shelf. Most common along the southwestern shelf but have been frequently noted as far up the shelf as Sable Island. Within the Study Area, cusk can be found along the Scotian Shelf Slope, as well as within the Gully and the Laurentian Channel.
Deepwater Redfish (Gulf of St. Lawrence - Laurentian Channel population)	*Sebastes mentalla*	Not Listed	Endangered	High potential for occurrence - Closely associated with the seafloor commonly found inhabiting waters 350 to 500 m in depth in the Gulf / Laurentian Channel.

Table 3.8 Fish Species of Special Status Potentially Occurring in the Study Area

Common Name	Scientific Name	*SARA* Schedule 1 Status	COSEWIC Designation	Potential Occurrence in Study Area
Deepwater Redfish (Northern population)		Not Listed	Threatened	Low potential for occurrence - Closely associated with the seafloor commonly found inhabiting waters 350 to 500 m in depth from the Grand Banks to northern Labrador.
Porbeagle Shark	*Lamna nasus*	Not Listed	Endangered	Moderate potential for occurrence – Migrant in Atlantic Canadian waters between the Gulf of Maine and Atlantic waters off Newfoundland, moving onto the Scotian Shelf in the spring. Most often caught in water depths of 35 to 100 m. Porbeagles can be found in a similar distribution as the blue shark inhabiting the Scotian Shelf Edge and Slope, as well as on the Gully and the mouth of the Laurentian Channel.
Roundnose Grenadier	*Coryphaenoides rupestris*	Not Listed	Endangered	Low potential for occurrence – More abundant in the northern portion of its Canadian range although some captures have been made along the Scotian Shelf. Closely associated with the seafloor, commonly found inhabiting waters 800 to 1,000 m in depth. Could occur at any time of the year. Non-migratory. Spawning occurs in summer and fall.
Roughhead Grenadier	*Macrourus berglax*	Not Listed	Special Concern	Low potential for occurrence – Closely associated with the seafloor commonly found in water depths of 400 to 1,200 m on or near the continental slope of the Newfoundland and Labrador Shelves from the Davis Strait to the southern Grand Banks, including around Sable Island. Spawning may occur within the southern Grand Banks.
Shortfin Mako	*Isurus oxyrinchus*	Not Listed	Threatened	Low to moderate potential for occurrence – A pelagic species which migrates north following food stocks (*i.e.*, mackerel, herring, and tuna) in the late summer and fall. Known to frequent the Scotian Shelf, Grand Banks and Georges Banks. Any occurrence would likely be transient in nature. Have been shown to be sensitive to low frequency (25-200 Hz) pulses.
Smooth Skate (Laurentian-Scotian population)	*Malacoraja senta*	Not Listed	Special Concern	Low to moderate potential for occurrence – Population can be found throughout the northwest Atlantic including the Scotian Shelf and Laurentian Channel at depths of greater than 90 m.

Table 3.8 Fish Species of Special Status Potentially Occurring in the Study Area

Common Name	Scientific Name	*SARA* Schedule 1 Status	COSEWIC Designation	Potential Occurrence in Study Area
Spiny Dogfish (Atlantic population)	*Squalus acanthias*	Not Listed	Special Concern	High potential for occurrence – Commonly found from the intertidal zone to the continental slope in water depths up to 730 m. Most abundant between Nova Scotia and Cape Hattaras. Highest concentration in Canadian waters is along the Scotian Shelf.
Thorny Skate	*Amblyraja radiata*	Not Listed	Special Concern	Low to moderate potential for occurrence – Population is common throughout the north Atlantic, is concentrated on the Grand Banks with some occurrence on the Scotian Shelf. Common at depths from 30 to 440 m.
Winter Skate (Eastern Scotian Shelf Population)	*Leucoraja ocellata*	Not Listed	Threatened	High potential for occurrence – Located along the eastern Scotian Shelf and into the Laurentian Channel. Non-migratory spawning has been observed in the fall. Eggs / larvae may be present up to 22 months after spawning and are attached to the seafloor.

3.2.5 Marine Mammals and Sea Turtles

There are three groups of marine mammals that have the potential to inhabit the Study Area: the Mysticetes (toothless/baleen whales), Odontocetes (toothed whales), and Pinnipeds (Seals). In 2007, a large scale aerial survey of marine megafauna was conducted in the Northwest Atlantic (DFO 2011b). During this survey 20 species of cetaceans were identified on the Scotian Shelf. Common dolphins were the most prevalent species, followed by pilot whales and white-sided dolphins. Future operators may wish to access whale sighting data on the eastern Scotian Shelf and Slope which may be made available by Fisheries and Oceans Canada, for more detailed information on species presence.

3.2.5.1 Mysticetes and Odontocetes

Table 3.9 lists cetacean species known to inhabit the Study Area. Special designations by SARA and/or COSEWIC are included as applicable.

Table 3.9 Marine Mammals Known to Occur within the Study Area

Common Name	Scientific Name	SARA Status	COSEWIC Designation	Potential Occurrence in Study Area
Mysticetes (Toothless or Baleen Whales)				
Blue whale (Atlantic population)	*Balaenoptera musculus*	Schedule 1, Endangered	Endangered	Has a large range, including along the Scotian Shelf but a low population density. Forages for krill in both coastal and offshore waters, especially in areas of upwelling such as the continental shelf during spring, summer and fall. Found in small migrant herds and surface every 5 to 15 minutes for breathing. On the Scotian Shelf, they can be found from May to October in areas of high primary productivity. There have been a few sightings in the Gully in late summer, and the species is more commonly sighted in-between Emerald and LaHave Banks.
Fin whale (Atlantic Population)	*Balaenoptera physalus*	Schedule 1, Special Concern	Special Concern	Concentrated in the northwest Atlantic region during summer months (but seen year round) for feeding, with a high concentration on the Scotian Shelf. The most commonly sighted whale species along the Scotian Shelf. Calving occurs in winter, in lower latitudes. Within the Study Area they can commonly be sighted on Sable Island Bank, Banquereau Bank, the Gully, Shortland and Haldimand Canyons, and east of Cape Breton.
Humpback whale (Western North Atlantic population)	*Megaptera novaeangliae*	Schedule 3, Special Concern	Not at Risk	Humpback whales are common in the summer and can be sighted from the Gulf of Mexico to southeastern Labrador. Newfoundland and Gulf of Maine subpopulations migrate to the Scotian Shelf and Slope during the summer months to forage. Few have been sighted within the area during the winter. Commonly found on Sable Island Bank, Banquereau Bank, the Gully, Shortland, and Haldimand Canyons.
Minke whale	*Balaenoptera acutorostrata*	Not Listed	Not at Risk	The minke whale can be found from the Davis Strait in the north to the Gulf of Mexico. Minke whales can be found in the Study Area during the spring and summer.
North Atlantic right whale	*Eubalaena glacialis*	Schedule 1, Endangered	Endangered	Range along the Atlantic coast from the southeastern U.S. to the Scotian Shelf, with the *Roseway Basin Area to be Avoided* (also SARA designated Critical Habitat) located on the southwestern Scotian Shelf. They are commonly found feeding and socializing from the western end of Sable Island bank to Browns Bank. Migration patterns typically bring them to the waters of the Scotian Shelf from July to October. Primarily feeds on copepod and other zooplankton.

Table 3.9 Marine Mammals Known to Occur within the Study Area

Common Name	Scientific Name	SARA Status	COSEWIC Designation	Potential Occurrence in Study Area
Sei whale	*Balaenoptera borealis*	Not Listed	Not Listed	In Atlantic Canadian waters sei whales can be found from Georges Bank in the south to Labrador in the north. During the summer and early autumn months, a large portion of the population can be found on the Scotian Shelf.
Odontocetes (Toothed Whales)				
Atlantic white-sided dolphin	*Lagenorhynchus acutus*	Not Listed	Not at Risk	Atlantic white-sided dolphins are distributed throughout the continental shelf and slope areas of the North Atlantic. Atlantic white-sided dolphins prefer depths of less than 100 m and are spotted most often during the summer and early autumn months on the Scotian Shelf.
Harbour porpoise (Northwest Atlantic population)	*Phocoena phocoena*	Schedule 2, Threatened	Special Concern	Harbour porpoises are widely distributed over the continental shelves of the northern hemisphere and are generally found within 250 km of shore. They are an occasional visitor to the shallow banks of the Scotian Shelf, although they are rarely sighted.
Killer whale	*Orcinus orca*	Not Listed	Special Concern	Occasional visitor to the area, although rarely seen.
Long-finned pilot whale	*Globicephala melas*	Not Listed	Not at Risk	Long-finned pilot whales can be found on the Scotian Shelf and Slope year round. The species can be found frequenting coastal waters of Cape Breton during the summer months, and moving further offshore during the winter.
Northern bottlenose whale (Scotian Shelf Population)	*Hyperoodon ampullatus*	Schedule 1, Endangered	Endangered	The Scotian Shelf population occurs around the Gully, Shortland and Haldimand Canyons (all designated Critical Habitat under SARA), this being the southernmost extent that they are routinely sighted. Highly concentrated at the mouth of the Gully and at depths from 800 m to 1500 m. Non-migratory with mating and calving occurring in August. Known to be extremely curious and will investigate vessels or equipment. The shelf break areas around the Gully and Shortland and Haldimand Canyons is considered year-round important habitat for the species.
Sowerby's beaked whale	*Mesoplodon bidens*	Schedule 1, Special Concern	Not Listed	Only found in the north Atlantic with some known occurrence along the Scotian Shelf but not often sighted; have been seen in the Gully MPA. In recent years, sightings have significantly increased in the Gully, Shortland, and Haldimand Canyons. Habitat tends to concentrate around shelf edges and slopes.

Table 3.9 Marine Mammals Known to Occur within the Study Area

Common Name	Scientific Name	SARA Status	COSEWIC Designation	Potential Occurrence in Study Area
Short-beaked common dolphin	*Delphinus delphis*	Not Listed	Not at Risk	The common dolphin may be one of the most widely distributed cetacean species, inhabiting tropical, sub-tropical, and temperate areas. The species can be found on the Scotian Shelf during the summer and autumn months once water temperatures increase above 11°C.
Sperm whale	*Physeter macrocephalus*	Not Listed	Not at Risk	The sperm whale can be found along the Scotian Shelf edge and may be more common in the submarine canyons of the shelf, as it is regularly seen in the Gully. Sperm whales can also be found along the edge of the Laurentian Channel and can be commonly found in areas where water mixes to produce areas of high primary productivity. The sperm whale has been sighted more regularly on the eastern end of the Scotian Shelf at depths of 200 m – 1500 m.
Striped dolphin	*Stenella coeruleoalba*	Not Listed	Not at Risk	The striped dolphin can be found from Cape Hatteras to the southern margin of Georges Bank and also offshore over the continental slope and rise in the mid-Atlantic regions. They prefer the warm waters found on the Shelf edge and are often seen in the Gully. Few striped dolphins have been sighted on the Scotian Shelf over the winter months.
White-beaked dolphin	*Lagenorhynchis albiorostris*	Not Listed	Not at Risk	The species is a year-round resident of the area inhabiting waters from Cape-Cod to Greenland.

Source: DFO 2011a, DFO 2011b, SARA 2011, Breeze *et al.* 2002

3.2.5.2 Pinnipeds (Seals)

Sable Island is a significant area for seals on the Scotian Shelf. It is important for two breeding populations of seals, containing approximately 80% of the world's largest breeding population of grey seals, as well as a smaller population of harbour seals. Seals feed off Sable Island and in the Gully year-round (DFO 2011b). Table 3.10 lists pinniped species found within the Study Area. No seal populations within the Study Area are designated under SARA or by COSEWIC.

Table 3.10 Pinniped Species found within the Study Area

Common Name	Scientific Name	Potential Occurrence in Study Area
Grey seal	*Halichoerus grypus*	Largest breeding population, pupping on Sable Island mid-December to late January. Forages in Study Area year round.
Harbour seal	*Phoca vitulina*	Breeding population uses Sable Island for pupping mid-May to mid-June and forages in the Study Area year round.
Harp seal	*Phoca groendlandica*	Forage in the Study Area.
Hooded seal	*Cystophora cristata*	Forage in the Study Area.
Ringed seal	*Phoca hipsida*	Forage in the Study Area.

Source: DFO 2011a, DFO 2011b

3.2.5.3 Sea Turtles

There are four species of turtles that can be found migrating and foraging within the Study Area (Table 3.11).

Table 3.11 Sea Turtle Species Known to Occur in the Study Area

Common Name	Scientific Name	SARA Status	COSEWIC Designation	Potential Occurrence in Study Area
Leatherback turtle	*Dermochelys coriacea*	Endangered	Endangered	The species forages for jellyfish in the waters of the Scotian Shelf during the summer and fall months. Leatherback turtles can be found in three primary areas by July and August. These areas include waters east and southeast of Georges Bank, the southeastern Gulf of St. Lawrence including Sydney bight, the Cabot Strait, Magdalen Shallows, and waters adjacent to the Laurentian Channel, and waters south of the Burin Peninsula, Newfoundland. Leatherback turtles begin a migration south in September and October.
Loggerhead turtle	*Caretta caretta*	Not Listed*	Endangered	Immature loggerhead turtles occur regularly at the edge of the Scotian Shelf and on the Slope. They migrate north during the summer months and return south for the winter.
Kemp's ridley turtle	*Lepidochelys kempii*	Not Listed	Not Listed	Occasionally seen in the waters of Nova Scotia, but it is generally found further south. The Scotian Shelf is not a regular foraging area.
Green turtle	*Chelonia mydas*	Not Listed	Not Listed	Recently documented on the Scotian Shelf, although it does not regularly occur in the area.

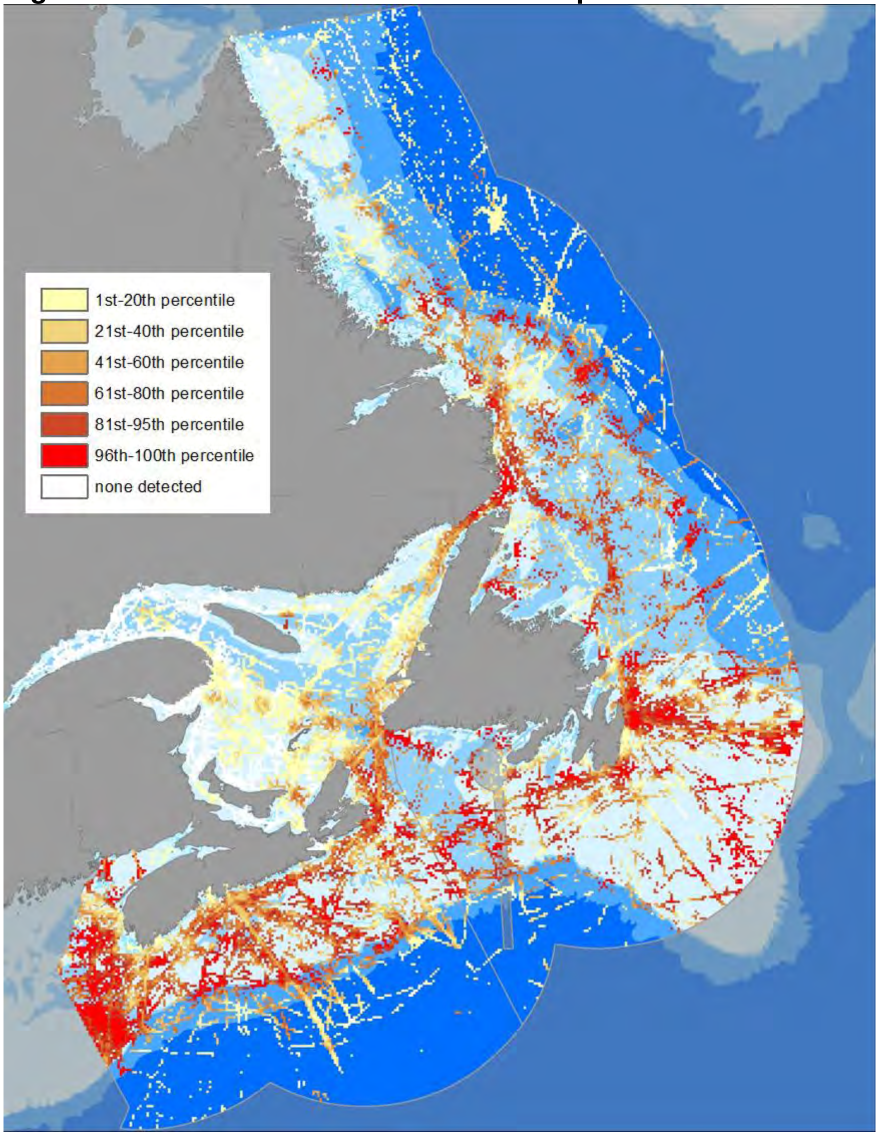
*Being considered for inclusion under SARA (DFO 2010a)
Source: DFO 2011a

3.2.6 Marine Birds

The waters of the Scotian Shelf are known to be nutrient-rich because of the interaction of a variety of physical drivers (*e.g.*, see Section 3.1, Physical Characteristics, above) (Fifield *et al*. 2009). These physical drivers include major current systems, bathymetry, and temperature and salinity patterns; the resulting nutrient-rich waters support highly productive marine ecosystems, including the over 30 million seabirds known to utilize Eastern Canadian Waters each year (Fifield *et al.* 2009). The east coast of Canada supports large numbers of breeding marine birds as well as millions of migrating birds from the southern hemisphere and the northeastern Atlantic (Gjerdrum *et al.* 2008). The combination of northern hemisphere breeding birds and southern hemisphere migrants results in seabird diversity peaking in the spring (Fifield *et al.* 2009). During the fall and winter, significant numbers of over-wintering alcids, gulls, and Northern Fulmars (*Fulmarus glacialis*) use Eastern Canadian waters (Brown 1986). Marine birds are reliant upon land when they are raising their young, but the majority of their lives are spent in the marine environment.

The Scotian Shelf is an important area for a number of seabirds, including the planktivorous Dovekie and storm-petrels (both Leach's and Wilson's), the piscivorous murres (both Common and Thick-billed), and the generalist foraging gulls and terns (C. Gjerdrum, CWS, pers. comm., 2012). Great Shearwater, Sooty Shearwater, Cory's Shearwater and Manx Shearwater are the shearwater species most often encountered over Atlantic Canada's continental shelves, including the Scotian Shelf (see Figure 3.3). The patterns presented in Figure 3.3 provide evidence of extensive use of Canadian continental shelf areas by shearwaters, notably on George's Bank and within the Gulf of Maine, on the Scotian Shelf and the Newfoundland and Labrador Shelves (C. Gjerdrum, CWS, pers. comm., 2012).

Figure 3.3 Shearwater Distribution Map



Note: *Shearwater distribution map presenting relative linear densities of counts of all shearwater species, across all seasons, for Atlantic waters within Canada's EEZ. Estimates for each 5X5 km cell are classed within 20% quantiles, with the top quantile split to show the top 5% of estimates. Estimates are corrected according to the number of days cells were surveyed. No interpolation was applied to ascribe values to cells in which no surveys occurred. The latter cells are transparent, revealing the underlying bathymetry. It should be noted that this map highlights "hot-spots" or areas where large numbers of birds congregate. The pattern shown is strongly influenced by the most common species observed, and therefore under-represents less common species, including those of conservation concern. Areas that are not highlighted as hot-spots do not necessarily mean those areas are not also important habitats for birds.*
Source: CWS unpublished data (C. Gjerdrum, CWS, pers. comm. 2012)

Following the 2004 crude oil spill at the Terra Nova Floating Production, Storage and Offloading vessel on the northeastern Grand Banks and the subsequent identification of a lack of area-specific seabird abundance information, the Environmental Studies Research Fund (ESRF) funded a 3.5-year project to assess seabird abundance and distribution in multiple areas of oil industry activity in eastern Canada, including the Scotian Shelf. This resulted in the ESRF Offshore Seabird Monitoring Program. Fifield *et al*. (2009), which presents results from the Offshore Seabird Monitoring Program, identifies persistent seasonal and year-round hotspots of high seabird concentration and identifies nine groups of seabirds (Table 3.12) recognized as the most abundant within their study area (*i.e.*, Grand Banks, Scotian Shelf, Flemish Cap, Laurentian Channel, Gulf of Maine, Orphan Basin/Knoll and the Labrador Sea).

Table 3.12 Species Groupings for Fifield *et al*. (2009) Seabird Abundance and Distribution Analysis

Group	Common Name	Scientific Name
Northern Fulmar	Northern Fulmar	*Fulmarus glacialis*
Shearwaters	Greater Shearwater	*Puffinus gravis*
	Manx Shearwater	*Puffinus puffinus*
	Sooty Shearwater	*Puffinus griseus*
	Cory's Shearwater	*Calonectris diomedea*
	Audubon's Shearwater	*Puffinus therminieri*
	Unidentified Shearwater	-
Storm-Petrels	Wilson's Storm-Petrel	*Oceanites oceanicus*
	Leach's Storm-Petrel	*Oceanodromoa leucorhoa*
	Unidentified Storm-Petrel	-
Gannet	Northern Gannet	*Morus bassanus*
Gulls	Herring Gull	*Larus argentatus*
	Iceland Gull	*Larus glaucoides*
	Glaucous Gull	*Larus hyperboreus*
	Great Black-backed Gull	*Larus marinus*
	Lesser Black-backed Gull	*Larus fuscus*
Black-legged Kittiwake	Black-legged Kittiwake	*Rissa tridactyla*
Murres	Common Murre	*Uria aalge*
	Thick-billed Murre	*Uria lomvia*
	Unidentified Murre	*Uria sp.*
Dovekie	Dovekie	*Alle alle*
Other Alcids	Atlantic Puffin	*Fratercula arctica*
	Black Guillemot	*Cepphus grylle*
	Razorbill	*Alca torda*
	Unidentified Alcid	-

Through their surveying and analysis, Fifield *et al*. (2009) identified several geographical areas that they deemed to be important to one or more species/groups of seabirds in one or more seasons. The Scotian Shelf and Laurentian Channel were grouped and designated as one of the geographical areas recognized as important using the absolute densities of seabirds reported by Fifield *et al*. (2009). Specifically, they determined this to be one of the more productive regions for seabirds in their study area.

Fulmars were abundant in the Scotian Shelf and Laurentian Channel region throughout the year. Table 3.13 summarizes the seasonal abundances of the nine most abundant groups of seabirds in the area. During the spring season, high numbers of gulls, murres and gannets frequented the area (Fifield *et al.* 2009). The study team found that murres and gannets were joined by large numbers of storm-petrels and shearwaters in the summer. However, the storm-petrels were particularly abundant on the western Scotian Shelf (outside the Phase 2 Study Area). Storm-petrels and shearwaters remained in the Scotian Shelf and Laurentian Channel area into the fall season and were joined by gulls (Fifield *et al*. 2009). Fifield *et al*. 2009 observed that winter in this region brought large numbers of gulls, murres and other alcids. Table 3.13 is adapted from Fifield *et al*. (2009) and provides the seasonal weighted median (range in parenthesis) of 1° blocks surveyed of absolute densities (birds/km^2) by species group in the Scotian Shelf – Gulf of Maine ocean region. Individual 1° block density estimates were weighted by block survey effort to compute the overall regional weighted median. Only blocks having at least 25 km of survey effort were included (Fifield *et al*. 2009).

Table 3.13 Summary of Seasonal Abundances in the Scotian Shelf - Gulf of Maine Ocean Region (adapted from Fifield *et al*. 2009, Table 5).

Species	Season	Scotian Shelf - Gulf of Maine (Median Birds/Km^2)
All Waterbirds	Spring	7.92 (0.68 - 25.37)
	Summer	8.30 (1.73 - 148.56)
	Fall	4.23 (0.97 - 21.18)
	Winter	7.67 (4.39 - 29.44)
Northern Fulmars	Spring	0.75 (0 - 4.24)
	Summer	0.15 (0 - 1.64)
	Fall	0.30 (0 - 3.31)
	Winter	1.08 (0 - 12.37)
Shearwaters	Spring	0 (0 - 0.46)
	Summer	1.78 (0.29 - 84.02)
	Fall	2.20 (0 - 18.40)
	Winter	0 (0 - 3.74)
Storm-Petrels	Spring	0 (0 - 1.36)
	Summer	0.78 (0 - 12.74)
	Fall	0.02 (0 - 1.47)
	Winter	0 (0 - 0)
Northern Gannets	Spring	0.40 (0 - 1.03)
	Summer	0 (0 - 1.69)
	Fall	0.19 (0 - 2.83)
	Winter	0.04 (0 - 0.22)
Large Gulls	Spring	1.22 (0 - 21.33)
	Summer	0.08 (0 - 8.39)
	Fall	0.58 (0 - 2.86)
	Winter	0.62 (0 - 2.31)
Black-legged Kittiwakes	Spring	0.06 (0 - 3.74)
	Summer	0 (0 - 0.76)
	Fall	0.11 (0 - 1.39)
	Winter	1.96 (0 - 21.31)
Dovekies	Spring	0.71 (0 - 36.98)
	Summer	0 (0 - 2.68)
	Fall	0 (0 - 0.25)
	Winter	2.13 (0 - 10.93)
Murres	Spring	0.88 (0 - 4.37)
	Summer	0.06 (0 - 2.60)
	Fall	0 (0 - 0.14)
	Winter	0.61 (0 - 7.71)
Other Alcids	Spring	0.14 (0 - 1.53)
	Summer	0.04 (0 - 0.91)
	Fall	0.05 (0 - 0.65)
	Winter	0.37 (0 - 4.69)

Of particular relevance to the Phase 2 Study Area is the potential for multiple marine bird species of Special Status to occur in the area. Specifically, two marine birds designated as Species at Risk have the potential to occur in the Study Area: the Roseate Tern (*Sterna dougallii*) and the Savannah (Ipswich) Sparrow (*Passerculus sandwichensis princeps*). Details on these two species, as well as other marine bird species of special status are included in Table 3.14.

Table 3.14 Marine Bird Species of Special Status Which May Occur in the Study Area

Common Name	Species Name	*SARA* Schedule 1 Status	COSEWIC Designation	Potential Occurrence in Study Area
Shore, Migratory and Marine Birds				
Barrows Goldeneye	*Bucephala islandica*	Special Concern	Special Concern	Low potential for occurrence – A migratory duck that is largely concentrated in the Rocky Mountains with only a small portion of its population extending east to Atlantic Canada, wintering in coastal areas.
Harlequin Duck	*Histrionicus histionicus*	Special Concern	Special Concern	Low potential for occurrence – Eastern population known to winter in Nova Scotia, along the coast with a preference for coastal islands.
Piping Plover (melodus subspecies)	*Charadrius melodus melodus*	Endangered	Endangered	Low potential for occurrence – Population inhabits sandy beach ecosystems throughout Atlantic Canada but is not known to inhabit Sable Island. Winters on the southern Atlantic coast of the U.S.
Roseate Tern	*Sterna dougallii*	Endangered	Endangered	Moderate potential for occurrence – Small population breeds almost exclusively on a small number of islands off of Nova Scotia, Sable Island being one of them. Noted to be sensitive to increases in large shipping traffic and any possible beach activity on Sable Island.
Savannah Sparrow (Ipswich Sparrow)	*Passerculus sandwichensis princeps*	Special Concern	Special Concern	High potential for occurrence – Population nests almost exclusively on Sable Island. Winters in the mid-Atlantic U.S. and therefore would migrate across Study Area.

Source: SARA 2011

3.2.7 Special Areas

Special Areas within the SEA Study Area include a National Parks Act Park Reserve, an *Oceans Act* MPA and AOIs, *Species at Risk Act* Critical Habitat areas, a Fisheries Act closure area (*e.g.* coral conservation area), and Ecologically and Biologically Significant Areas (EBSAs). The Special Areas are not equally ecologically significant or sensitive. Protected areas such as the Sable Island National Park Reserve and Gully MPA (Zone 1), as well as the Shortland and Haldimand Canyons Northern bottlenose whale Critical Habitats, for example, are afforded more significance given their legal designations and long-term protection.

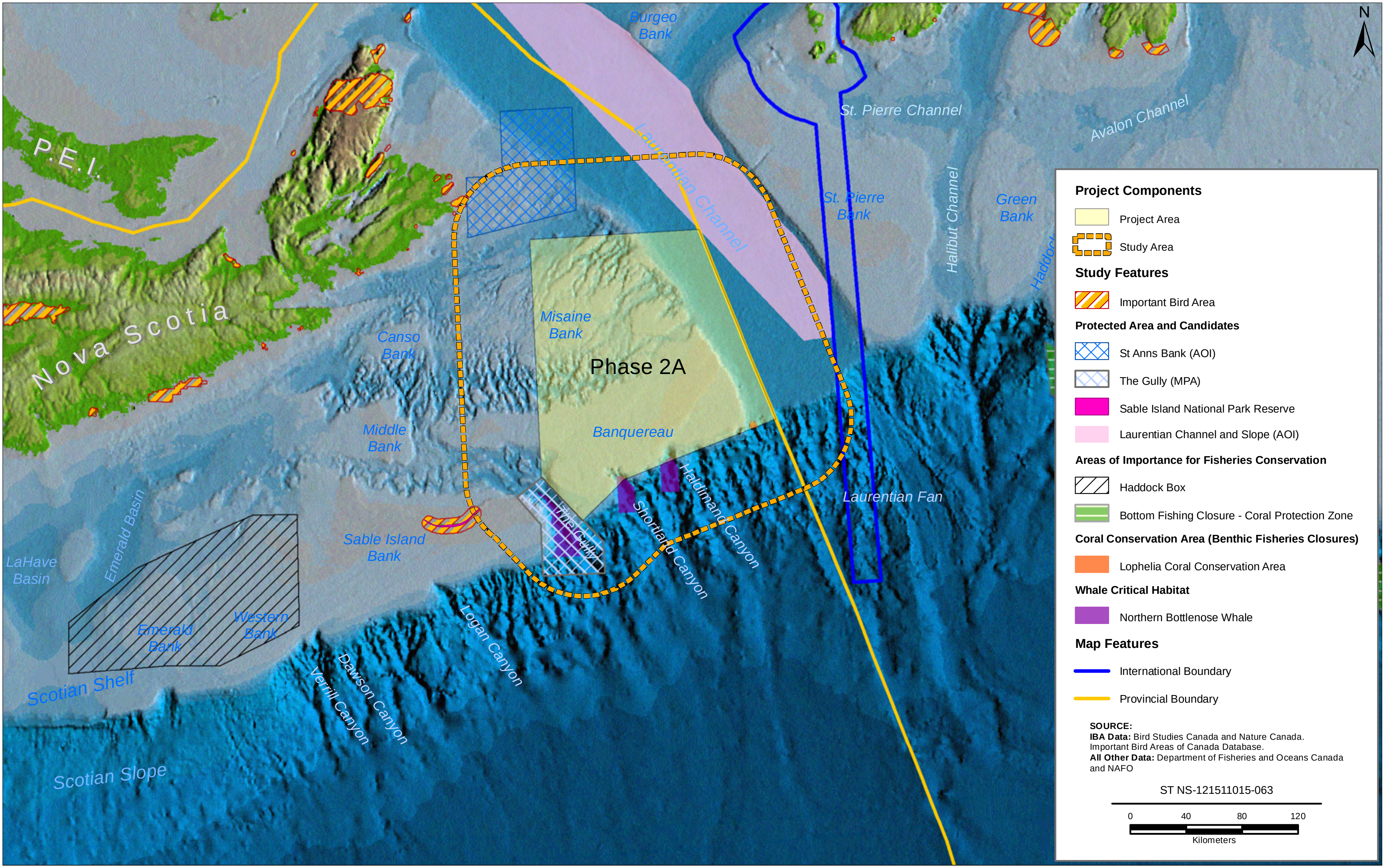
Middle Bank, Misaine Bank and Eastern Shoal, and St. Anns Bank were identified by Fisheries and Oceans Canada (DFO) as candidate *Oceans Act* MPAs. These sites were subject to public consultation, national and regional guidelines, requirements outlined in the *Oceans Act*, as well as ecological, biological and socio-economic factors which resulted in St Anns Bank being chosen as the next AOI on the Scotian Shelf to move through the *Oceans Act* MPA regulatory establishment process. Although Middle Bank and Misaine Bank and Eastern Shoal were not chosen as AOIs, they have several key ecological features which may identify them as future sites within the MPA network planning process that is currently underway (DFO 2012).

St Anns Bank includes a portion of a migration corridor between the Gulf of St. Lawrence and St. Lawrence estuary for herring, mackerel, bluefin tuna as well as fin, humpback, and blue whales. Leatherback turtles forage in the area and it is also important habitat for Atlantic wolffish and commercial groundfish species, including Sydney Bight and southern Gulf of St. Lawrence population of Atlantic cod, which overwinter in the region. St. Anns Bank contains rare cold water corals and contains habitat types ranging from shallow banks to deep channels which support diverse fish and invertebrate assemblages (DFO 2011h).

DFO has undertaken a detailed analysis to identify a network of marine protected areas. Using the criteria of uniqueness, diversity, importance for threatened, endangered or declining species and/or habitats, sensitive habitat, and abundance of key species, this network is a cohesive set of sites that addresses conservation objectives (Horsman 2011). The network covers the Maritimes Region of DFO, and includes the Scotian Shelf. The main goal of the network analysis work undertaken in 2011 was to identify sites that will contribute to a protected area network in a spatially efficient manner and that aims to reduce the economic impact of formally protecting marine areas by minimizing the overall conservation footprint (Horsman 2011). DFO's analysis (Horsman 2011) highlights several sites within the Phase 2 Study Area that are of particular interest for inclusion in a marine protected area network. Within Phase 2A Study Area, are the St. Anns Bank AOI and the Laurentian Channel AOI, both of which are under consideration for inclusion as marine protected areas. For details on these Areas refer to Table 3.15 below.

Figures 3.4 and 3.5 depict Special Areas and EBSAs respectively found not only within the Study Area but also the larger Scotian Shelf area. Table 3.15 describes the designated protected areas in the Study Area (*i.e.*, Sable Island National Park and The Gully MPA) and Table 3.16 describes the other Special Areas (including EBSAs) in the Study Area.

Although there are several overlapping Special Areas (*e.g.*, the Gully MPA and the Gully EBSA) they are described separately in this section as illustrated in Figures 3.4 and 3.5. Overlapping areas are consolidated in Section 5.2 in the assessment of potential effects.



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REVIEWED BY:
C. Shupe

CLIENT:
Canada - Nova Scotia Offshore Petroleum Board

Eastern Scotian Shelf - Misaine and Banquereau Bank Strategic Environmental Assessment

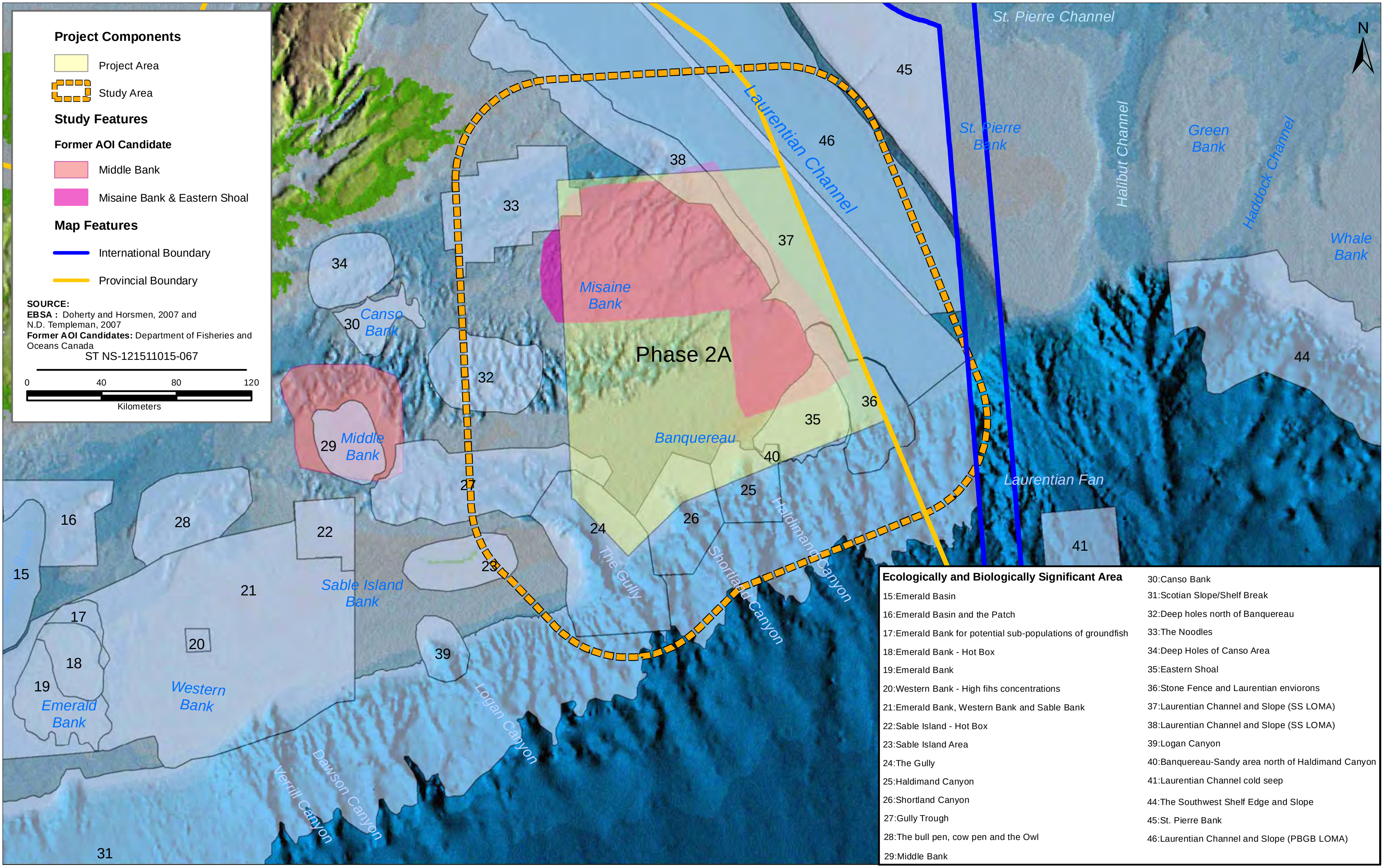
Designated Special Areas

FIGURE NO.:
3.4

DATE:
Jan 09, 2013

Stantec

File Path: V:\1215\active\121510xxx\121511015_cnsopb_sea\geomatics\mapping\mxd\report\Phase2A\ST NS_121511015-063_Special_areas_Phase2A.mxd



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CLIENT:
Canada - Nova Scotia Offshore Petroleum Board

Eastern Scotian Shelf - Misaine and Banquereau Bank Strategic Environmental Assessment

Ecologically and Biologically Significant Areas

FIGURE NO.:
3.5

DATE:
Dec 06, 2012

Stantec

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Table 3.15 Designated and Candidate Protected Areas

Sable Island National Park Reserve	
Location	• Located 290 km offshore from Halifax, Sable Island is a windswept crescent-shaped sandbar 42 km long by 1.5 km wide that emerges from the Atlantic Ocean near the edge of the Continental Shelf (Parks Canada 2010).
Designation and Protection	• Sable Island is protected under the *Canada National Parks Act* which prohibits drilling from the surface of Sable Island and one nautical mile seaward of the low water mark of Sable Island as defined by the Canadian Hydrographic Service (Parks Canada 2011).
	• To comply with the *National Parks Act*, an *Amending Agreement of Significant Discovery Licence 2255E* was executed on December 21, 2011 (CNSOPB 2011a).
	• As of April 1, 2012, Parks Canada is responsible for managing access to the island by coordinating registrations, schedules, logistics, and written authorizations from the Canadian Coast Guard pursuant to the *Canada Shipping Act*, as is required in the current legislative context until the Canada *National Parks Act* is amended to include Sable Island National Park Reserve. (J. Sheppard, Parks Canada, pers. comm., 2012).
	• Sable Island was designated as a Migratory Bird Sanctuary (MBS) in 1977 and is administered by the Canadian Wildlife Service (CWS) and is also an Important Bird Area (IBA) (Environment Canada 2012b).
	• Sable Island is protected under the *Special Places Protection Act* for its rich archaeological and heritage resources.
	• Sable Island is listed as a site considered for designation as a World Heritage Site (Parks Canada 2009).
Administration	• The Meteorological Service of Canada, a branch of Environment Canada, maintains a continuous presence on the island. They also continue to provide operational services by agreement with Parks Canada, including all services related to landing on and visiting the island (J. Sheppard, Parks Canada, pers. comm. 2012).
	• There are seasonally occupied facilities belonging to Department of Fisheries and Oceans, and Coast Guard including a number of buildings, two lighthouses, two helicopter landing pads and a navigation beacon (Canadian Coast Guard 2012).
Ecological Significance	• Over 190 species of plants and 350 species of birds recorded. The Ipswich (Savannah) Sparrow and the Roseate Tern both breed on the island and are protected under SARA.
	• The Ipswich Sparrow nests almost exclusively on Sable Island and is the dominant terrestrial bird on the island. The birds breed on virtually all vegetated areas on Sable Island, including healthy terrain and areas dominated by Marram Grass. In winter, they occur in coastal dunes, especially in areas with dense beach grass (COSEWIC 2009). The species' localized distribution makes it particularly vulnerable to potential threats such as chance events (*e.g.*, harsh weather and disease during breeding season), predation, human activity, and habitat loss.

Table 3.15 Designated and Candidate Protected Areas

	• The 2006 proposed Recovery Strategy for the Roseate Tern (Environment Canada 2006) was the first recovery strategy for a migratory bird posted on the *SARA* Public Registry to identify "critical habitat" as defined in the Act (200 m buffer zone around tern colonies). The Amended Recovery Strategy for the Roseate Tern (Environment Canada 2010) has the objective to continue to maintain the small peripheral colonies of Roseate Terns nesting on Sable Island. A former recommended focus on restoration of Roseate Terns to Sable Island was not attempted on Sable Island (primarily due to financial constraints) and since then, only one or two pairs of Roseate Terns have nested there each year (Environment Canada 2010).
	• Home to the world's largest breeding colony of grey seals, which pup on the island between late December and early February. Harbour Seals also breed on the island and are year round residents.
	• Hundreds of Harp and Hooded seals and one or two Ringed seals come ashore for a few hours or days during the winter and early spring (Sable Island Green Horse Society 2002).
	• Over 400 Wild horses, believed to have been introduced sometime in the mid-1700s, inhabit the island (Parks Canada 2011).
The Gully Marine Protected Area (MPA)	
Location	• The Gully is located approximately 200 km south-east of Nova Scotia, east of Sable Island, on the edge of the Scotian Shelf (DFO 2008A).
	• In the Gully the seafloor drops away over 2.5 km extending approximately 65 km long and 15 km wide making it one of the most prominent undersea features on the east coast of Canada (DFO 2008A).
Designation and Administration	• In 1994, DFO identified part of the Gully as a Whale Sanctuary to reduce noise disturbance and ship collisions with whales (DFO 2008A).
	• In May 2004, the Gully was designated an MPA under the *Oceans Act* (DFO 2011c).
	• The Gully MPA Regulations prohibit any activity within or in the vicinity of the MPA that disturbs, damages, destroys or removes any living marine organism or any part of its habitat within the MPA and in the vicinity of the MPA. These regulations apply to the entire water column and the seabed to a depth of 15 m (DFO 2011c).
	• The Gully MPA Management Plan was developed to support the MPA Regulations and provide guidance to DFO, other regulators, marine users, and the public on protecting and managing this important ecosystem (DFO 2008A, DFO 2011c).
	• The MPA contains three management zones, each providing varying levels of protection based on conservation objectives and ecological sensitivities (DFO 2008A): Zone 1 consists of the deepest sections of the canyon and is preserved in a near-natural state with full ecosystem protection - this zone is highly restricted with few activities permitted (research and limited vessel transit); Zone 2 provides strict protection for the canyon sides and outer area of the Gully - some fisheries are allowed in this region; and Zone 3 includes the shallow water and sandy banks that are prone to regular natural disturbance and allows some fishing.

Table 3.15 Designated and Candidate Protected Areas

	• Fishing for halibut, tuna, shark and swordfish have been allowed in Zones 2 and 3 provided the activities are conducted under a federal fishing license and approved management plan (DFO 2008A). Scientific research and monitoring may be approved in all three zones provided a plan is submitted and the research meets all regulatory requirements. Other activities may be permitted in Zone 3 provided they do not cause disturbance beyond the natural variability of the ecosystem and are subject to plan submission and Ministerial approval.
	• The CNSOPB has not allowed petroleum activities in the Gully since 1998 (CNSOPB 2012).
Ecological Significance	• The Gully has significant coral communities, a diversity of both shallow and deep-water fishes, and a variety of whales and dolphins including blue whales, sperm whales, Sowerby's beaked whales, and aggregations of prey of whale species. A resident population of endangered Northern bottlenose whales is found in the deep canyon area. These whales are among the world's deepest divers and make regular trips to the canyon depths for food (DFO 2008A).
St. Anns Bank Area of Interest (AOI)	
Location	• St. Anns Bank is located east of Scatarie Island, off Cape Breton. It covers approximately 5100 km^2 and includes part of St Anns Bank, Scatarie Bank, and a portion of the Laurentian Slope and Channel (DFO 2011h).
Designation and Administration	• In 2011, DFO announced St Anns Bank as a new Area of Interest for potential designation as a Marine Protected Area under the *Oceans Act* (DFO 2011h).
	• According to national and regional guidelines, requirements outlined in the *Oceans Act*, as well as ecological, biological, and socio-economic factors, St Anns Bank was chosen over two alternative areas (Middle Bank, Misaine Bank & Eastern Shoal) (DFO 2011h)
Ecological Significance	• St Anns Bank is a portion of a migration corridor between the Gulf of St. Lawrence and St. Lawrence estuary for herring, mackerel, bluefin tuna as well as fin, humpback, and blue whales. Leatherback turtles forage in the area and it is also critical habitat for Atlantic wolffish and commercial groundfish species, including Sydney Bight and southern Gulf of St. Lawrence population of Atlantic cod, which overwinter in the region. St. Anns Bank contains rare cold water corals and contains habitat types ranging from shallow banks to deep channels which support diverse fish and invertebrate assemblages.
Laurentian Channel Area of Interest (AOI)	
Location	• The Laurentian Channel AOI is a 17,950 km^2 area of a long submarine valley extending from the intersection of the St. Lawrence and Saguenay Rivers to the edge of the continental shell off Newfoundland (DFO 2011j).
Designation and Administration	• In June 2010, the Laurentian Channel was announced as an Area of Interest for consideration for designation as an MPA under the *Oceans Act* (DFO 2011j).

Table 3.15 Designated and Candidate Protected Areas

	• The Laurentian Channel AOI Advisory Committee was formed in March 2011 to advise DFO on MPA development issues such as boundary lines, management scenarios, and developing management and monitoring plans. The committee is chaired by DFO and is composed of representatives from various federal and Newfoundland and Labrador provincial government departments, environmental non-governmental associations (ENGOs), academia, fishing industry associations, and petroleum industry. (DFO 2011k).
Ecological Significance	• The Laurentian Channel is home to the only pupping grounds for black dogfish off Canada while areas near St. Pierre Bank contain the highest concentration of this species in Canadian waters (Kulka 2006).
	• The Laurentian Channel is an important nursery area for juvenile Smooth skate (< 30cm) (DFO 2007c).
	• The Cabot Strait region is the sole migratory corridor for marine mammals moving in and out of the Gulf of St. Lawrence (Templeman 2007).
	• Monkfish, pollock, and white hake in the region occur exclusively along the Southwest Slope of the Grand Banks and the region of the Laurentian Channel, with highest concentrations in spring (Kulka *et al.* 2003).
***Lophelia* Conservation Area (LCA)**	
Location	• The *Lophelia* Conservation Area (LCA) is 15 km^2 area located at the mouth of the Laurentian Channel on southeast Banquereau Bank, about 260 km southeast of Louisbourg
Designation and Administration	• Created in 2004 to include the reef area and a one nautical mile buffer closed to all bottom fisheries, based on consultation with active fisheries representatives (Cogswell *et al.* 2009).
	• The larger area surrounding the conservation area is regionally known to fishermen as the Stone Fence.
	• The *Lophelia* Conservation Area is closed to fishing under the *Fisheries Act*.
Ecological Significance	• Nine coral species, including the reef-building *Lophelia pertusa*, have been identified from the area (Cogswell *et al*. 2009).
	• The LCA contains the only known living *Lophelia pertusa* reef in Atlantic Canada (DFO 2011i).
	• Evidence of coral rubble, overturned rocks, and lost fishing gear indicate areas have been impacted by bottom fishing (Cogswell *et al*. 2009).
	• Predicted to contain high marine mammal diversity in entrances of channels, particularly dolphins and deep diving whales (Doherty and Horsman 2007).
Northern Bottlenose Whale Critical Habitat (Sanctuaries): The Gully, Shortland Canyon, Haldimand Canyon	
Location	• The Recovery Strategy for Northern bottlenose whale identifies the entirety of Zone 1 of the Gully Marine Protected Area and areas with water depths of more than 500 m in Haldimand Canyon and Shortland Canyon as Critical Habitat under *SARA* for the Scotian Shelf population. Since Northern bottlenose whales use the full depth range in these areas, breathing and socializing at the surface and diving to feed at or

Table 3.15 Designated and Candidate Protected Areas

	near the bottom, Critical Habitat for this species should be considered to include the entire water column and the seafloor (DFO 2011d).
Designation and Administration	• In 1994, DFO designated a "Whale Sanctuary" in the Gully for the Northern bottlenose whales. Using an annual Notice to Mariners, vessel operators are asked to avoid the Gully or transit it cautiously.
	• Pursuant to section 58(5) of *SARA*, Critical Habitat for the Northern bottlenose whale was identified in the Final Recovery Strategy for this species, and posted on the *SARA* Public Registry in May 2010. Note the portion of the Northern bottlenose whale Critical Habitat located in the Gully MPA Zone 1 was described in the Canada Gazette 1 on August 14, 2010. The prohibition in section 58(1) of SARA came into force within the Gully MPA Zone 1 area on November 11, 2010 (DFO 2010d). Critical habitat is protected under *SARA* through provisions set out Section 32 of the Act.
Ecological Significance	• Northern bottlenose whales are sighted consistently, throughout the year, at the entrance of the Gully (COSEWIC 2002).
	• The Scotian Shelf population of Northern bottlenose whales live at the southern extreme of the species' range and appear to be largely or totally distinct from the populations further north, seem to be non-migratory, and spend an average of 57% of their time in a small core area at the entrance of the Gully, which has seafloor relief that is unique in the western North Atlantic. These characteristics make the population particularly sensitive to human activities (COSEWIC 2002). Recent acoustic monitoring studies indicate that Northern bottlenose whales feed year-round in the Gully, Shortland, and Haldimand Canyons, as well as in between these canyons (Moors 2012).
	• Northern bottlenose whale habitat is characterized by waters of more than 500 m in bottom depth, particularly around steep-sided features (*e.g.,* underwater canyons and continental slope edge), and access to sufficient accumulations of prey (*Gonatus* squid) (DFO 2011d).
	Distribution of this species extends west of the Gully and it is believed that other canyons along the Scotian Slope (*e.g.*, Logan canyon) may also provide important habitat for this species (DFO 2010c).

Table 3.16 Additional Special Areas in the Study Area

Ecologically and Biologically Significant Areas (Doherty and Horsman 2007)	
35 Misaine Bank & Eastern Shoal	• The site consists of unique seabed features which provide habitat for a diverse range of fishes and invertebrates that includes commercial species (*e.g.*, redfish, snow crab, and shrimp), non-commercial species (*e.g.*, sponges, corals, anemones, and sea raven) and several SARA and COSEWIC designated species (*i.e.*, wolffish, winter skate and Atlantic cod).
	• Eastern Shoal is a key area for groundfish (*e.g.,* cod, yellowtail flounder, and thorny skate) and invertebrates (*i.e.,* surf clams).
	• Misaine Bank is important for snow crab, shrimp, urchin, and American plaice.
	• The Laurentian Channel is a significant habitat for redfish, white hake, and witch flounder. The Laurentian Channel is the largest channel in Atlantic Canadian waters and a known migration route for a range of whales, including the endangered blue whale, and many fishes moving in and out of the Gulf of St. Lawrence. Migrating species feed on krill and other forage species that flourish in the channel.
	• The largest fisheries in the Misaine Bank & Eastern Shoal consist of surf clams, snow crab, redfish, and flatfishes. Groundfish (*e.g.*, redfish, halibut, yellowtail flounder, skates, and American plaice) are still caught but landings are much lower than they were in the past. Shrimp trawling has also occurred along the northern boundary. Additionally, parts of the area are being considered for a developing sea cucumber fishery.
	Source: DFO 2009a
29 Middle Bank	• Middle Bank includes several different seabed features. The eastern part of the bank is dominated by a shallow and dynamic sand wave field, while a distinct gravel region occurs along the northern flank, and the west is characterized by rough terrain. To the north of the bank is a complex area of deep holes, channels, and mounds.
	• Fish species diversity on Middle Bank is high compared to other parts of the Eastern Scotian Shelf. It has also been identified as an area of high larval fish diversity. Ocean currents over the bank may help retain fish eggs and larvae in the area.
	• Important area to a wide variety of species including many groundfish (*e.g.*, haddock, yellowtail flounder), commercial invertebrates (*e.g.*, shrimp, sea cucumber) and at-risk species (*e.g.*, winter skate and Atlantic cod).
	• Middle Bank is a fishing ground for cod and other groundfish as well as shrimp and snow crab along the northern edge of the bank. There are also vessels fishing for sea cucumber, scallops, halibut, and bluefin tuna in some years.
	Source: DFO 2009a
23 Sable Island Area	• Area with high concentrations of juvenile fish, particularly haddock (young-of-year and age 1)

Table 3.16 Additional Special Areas in the Study Area

24 The Gully	• A unique geological feature with unique current patterns resulting in a highly productive area with very high diversity and density of cetacean species.
	• Largest abundance of endangered Northern bottlenose whales on the Scotian Shelf.
	• Habitat for aggregations of other whales, including endangered blue and sperm whales, and aggregations of prey of whale species.
25 Haldimand Canyon	• Aggregation of endangered Northern bottlenose whales and likely sperm and blue whales.
	• Presence of gorgonian corals.
	• Bottlenose whales move between the Gully, Shortland Canyon and Haldimand Canyon, likely along deeper contours of 800-1200 m.
26 Shortland Canyon	• Aggregation of endangered Northern bottlenose whales and probably other species (*e.g.*, sperm and blue whales).
	• Presence of gorgonian corals.
	• Bottlenose whales move between the Gully, Shortland Canyon and Haldimand Canyon, likely along deeper contours (800-1200 m).
	• Area of high finfish diversity with a variety of depth preferences.
27 Gully Trough	• Common foraging area for seals and other marine mammals.
31 Scotian Slope/Shelf Break	• Includes areas of unique geology (iceberg, furrows, pits, complex/irregular bottom).
	• High finfish diversity due to habitat heterogeneity provided by depth
	• Primary residence for mesopelagic fishes
	• Inhibited by corals, whales, porbeagle shark, tuna, swordfish.
	• Migratory route for endangered leatherback turtles – the area supports concentrations of salps which are a source of food for turtles.
	• High diversity of squid
	• Overwintering area for number of shellfish species
	• Halibut overwintering, lobster overwintering
	• Seabird feeding/overwintering area
	• Greenland sharks.

Table 3.16 Additional Special Areas in the Study Area

32 Deep Holes North of Banquereau	• Very productive snow crab bottom. Area of high density of commercial sized snow crab.
33 The Noodles	• Shrimp aggregation. Possible snow crab retention.
34 Deep Holes of Canso Area	• Topographically diverse area that serves as a deep water reserve for lobster. Largest lobsters along the Eastern Shore are found here and may serve as larval supply downstream.
35 Eastern Shoal	• Surf clam, sand lance, scallop and quahog aggregations.
	• Area of planktonic significance.
	• Contains gyres and unique geology.
	• Northern portion overlaps with Misaine Bank & Eastern Shoal former candidate AOI.
36 Stone Fence and Laurentian Environs	• Variety of corals present as well as only known record of *Lophelia* coral on Scotian Shelf.
	• Important habitat for juvenile fishes.
	• Predicted to contain high marine mammal diversity in entrances of channels, particularly dolphins and deep diving whales.
37 Laurentian Channel & Slope	• Overwintering area for 4Vs cod, *Calanus*, white hake, Dover sole, turbot (Greenland halibut), redfish and Greenland shark.
	• Important migration route via Cabot Strait to Gulf of St. Lawrence.
38 Laurentian Channel & Slope	• High fish diversity for demersal, pelagic & mesopelagic fishes.
	• Migration route for white hake, cod, redfish, flatfish and Greenland shark.
	• Portion of important mating area for porbeagle sharks (COSEWIC).
	• Primary overwintering area for 4T cod (COSEWIC), white hake and *Calanus*.
	• Important aggregation area for krill.
	• Important migration route via Cabot Strait to Gulf of St. Lawrence .
40 Banquereau – Sandy Area North of Haldimand Canyon	• Important area for infauna shellfish species.
	• High sea urchin density.
46 Laurentian Channel & Slope (PBGB LOMA)	• The Laurentian Channel is home to the only pupping grounds for black dogfish off Canada while areas near St. Pierre Bank contains the highest concentration of this species in Canadian waters (Kulka 2006).

Table 3.16 Additional Special Areas in the Study Area

	• Laurentian Channel is an important nursery area for juvenile Smooth skate (< 30cm) (DFO 2007c).
	• The Cabot Strait region is the sole migratory corridor for marine mammals moving in and out of the Gulf of St. Lawrence (Templeman 2007).
	• Monkfish, pollock, and white hake in the region occur exclusively along the Southwest Slope of the Grand Banks and the region of the Laurentian Channel, with highest concentrations in spring (Kulka *et al*. 2003).

3.3 SOCIO-ECONOMIC CHARACTERISTICS

3.3.1 Commercial Fish and Fisheries

Commercial fishing started in the mid-1500s and by 1700, Nova Scotia was exporting cod, mackerel, and herring. In 1973, the total landings of fish on the Scotian Shelf peaked, with catches exceeding 750,000,000 kg (750 000 t) (DFO 2011b). Throughout most of history groundfish have dominated the commercial catch, although the catch of shellfish has steadily been increasing and overtook groundfish as the main contributor in 1996. In 1993 a moratorium on the groundfish fishery, particularly for cod, was imposed on the Eastern Scotian Shelf encompassing all of the Study Area (NAFO Divisions 4W, 4Vs, 4Vn, and 3Ps) and remains in effect (Worcester and Parker 2010). A longline fishery for Atlantic halibut is presently the only major ground fishery operating on the Eastern Scotian Shelf. The overall total landings of fish have dropped; however, the overall landed value of fish increased dramatically in 1977-1978 with the extension of the Canadian jurisdiction to 200 miles, eliminating foreign fishing (Worcester and Parker 2010). During 2010, within the Study Area, invertebrates made up the majority of the catch value (91.2%), with groundfish (8%), and pelagic species (0.8%) making up the remainder of the catch value respectively (refer to Table 3.17). The Department of Fisheries and Oceans Catch and Effort Database was consulted to determine landings within the Study Area.

Table 3.17 2010 Catch (Landings and Value) for all Species Caught Within the Phase 2A Study Area

Species Group	Landings (kg)	Value ($)
Pelagics	118,127	578,520
Groundfish	5,679,542	6,007,660
Invertebrates	32,735,040	69,096,273
Total	38,532,709	75,682,453

Source: DFO Catch and Effort Database 2006-2010

Table 3.18 outlines the number of fishery licenses (commercial and communal commercial) that may fish in the vicinity of SEA Areas 2A and 2B. This data, provided courtesy of DFO, is meant to demonstrate the relative context of fisheries operating in the vicinity of the Phase 2A and 2B Study Areas, based primarily on licensing data from NAFO 4W, 4Vn, 4Vs, and 3Ps.

Table 3.18 Summary of Fishery Licenses in General Phase 2A Study Area

Fishery by Species and Management Zone	Total Number of Fishery Licenses by Species (*i.e.* Commercial and Communal Commercial)	Number of Communal Commercial Fishery Licenses by Species	Total Number of Atlantic-wide Fishery Licenses by Species (*i.e.* Commercial and Communal Commercial *	Number of Communal Commercial Atlantic-wide Fishery Licenses by Species*
CFA 22 Snow crab	78	0	0	0
CFA 23 Snow crab	62	20	0	0
NAFO 4Vn Groundfish				
• Fixed gear (<45)	465	7	0	0
• Fixed gear (45-65)	56	0	0	0
• Fixed gear (65-100)	0	0	11	0
• Mobile gear (<65)	309	11	0	0
• Midshore (65-100)	20	0	9	0
• Offshore (>100)	24	0	32	0
NAFO 4Vs Groundfish				
• Fixed gear (<45)	555	1	0	0
• Fixed gear (45-65)	56	0	0	0
• Fixed gear (65-100)	0	0	11	0
• Mobile gear (<65)	313	11	0	0
• Midshore (65-100)	20	0	9	0
• Offshore (>100)	24	0	32	1
Large Pelagics				
• Swordfish Harpoon	835	4	0	0
• Swordfish LL/ Other Tuna	74	9	3	0
• Offshore	1	0	0	0
• Bluefin tuna (MAR Region)	1	0	0	0
• Porbeagle shark	0	0	0	0
Mobile shrimp	28	13	0	0
Offshore scallops	6	0	0	0
Sea Cucumber (Now Commercial)	1	0	0	0
Offshore Whelk (Exploratory)	1	0	0	0
Offshore Clam	1	0	3	0

* Note that these licenses may fish in the Phase 2 Study Area, but may not land their catch in the DFO Maritimes Region.

Table 3.19 summarizes fishing seasons for key commercial fisheries occurring in the Study Area. Additional details on the groundfish, pelagic and invertebrate fisheries are provided in the following sections. Spatial data for fisheries landings 2006 to 2010 are provided in Appendix B to illustrate a regional context of fisheries activities offshore Nova Scotia and Newfoundland. Figures 3.6 to 3.8 in this section illustrate general locations and species caught in each fishery, although this does not depict intensity of fishing effort. Although there is minimal offshore lobster fishing occurring in the Study Area (single license holder), this is not depicted on invertebrate fishing mapping (Figure 3.8).

Table 3.19 Summary of Fishing Seasons for Principal Commercial Fisheries Species Potentially Within Study Area

Common Name	Latin Name	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec
Pelagic Species													
Albacore tuna	*Thunnys alalunga*	🟩	🟩	🟩	🟩	🟨	🟨	🟥	🟥	🟥	🟥	🟥	🟨
Bigeye tuna	*Thunnus obesus*	🟩	🟩	🟩	🟩	🟨	🟨	🟥	🟥	🟥	🟥	🟥	🟨
Bluefin tuna	*Thunnus thynnus*	🟩	🟩	🟩	🟩	🟩	🟨	🟥	🟥	🟥	🟥	🟥	🟨
Porbeagle shark	*Lamna nasus*	🟩	🟨	🟥	🟥	🟥	🟥	🟩	🟩	🟩	🟨	🟨	🟨
Swordfish	*Xiphias gladuis*	🟩	🟩	🟩	🟩	🟨	🟨	🟥	🟥	🟥	🟥	🟥	🟨
White marlin	*Tetrapturus albidus*	🟩	🟩	🟩	🟩	🟨	🟨	🟥	🟥	🟥	🟥	🟥	🟨
Groundfish Species													
American plaice	*Hippoglossoides platessoides*	🟨	🟨	🟨	🟨	🟨	🟩	🟥	🟥	🟥	🟩	🟨	🟨
Atlantic cod	*Gadus morhua*	🟨	🟨	🟨	🟨	🟨	🟩	🟥	🟥	🟥	🟩	🟨	🟨
Atlantic halibut	*Hippoglossus hippoglossus*	🟨	🟨	🟨	🟨	🟨	🟩	🟥	🟥	🟥	🟩	🟨	🟨
Cusk	*Brosme brosme*	🟨	🟨	🟨	🟨	🟨	🟩	🟥	🟥	🟥	🟩	🟨	🟨
Greysole-Witch flounder	*Glyptocephalus cynoglossus*	🟨	🟨	🟨	🟨	🟨	🟩	🟥	🟥	🟥	🟩	🟨	🟨
Haddock	*Melanogrammus aeglefinus*	🟨	🟨	🟨	🟨	🟨	🟩	🟥	🟥	🟥	🟩	🟨	🟨
Monkfish	*Lophius spp.*	🟨	🟨	🟨	🟨	🟨	🟩	🟥	🟥	🟥	🟩	🟨	🟨
Pollock	*Pollachius virens*	🟨	🟨	🟨	🟨	🟨	🟩	🟥	🟥	🟥	🟩	🟨	🟨
Redfish (deepwater and Acadian)	*Sebastes mentella / Sebastes fasciatus*	🟨	🟨	🟨	🟨	🟨	🟩	🟥	🟥	🟥	🟩	🟨	🟨
Stripped catfish (wolfish)	*Anarchichas lupus*	🟨	🟨	🟨	🟨	🟨	🟩	🟥	🟥	🟥	🟩	🟨	🟨
Turbot – Greenland flounder	Reinhardtius hippoglossoides	🟨	🟨	🟨	🟨	🟨	🟩	🟥	🟥	🟥	🟩	🟨	🟨
White hake	*Urophycis tenuis*	🟨	🟨	🟨	🟨	🟨	🟩	🟥	🟥	🟥	🟩	🟨	🟨
Invertebrate Species													
Cockles	*Cerastoderma edule*	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩
Northern Shrimp	*Panadalus borealis*	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩
Scallop	potential for multiple species	🟨	🟨	🟨	🟨	🟩	🟩	🟩	🟩	🟩	🟩	🟨	🟨
Sea cucumber	*Class* Holothuroidea	🟨	🟨	🟨	🟨	🟩	🟩	🟩	🟩	🟩	🟩	🟨	🟨

Table 3.19 Summary of Fishing Seasons for Principal Commercial Fisheries Species Potentially Within Study Area

Common Name	Latin Name	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec
Snow crab	*Chionoecetes opilio*	⬜	⬜	⬜	🟩	🟩	🟩	🟩	🟩	🟩	⬜	⬜	⬜
Stimpson's surf clam	*Mactromeris Polynyma*	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩
Whelks	*Buccinum undatum*	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩

Data sources: Breeze and Horsman 2005

🟩	Open Fishing Season * Note all large pelagic fisheries are open year round.
⬜	Closed Fishing Season
🟥	High Fishing Activity within the Season
🟨	Low Fishing Activity within the Season

3.3.1.1 Pelagic Fisheries

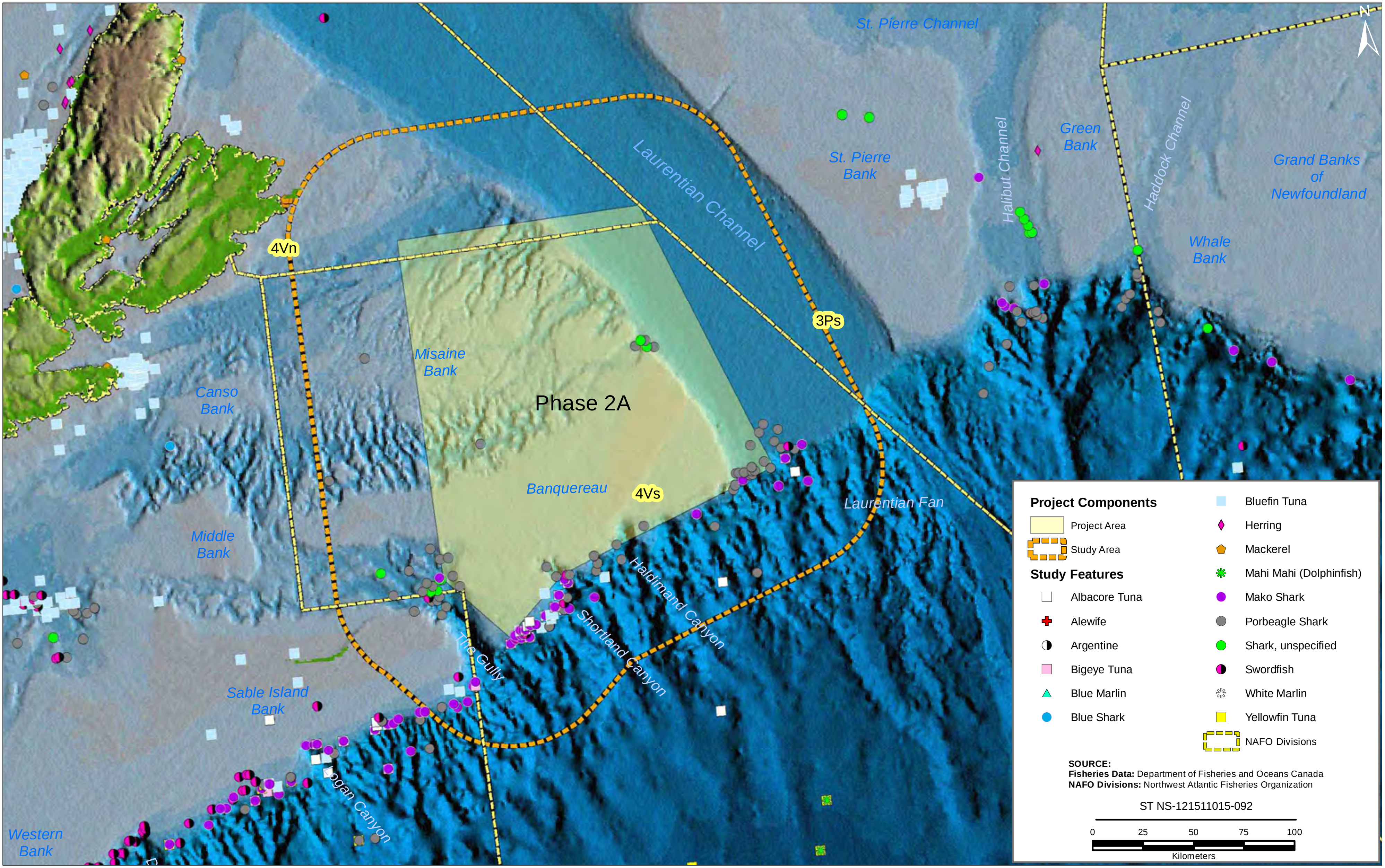
During the period from 1980-2000 pelagic species have shown fluctuations in catch and have ranged from 8 % - 15 % of the total landed value (Worcester and Parker 2010). In 2010 pelagic species accounted for 0.8 % of the total landed value in the Study Area. Of the pelagic species, swordfish are one of the main large species found within the waters of the Scotian Shelf. From 1980-2008, the North Atlantic average landings by the Canadian fleet averaged 1300-1500 t annually (DFO 2012b). On the Scotian Shelf bigeye tuna, yellowfin tuna, swordfish and blue shark stocks are considered to be in a healthy state, while bluefin tuna, Albacore tuna, shortfin mako, porbeagle, blue marlin, and white marlin stocks are in a critical state (DFO 2012b).It should be noted that the health of fish stocks have been determined by DFO (2012b). In 2010 swordfish accounted for 89 % of the total landed value, while bigeye tuna (5 %) and mako shark (3 %) (caught as bycatch) made up the remainder of the top three pelagic species respectively (see Table 3.20).

Table 3.20 2010 Catch (Landings and Value) for Key Pelagic Species Caught Within the Phase 2A Study Area

Species	Landings (kg)	Value ($)
Albacore tuna	403	830
Bigeye tuna	2,715	31,810
Mako shark	6,677	17,938
Porbeagle shark	10,356	10,435
Swordfish	97,976	517,513
Total	**118,127**	**578,526**

Source: DFO Catch and Effort Database 2006-2010

Figure 3.6 depicts locations of pelagic species catches within the Study Area. As shown on Figure 3.6 and Figure 4 in Appendix B, pelagic fisheries in the Study Area are concentrated primarily along the shelf break. Table 3.21 summarizes information regarding fishing seasons and gear types.



SOURCE:
Fisheries Data: Department of Fisheries and Oceans Canada
NAFO Divisions: Northwest Atlantic Fisheries Organization

ST NS-121511015-092

PREPARED BY: M. Huskins-Shupe	Eastern Scotian Shelf - Misaine and Banquereau Bank Strategic Environmental Assessment	FIGURE NO.: 3.6
REVIEWED BY: C. Shupe		DATE: Dec 07, 2012
CLIENT: Canada - Nova Scotia Offshore Petroleum Board	**Pelagic Fisheries, 2006-2010**	Stantec

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Table 3.21 Pelagic Fishery Seasons and Gear Type

Species	Fishing Season and Gear Type
Bluefin tuna	• Season is open year round with the main season taking place during the summer and fall months • Catch limits are governed by the International Commission for the Conservation of Atlantic Tuna (ICCAT) • Gear used is either direct fishing by angling (rod and line), tended line trap, or electric harpoon and indirect fishing by longline
Albacore tuna Bigeye tuna Yellowfin tuna	• Season is open year round with the main season taking place from July to November • Gear used is pelagic (floating) longline, with some trolling using rod and line • Mainly fished for along the shelf edge and slope
Swordfish	• Season is open year round with the main seasons taking place from June to July for harpoon, and July to November for longline • Catch limits are governed by the ICCAT • Gear used includes pelagic longline, and harpoon • Mainly fished for along the shelf edge and slope
Porbeagle shark	• A large proportion of sharks are caught as bycatch in the swordfish longline fishery. • There is a direct fishery for porbeagle sharks using pelagic longline gear and angling. • The main commercial fishery occurs along the Scotian Slope.

Source: DFO 2011 d

3.3.1.2 Groundfish Fisheries

Total landings of groundfish on the eastern Scotian Shelf declined from a maximum of 450,000 t in 1973 to less than 15,000 t in 1997 (Worcester and Parker 2010). A moratorium for cod and haddock fishing was imposed in 1993 and remains in effect. The longline fishery for Atlantic halibut is presently the major groundfish fishery operating on the eastern Scotian Shelf. In the 1960s the average landing of halibut was 2460 t, dropping to an average of 1484 t in the 2000s. In 1980, 1990, and 2000, the percentage contribution of groundfish to the total landed value was 73 %, 55 %, and 9 %, respectively. Healthy groundfish stocks on the Eastern Scotian Shelf include the witch flounder, yellowtail flounder, Atlantic halibut, and redfish. Stocks deemed to be at a critical level include: Atlantic cod, haddock, pollock, American plaice, sculpin, silver hake, white hake, spotted wolfish, northern wolfish, and cusk (DFO 2012b). In 2010, Atlantic halibut contributed to 50 % of the total landed value, while redfish (46 %) and turbot-Greenland halibut (2 %) made up the remainder of the top three species of groundfish respectively. In 2010, groundfish accounted for 8 % of the total landed value. Table 3.22 lists 2010 catch landings and value for key groundfish species harvested in the Study Area.

Table 3.22 2010 Catch (Landings and Value) for Key Groundfish Species Caught Within the Phase 2A Study Area

Species	Landings (kg)	Value ($)
American plaice	3,265	3,931
Atlantic halibut	331,242	2,973,966
Atlantic cod	48,892	87,374

Table 3.22 2010 Catch (Landings and Value) for Key Groundfish Species Caught Within the Phase 2A Study Area

Species	Landings (kg)	Value ($)
Cusk	9,640	9,818
Flounders, Unspecified	5,486	6,967
Greysole-Witch flounder	5,583	2,786
Haddock	7,126	9,713
Monkfish	1,308	1,445
Pollock	5,360	4,306
Redfish	5,172,891	2,758,867
Skate	1,249	250
Striped wolffish	859	412
Turbot-Greenland flounder	55,490	116,481
White hake	31,151	31,344
Total	**5,679,542**	**6,007,660**

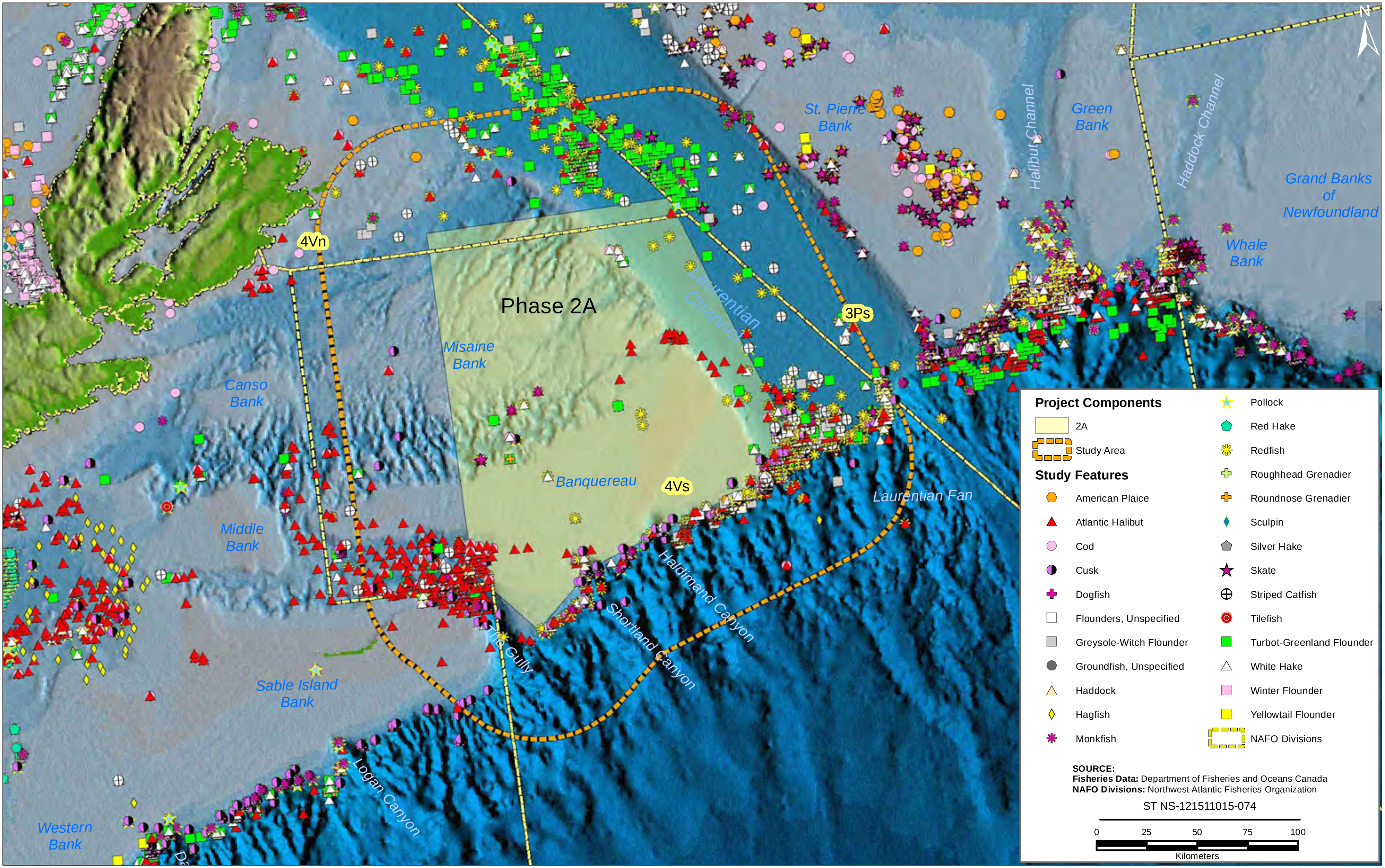
Source: DFO Catch and Effort Database 2006-2010

Figure 3.7 depicts locations of groundfish species catches within the Study Area. Table 3.23 summarizes information regarding fishing seasons and gear types.

Table 3.23 Groundfish Fishery Seasons and Gear Type

Fishing Seasons and Areas	• Ground fishery is open during all seasons. • Fishing occurs in NAFO subdivisions 4W, 4Vn, 4Vs, and 3Ps. • Cod and Haddock fishery has been closed since 1993, and species can only be caught and kept through by-catch. • Some seasons are more important than others based on the seasonal movement of fish species. • Most intensive fishing occurs in the summer from July to September where fishing activity is widespread on the Scotian Shelf. • The central shelf basins and valleys yield high landings year round. • In the fall months there is less fishing pressure and landings, as many fishermen fishing for groundfish switch to lobster in late November. • Halibut catch is concentrated in the Gully trough, along the shelf break, along the Laurentian Channel slope, and within the channel itself.
Gear Type	• The main gear types used are trawls and longlines. • Longlines are used most frequently on the shelf edge and deep water channels and basins. • Handlines and gillnets are rarely used.
Other Information	• The collapse and closure of the cod and haddock fisheries has resulted in a switch from groundfish as the main target to invertebrates.

Source: Breeze and Horsman 2005



SOURCE:
Fisheries Data: Department of Fisheries and Oceans Canada
NAFO Divisions: Northwest Atlantic Fisheries Organization

ST NS-121511015-074

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CLIENT:
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Eastern Scotian Shelf - Misaine and Banquereau Bank Strategic Environmental Assessment

Groundfish Fisheries, 2006-2010

FIGURE NO.:
3.7

DATE:
Dec 07, 2012

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3.3.1.3 Invertebrate Fisheries

During the years from 1980 to 1990 to 2000, the total landed value of invertebrates has rose from 12% to 38% to 85% respectively. This increase in invertebrate catch is mainly due to increased landings of snow crab and northern shrimp (*Panadalus borealis*). Both of these species prefer cold water and their increased landings coincide with the cooling of the eastern Scotian Shelf. Banquereau Bank plays a vital role in the offshore surf clam fishery, providing unique densities of catch that make the fishery commercially viable and profitable as indicated by local fishers (C. Boyd, Clearwater, pers. comm. 2012). Within the Study Area surf clams are the most important fishery with respect to both landings and value. Surf clam, shrimp, and snow crab stocks are all believed to be at healthy levels. The only invertebrate stock at a cautious level is the scallop (DFO 2012b). In 2010 within the Phase 2A Project Area, invertebrate species accounted for 91.2 % of the total landed value. In 2010 Stimpson’s surf clam (also commonly referred to as Arctic surf clam) accounted for 57% of the total landed value, while snow crab (40%) and northern shrimp (3%) made up the remainder of the top three invertebrate species respectively (see Table 3.24).

Table 3.24 2010 Catch (Landings and Value) for Key Invertebrate Species Caught Within the Phase 2A Project Area

Species	Landings (Kg)	Value ($)
Cockles	206,475	329,788
Northern shrimp	1,533,305	1,797,128
Sea cucumber	296,575	114,579
Snow crab	6,916,076	27,603,116
Sea scallops	6,157	9,619
Stimpsons surf clams	23,775,534	39,241,234
Whelks	918	809
Total	**32,735,040**	**69,096,273**

Figure 3.8 depicts locations of invertebrate species catches within the Study Area. Table 3.25 summarizes information regarding fishing seasons and gear types. As depicted on Figures 5 and 6 of Appendix B, fishing grounds for snow crab and shrimp fisheries (key invertebrate fisheries) on the Scotian Shelf are concentrated in and around the Phase 2A Study Area. Figure 7 of Appendix B depicts the concentration of Stimpson’s surf clams in and around the Phase 2A Study Area. Clearwater is the proprietary license holder for the offshore clam and offshore lobster fisheries. The condition of this information release is an understanding by Clearwater that the information will only be used in the CNSOPB SEA series. The released fishery landings information (*i.e.,* Figure 7, Appendix B) is not to be used in any other publication or analysis without prior consent of both DFO and Clearwater.

Table 3.25 Invertebrate Fishery Seasons and Gear Type

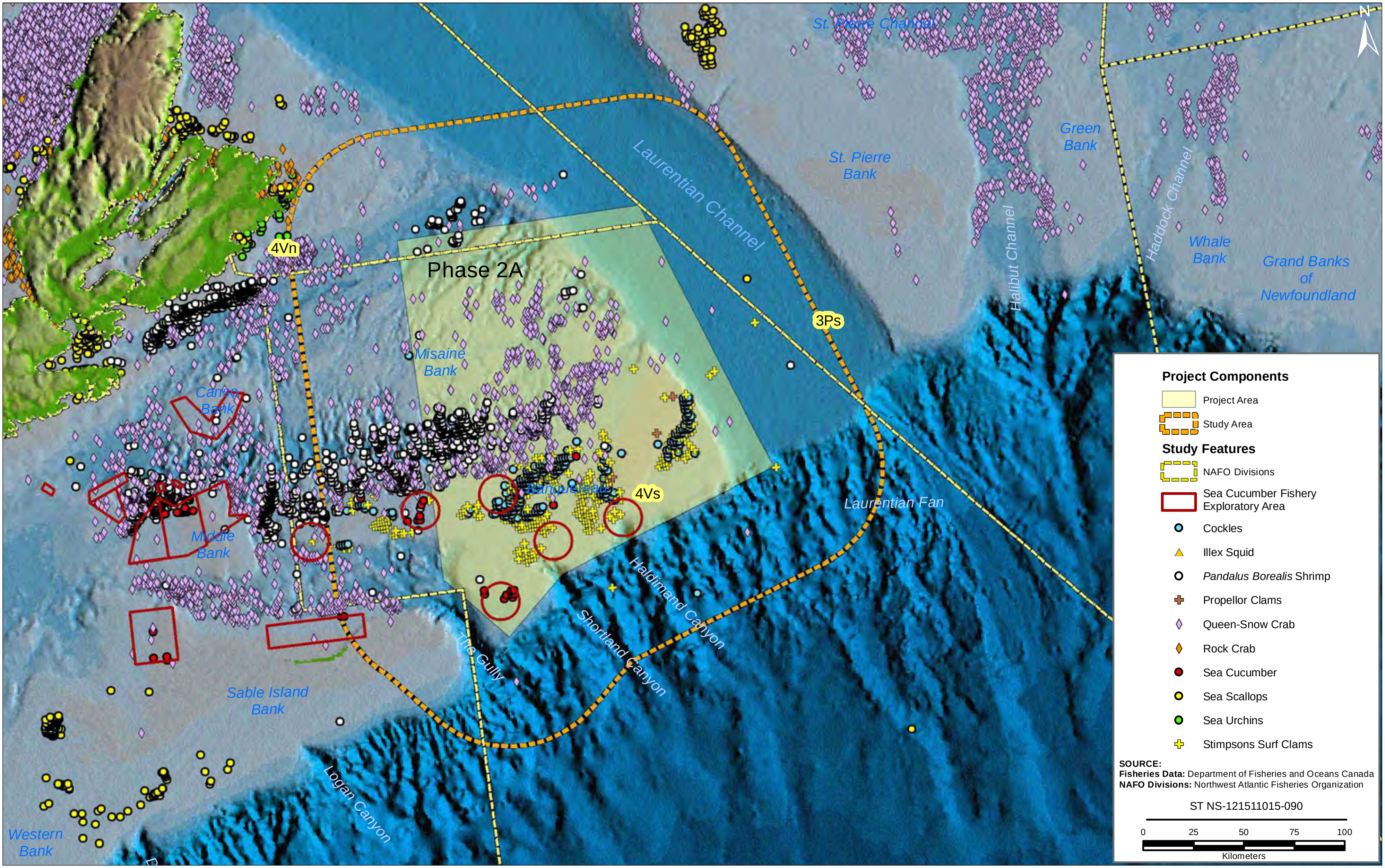
Species	Fishing Season and Gear Type
Snow Crab	• Crab Fishing Areas 22 and 23 are located within the Study Area. • The fishing season for CFA 22 runs from mid-April – end of July. • The fishing season for CFA 23 and 24 runs from April 2- September 30. • Gear used are crab traps, which are either conical or rectangular in shape.
Sea Scallop	• Scallop fishing area 25 is located within the Study Area. • The fishing season is open year-round; however there may be closures if catch rates or yields are low. • There is a lull in fishing activity during the winter months. • The gear used for fishing is mainly scallop drags.
Clam Species	• Clam fishing is mainly focused on Banquereau Bank • The fishing season is open year-round. • The gear used for fishing is mainly hydraulic clam dredges.
Northern Shrimp	• Shrimp Fishing Area 13 and 14 fall within the Study Area. • The fishing season is open year-round; DFO creates quotas based on information received from the Eastern Scotian Shelf Shrimp Advisory committee. • The gear used are shrimp trawls.
Sea Cucumber	• Main fishery is harvested from May to November using modified scallop drags. • Also caught as by-catch in the scallop fishery.

Source: Breeze and Horsman 2005

3.3.2 Aboriginal Fisheries

In 1990, the Supreme Court of Canada issued a landmark ruling in the Sparrow Decision. This decision found that the Musqueam First Nation had an Aboriginal right to fish for food, social and ceremonial purposes. The Court found that where an Aboriginal group has a right to fish for food, social and ceremonial (FSC) purposes, it takes priority, after conservation, over other uses of the resource. The Supreme Court also indicated the importance of consulting with Aboriginal groups when their fishing rights might be affected (DFO 2008b). In response to this decision, DFO developed an Aboriginal Fishing Strategy (AFS). The AFS assists DFO in managing the fishery in a manner consistent with Sparrow and subsequent Supreme Court of Canada decisions.

The Minister of Fisheries and Oceans issues communal fishing licenses to Aboriginal groups, which allows for fishing for FSC purposes. In the DFO Maritimes Region, communal FSC licenses are held by 16 First Nations (11 in Nova Scotia and 5 in New Brunswick) and the Native Council of Nova Scotia. These communal FSC licenses are for inland and inshore areas, however, as DFO does not provide access for FSC purposes in offshore areas (J. McQuaig, DFO, pers. comm. 2012).



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Eastern Scotian Shelf - Misaine and Banquereau Bank Strategic Environmental Assessment

Invertebrate Fisheries, 2006-2010

FIGURE NO.:
3.8

DATE:
Dec 06, 2012

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In 1999, the Supreme Court of Canada issued the Marshall Decision, which affirmed a Treaty right to hunt, fish, and gather in pursuit of a moderate livelihood, stemming from Peace and Friendship Treaties of 1760 and 1761. The Decision affected 34 Mi'kmaq and Maliseet First Nations in New Brunswick, Prince Edward Island, Nova Scotia, and the Gaspé region of Quebec. In response, DFO implemented the Marshall Response Initiative (MRI), to provide increased First Nations access to the commercial fishery through issuance of communal commercial licences. Communal commercial licences are held under the name of the First Nations community and not under the name of a specific individual.

There are 76 communal commercial licenses for commercial fishing within the Phase 2A SEA Study Area. These licenses are for snow crab, groundfish, swordfish and other tunas, bluefin tuna, and mobile shrimp (M. Eagles, DFO, pers. comm. 2012). The communal commercial licenses listed in Table 3.18 are held by Aboriginal groups in the DFO Maritimes Region, and do not include those communal commercial licenses held by the Pictou Landing First Nation and Paq'tnkek First Nation. These two First Nations are located in Nova Scotia, but fall under the jurisdictional authority of the DFO Gulf Region.

3.3.3 Recreational Fisheries

There are no recreational offshore fisheries in the SEA Study Area (K. Curran, DFO, pers. comm. 2012).

3.3.4 Other Ocean Uses

In addition to the fisheries described above, there are several other ocean activities and uses occurring within and around the Study Area including commercial shipping, military exercises, petroleum exploration and development, telecommunication cables, and scientific research (refer to Table 3.26).

Table 3.26 Other Ocean Uses In and Around the Study Area

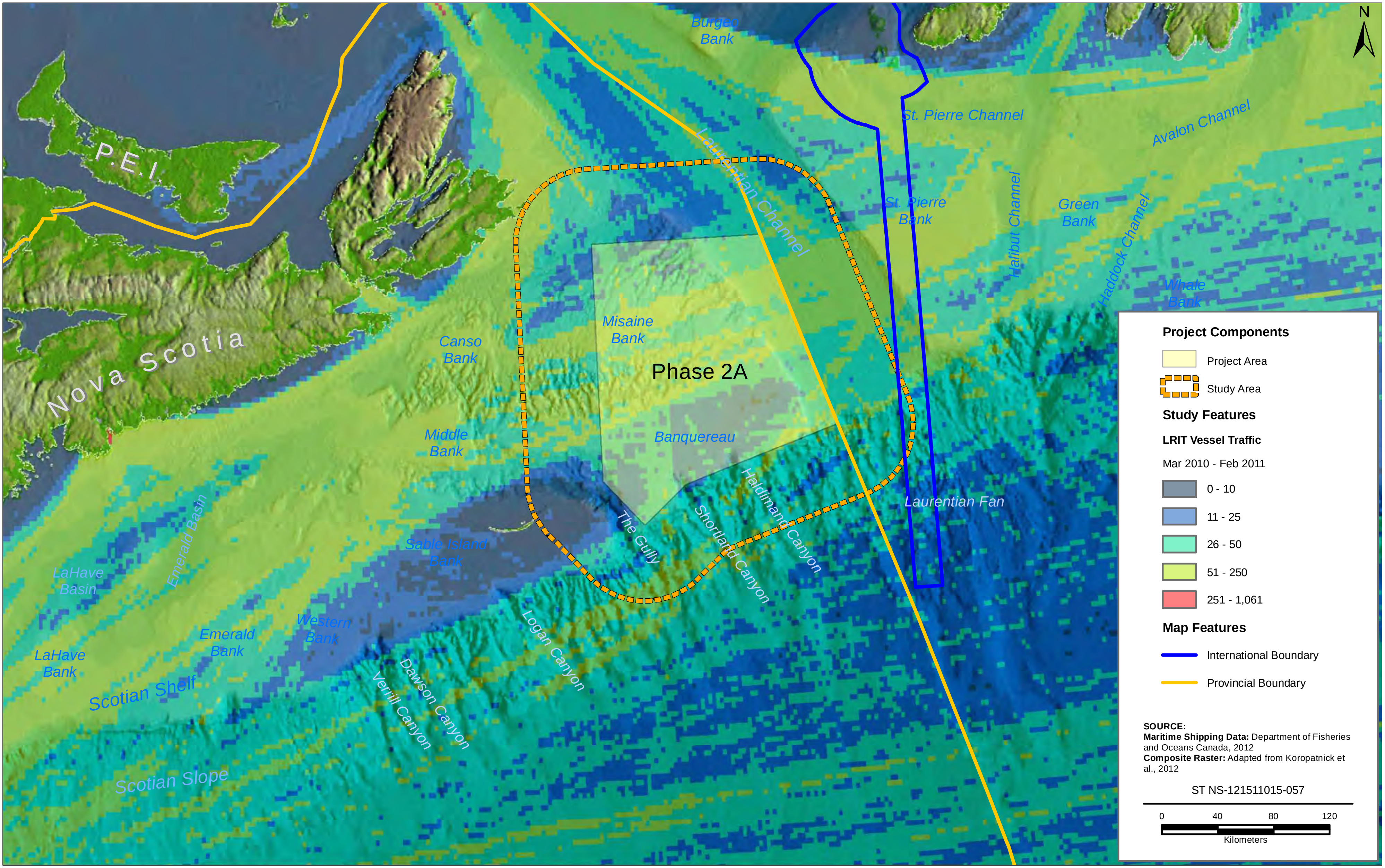
Use	Description
Commercial Shipping (refer to Figure 3.9)	• The Study Area is heavily used for domestic and international commercial shipping consisting of mostly tankers and bulk and containerized cargo carriers, as well as a range of fishing vessels, cruise ships and various government vessels. • There are four distinct regional traffic patterns including: international shipping over the Scotian Shelf as part of the "great circle route" (*i.e.*, shortest distance over the earth's surface) between Europe and the eastern seaboard of the United States and Canada; international and domestic shipping along the coast of Nova Scotia bound to and from the United States, Bay of Fundy, Gulf of St. Lawrence and Newfoundland; shipping through the Cabot Strait, a major sea route linking trans-Atlantic shipping lanes to the St. Lawrence Seaway and the Great Lakes; and traffic associated with the major ports of Halifax, Saint John, Port Hawkesbury (Strait of Canso) and Sydney (DFO 2011a). • Shipping traffic within the Study Area is greatest in the northern portion of the Study Area (north of Sable Island).

Table 3.26 Other Ocean Uses In and Around the Study Area

Use	Description
Military Activity (refer to Figure 3.10)	• Canada's east coast naval presence is provided through Maritime Forces Atlantic (MARLANT), which has its headquarters in Halifax. • MARLANT engages in a range of operations and activities including sovereignty patrols, maritime surveillance, naval training and combat readiness, search and rescue, humanitarian relief and aid to civil authorities, and operational support to other government departments, including fisheries and environmental protection (DFO 2011a). • MARLANT also conducts naval training activities in designated exercise areas off Nova Scotia. Exercise areas may also be used by foreign vessels or aircraft during periodic multinational exercises or with permission from the Government of Canada. Maps, coordinates and descriptions of military activities permitted in these exercise areas are provided in the Canadian Coast Guard's Annual Notice to Mariners (DFO 2011a). • The Study Area is not an actively used military training area.
Offshore Petroleum Activity (refer to Figure 3.11)	• Portions of the Study Area have been exploited in terms of oil and gas exploration in the Nova Scotia offshore. Significant discovery licenses and production licenses in the southwest corner of the Study Area on the Sable Island Bank demonstrate proven hydrocarbon resources in this area, including the Sable Offshore Energy Project (SOEP) gas field. The Sable Offshore Energy Project includes development of Thebaud, North Triumph, Venture, Alma, and South Venture gas fields. A central processing platform exists at Thebaud, with satellite platforms at Venture, North Triumph, Alma and South Venture. The Venture and South Venture platforms are located within the SEA Study Area. The remainder of the SOEP infrastructure lies outside the Study Area, as does the Deep Panuke Project. • There is no current petroleum activity in the SEA Project Area. Several exploratory wells have been drilled on the Banquereau Bank, all of which have been plugged and abandoned. ExxonMobil Canada holds a Significant Discovery License in the Phase 2A Project Area, centered on a plugged and abandoned gas well Banquereau C-21 that was drilled by PetroCan in 1981. ConocoPhilips Canada Resources Corp. holds an exploration license which is located at the edge of the Phase 2B Project Area. This license (EL 1119) is across the jurisdictional boundary, in the Newfoundland and Labrador jurisdiction. SEAs were prepared for petroleum exploration in the Laurentian Subbasin in 2003 and on the Misaine Bank in 2005.
Seabed Cables (refer to Figure 3.12)	• Several active submarine telecommunications cables make landfall in Nova Scotia, although these cables are outside the Phase 2A Study Area. • There are numerous inactive cables on the Scotian Shelf and Slope, some of which are more than 100 years old. (DFO 2005).
Shipwrecks and Legacy Sites (refer to Figure 3.13)	• As shown on Figure 3.13 there are several shipwrecks existing within the Study Area.
Scientific Research (refer to Figure 3.14)	• There are several ongoing scientific research programs on the Scotian Shelf, some of which occur in the Study Area. Figure 3.14 shows locations of some of the ongoing research initiatives but may not capture short-term research initiatives. • Environment Canada owns and operates a buoy on the Scotian Slope east of Haldimand Canyon. • The Louisbourg line of the Atlantic Zone Monitoring Program (AZMP) runs through the Study Area. This transect is sampled by DFO on a bi-weekly or monthly schedule during the ice free season.

Table 3.26 Other Ocean Uses In and Around the Study Area

Use	Description
	• The AZMP is a comprehensive environmental monitoring program designed and implemented by DFO in 1999. The program was introduced to increase DFO's capacity to understand, describe, and forecast the state of the ocean environment and to relate these changes to the predator prey relationships of marine resources. • The Continuous Plankton Recorder Survey, run by the Sir Alister Hardy Foundation for Ocean Science, has been using vessels of opportunity to collect plankton samples since 1931 (Sir Alister Hardy Foundation for Ocean Science, 2005) (DFO 2011a). • Scientists at DFO monitor fish populations of the Scotian Shelf, Bay of Fundy, and Gulf of Maine on an ongoing basis. Some of the most important sources of information on the state of marine fish populations are bottom trawl surveys (DFO 2011a). • Scientists from Dalhousie University (Whitehead Lab) conduct cetacean studies every 3-4 years within the Study Area. • DFO is conducting long-term acoustic monitoring studies in the Eastern Scotian Slope Region.
Eco-Tourism	• There is an emerging and small sized eco-tourism industry in the Gully canyon as well as Sable Island. With the recent classification of Sable Island as a National Park Reserve, visitation to the area is predicted to increase.



SOURCE:
Maritime Shipping Data: Department of Fisheries and Oceans Canada, 2012
Composite Raster: Adapted from Koropatnick et al., 2012

ST NS-121511015-057

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CLIENT:
Canada - Nova Scotia Offshore Petroleum Board

Eastern Scotian Shelf - Misaine and Banquereau Bank Strategic Environmental Assessment

Shipping Routes

FIGURE NO.:
3.9

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Dec 06, 2012

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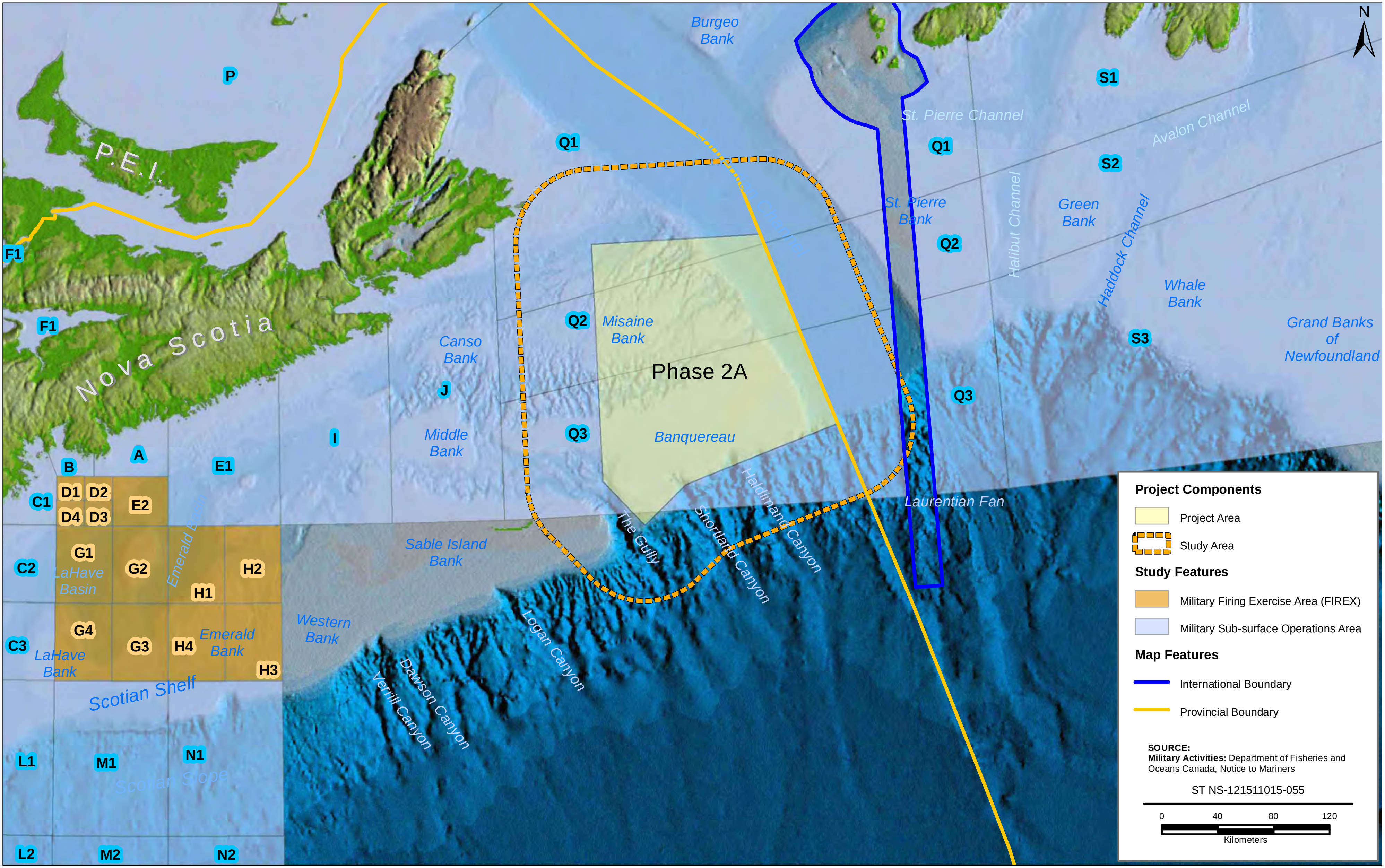

SOURCE:
Military Activities: Department of Fisheries and Oceans Canada, Notice to Mariners

ST NS-121511015-055

PREPARED BY:
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C. Shupe

CLIENT:
Canada - Nova Scotia Offshore Petroleum Board

Eastern Scotian Shelf - Misaine and Banquereau Bank Strategic Environmental Assessment

Military Exercise Areas

FIGURE NO.:
3.10

DATE:
Dec 06, 2012

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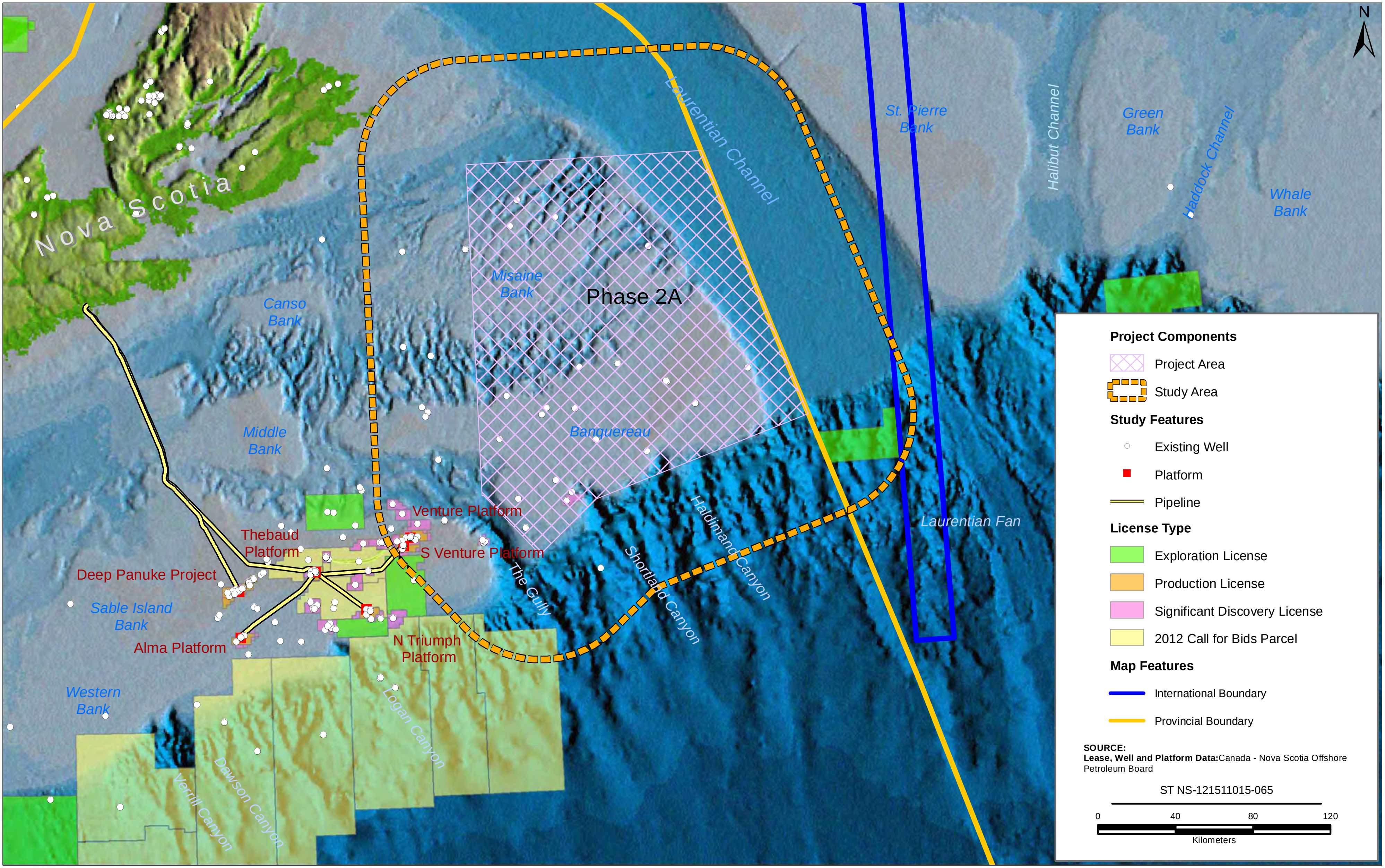

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CLIENT:
Canada - Nova Scotia Offshore Petroleum Board

Eastern Scotian Shelf - Misaine and Banquereau Bank Strategic Environmental Assessment

Offshore Petroleum Activities

FIGURE NO.:
3.11

DATE:
Dec 07, 2012

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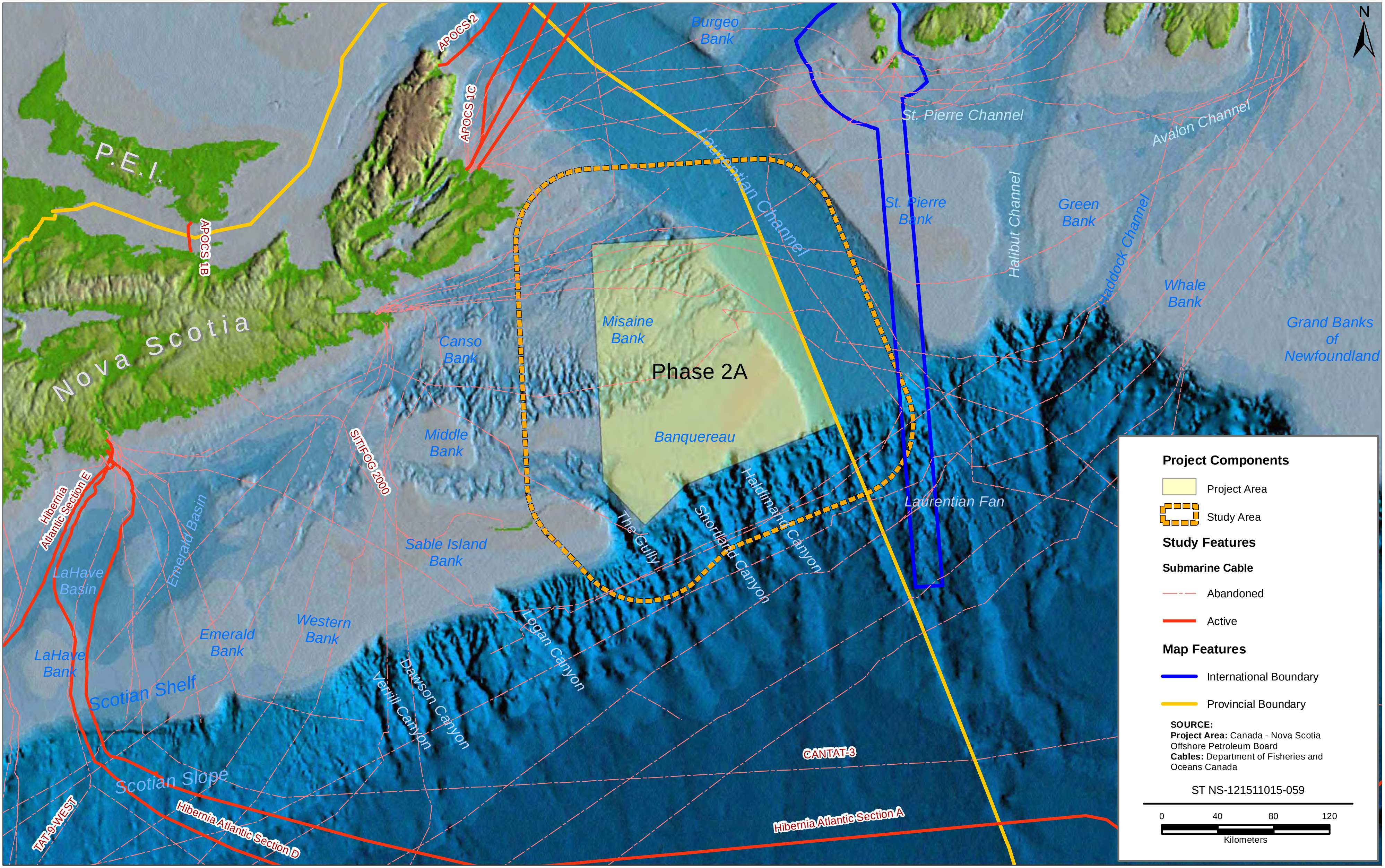

SOURCE:
Project Area: Canada - Nova Scotia Offshore Petroleum Board
Cables: Department of Fisheries and Oceans Canada

ST NS-121511015-059

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M. Huskins-Shupe

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CLIENT:
Canada - Nova Scotia Offshore Petroleum Board

Eastern Scotian Shelf - Misaine and Banquereau Bank Strategic Environmental Assessment

Subsea Cable Routes

FIGURE NO.:
3.12

DATE:
Dec 06, 2012

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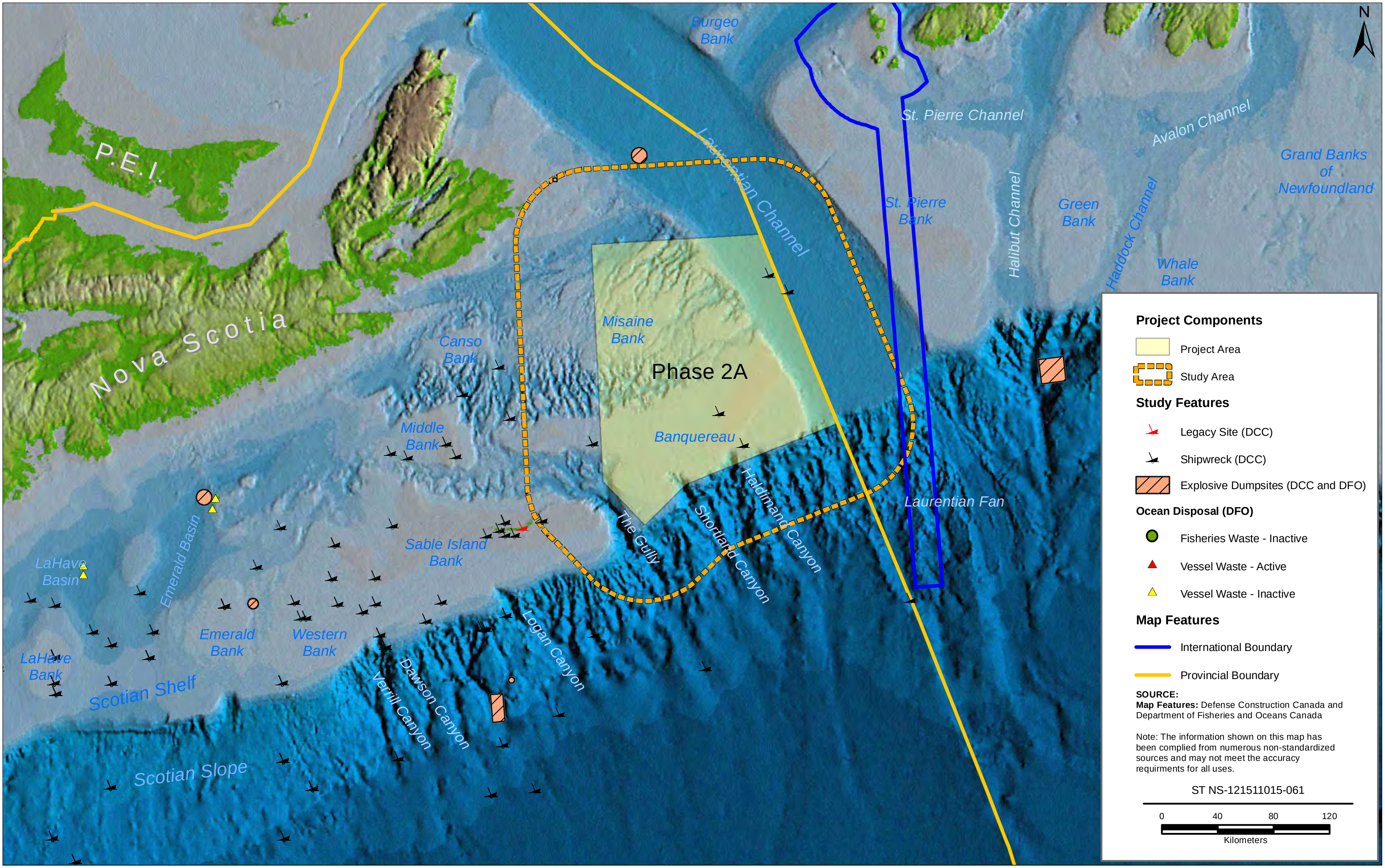

SOURCE:
Map Features: Defense Construction Canada and Department of Fisheries and Oceans Canada

Note: The information shown on this map has been complied from numerous non-standardized sources and may not meet the accuracy requirments for all uses.

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Canada - Nova Scotia Offshore Petroleum Board

Eastern Scotian Shelf - Misaine and Banquereau Bank Strategic Environmental Assessment

Shipwrecks and Legacy Sites

FIGURE NO.:
3.13

DATE:
Dec 06, 2012

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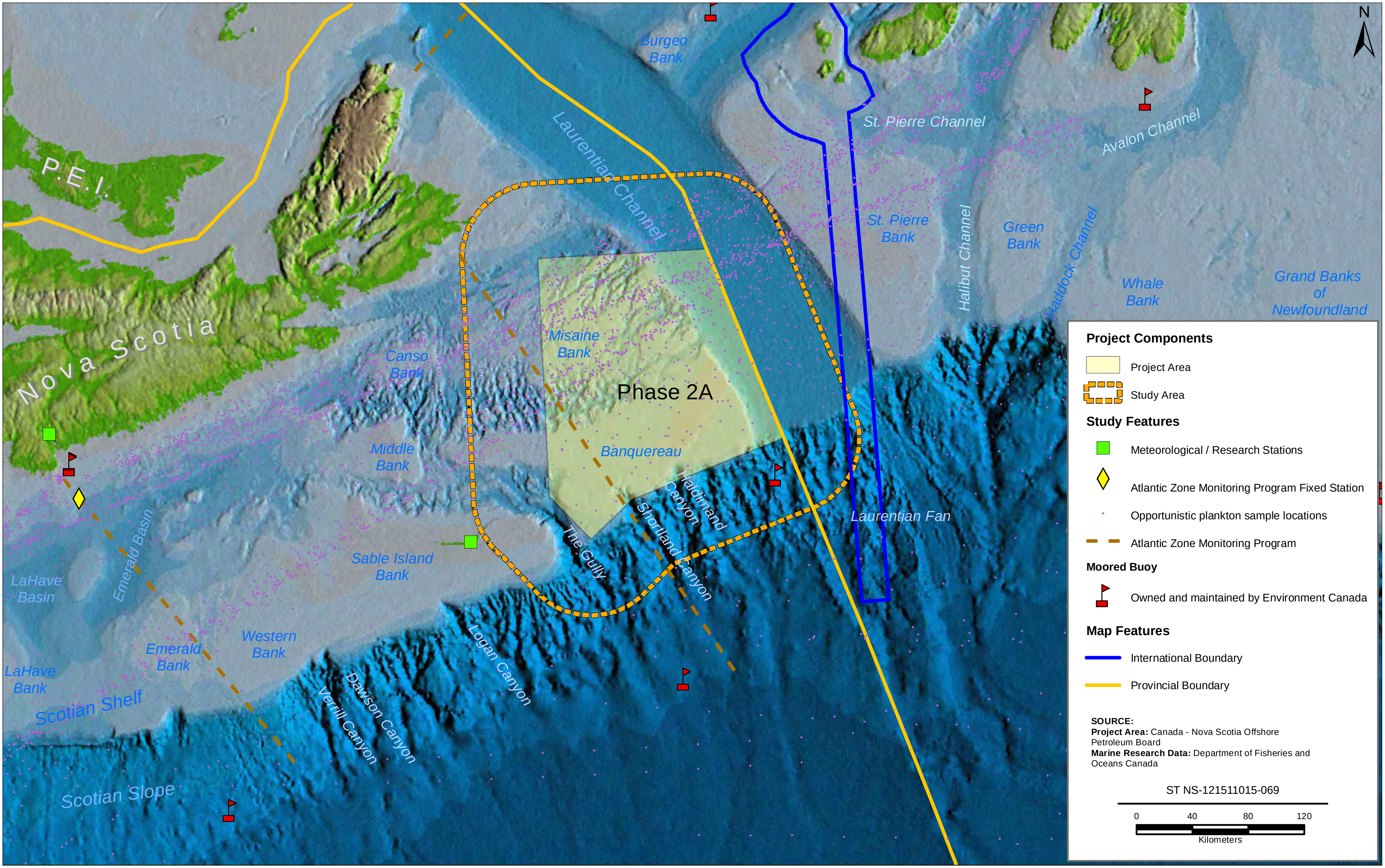

SOURCE:
Project Area: Canada - Nova Scotia Offshore Petroleum Board
Marine Research Data: Department of Fisheries and Oceans Canada

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CLIENT:
Canada - Nova Scotia Offshore Petroleum Board

Eastern Scotian Shelf - Misaine and Banquereau Bank Strategic Environmental Assessment

Marine Research Locations

FIGURE NO.:
3.14

DATE:
Dec 06, 2012

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4.0 Strategic Environmental Assessment Approach

4.1 OVERVIEW OF SEA APPROACH

Environmental assessment is a systematic process for analyzing and evaluating the potential environmental effects of proposed development activities, and is an important means of incorporating environmental considerations into decision-making. Although environmental assessment has traditionally been applied primarily to individual projects, recent years have seen increased interest in its application to policies, plans and programs. SEA expands the scope of environmental assessment to include these earlier stages of the planning process. SEA has been defined by Therivel *et al.* (1992) as:

[T]he formalized, systematic and comprehensive process of evaluating the environmental impacts of a policy, plan or programme and its alternatives...and using the findings in…decision-making.

The federal government's approach to SEA is set out in the Cabinet Directive on the Environmental Assessment of Policy, Plan and Program Proposals. The SEA approach is broader and more proactive in assessing and managing environmental effects than traditional project-specific EAs which focus on site-specific issues with defined geographic boundaries. An SEA:

- allows environmental issues to be identified and addressed at the earliest stages of planning, and typically focuses on "regional-scale" environmental concerns;
- can facilitate the consideration of stakeholder issues and concerns early in the planning process, and demonstrates accountability and due diligence in decision-making.; and
- can also help to define the environmental components and potential effects which may require consideration in subsequent project-specific EAs by identifying the key environmental issues associated with a particular sector and/or region.

The CNSOPB's approach to SEA is less broad than the Cabinet directive and more sector-specific (oil and gas exploration). In this particular case, information from the SEA will assist the CNSOPB:

- with respect to potential issuance of future exploration rights within the CNSOPB SEA Project Areas outlined on Figure 1.1; and
- to identify general restrictions or mitigation measures that should be considered for application to consequent exploration activities within this area.

The approach and methods used in this SEA were chosen to help deliver a focused SEA which is useful to both the CNSOPB in its decision making, but also for operators in their future project planning and approval processes.

4.2 SCOPING CONSIDERATIONS

The scope of environmental assessment, including definition of components and activities to be assessed as well as spatial and temporal assessment boundaries, must be established at the outset of the analysis to ensure the analysis remains focused and manageable. A scoping exercise for this SEA was based primarily on knowledge of existing environmental conditions (refer to Section 3), applicable regulatory guidance, results of stakeholder engagement, review of relevant publications and experience of the study team and government reviewers.

4.2.1 Regulatory Context

Petroleum activities in the Nova Scotia offshore are regulated by the CNSOPB, an independent joint agency of the federal and provincial governments. Under the *Canada-Nova Scotia Offshore Petroleum Resources Accord Implementation Act* and the *Canada-Nova Scotia Offshore Petroleum Resources Accord Implementation (Nova Scotia) Act,* collectively referred to as the Accord Acts, the CNSOPB is responsible for the management and conservation of the offshore petroleum resources, in a manner that protects the environment and health and safety of offshore workers, while maximizing employment and industrial benefits for Nova Scotians and Canadians. The CNSOPB reports to the federal Minister of Natural Resources Canada and the provincial Minister of Energy.

The Board enters into memoranda of understanding with government departments and agencies, such as Environment Canada and Fisheries and Oceans Canada (DFO), in order to effectively harmonize their plans, priorities, and activities of mutual interest. Annual work plan projects are developed with each department and implemented under these memoranda. Although typically authorizations are not required from these other federal agencies for exploration projects, legislation and regulatory guidance administered by these departments are taken into consideration during environmental assessment as applicable.

Table 4.1 summarizes federal legislation and guidelines relevant to exploration activities. They are used to inform environmental assessment by establishing mitigation and standards for compliance and have influenced the scope of this assessment.

Table 4.1 Summary of Key Relevant Legislation and Guidelines

Legislation/Guideline	Regulatory Authority	Relevance
Nova Scotia Offshore Area Petroleum Geophysical Operations Regulations (and associated Guidelines)	CNSOPB	These Regulations pertain to the geophysical operations in relation to exploration for petroleum in the Nova Scotia Offshore area and outline specific requirements for authorization applications and operations.

Table 4.1 Summary of Key Relevant Legislation and Guidelines

Legislation/Guideline	Regulatory Authority	Relevance
Nova Scotia Offshore Drilling and Production Regulations (and associated Guidelines)	CNSOPB	The Regulations outline the various requirements that must be adhered to when conducting exploratory and or production drilling for petroleum.
Offshore Waste Treatment Guidelines	National Energy Board (NEB) / CNSOPB/ Canada-Newfoundland and Labrador Offshore Petroleum Board (C-NLOPB	Guidelines to aid operators in the management of waste material associated with petroleum drilling and production operations in offshore areas regulated by the Boards. This document contains key mitigation to be adhered to by operators to allow streamlining of EA process.
Offshore Chemical Selection Guidelines	NEB / CNSOPB / C-NLOPB	The Offshore Chemical Selection Guidelines (OCSG) provide a framework for chemical selection which minimizes the potential for environmental impacts from the discharge of chemicals used in offshore drilling and production operations.
Compensation Guidelines Respecting Damage Relating to Offshore Petroleum Activity	CNSOPB / C-NLOPB	Guidelines describing the various compensation sources available to potential claimants for loss or damage related to petroleum activity offshore Nova Scotia and Newfoundland and Labrador; and outline the regulatory and administrative roles which the Boards exercise respecting compensation payments for actual loss or damage directly attributable to offshore operators.
Environmental Protection Plan Guidelines	CNSOPB	Guidelines to assist an operator in the development of an environmental protection plan (EPP) that meets the requirements of the Acts and Regulations and the objective of protection of the environment from its proposed work or activity.
Statement of Canadian Practice with respect to the Mitigation of Seismic Sound in the Marine Environment	DFO / Environment Canada (EC) / CNSOPB / C-NLOPB	Specifies the minimum mitigation requirements that must be met during the planning and conduct of marine seismic surveys, in order to minimize impacts on life in the oceans. This document contains key mitigation to be adhered to by operators.
Canadian Environmental Assessment Act, 2012	Canadian Environmental Assessment Agency	The *Canadian Environmental Assessment Act, 2012* (CEAA 2012) is new legislation aimed at updating the previous CEAA and streamlining environmental assessment of projects where federal authorities are involved.
Fisheries Act	DFO EC (administers Section 36, specifically)	The *Fisheries Act* contains provisions for the protection of fish, shellfish, crustaceans, marine mammals and their habitats. Under the *Fisheries Act*, no one may carry out any work or undertaking that results in the harmful alteration, disruption or destruction (HADD) of fish habitat, unless this HADD has been authorized by the Minister of Fisheries and Oceans Canada.Section 36 of the *Fisheries Act* pertains to the prohibition of the deposition of a deleterious substance into waters frequented by fish.

Table 4.1 Summary of Key Relevant Legislation and Guidelines

Legislation/Guideline	Regulatory Authority	Relevance
Canadian Environmental Protection Act, 1999	EC	The *Canadian Environmental Protection Act, 1999* (CEPA 1999) pertains to pollution prevention and the protection of the environment and human health in order to contribute to sustainable development. Among other things, CEPA provides a wide range of tools to manage toxic substances, other pollution and wastes, including disposal at sea.
Migratory Birds Convention Act, 1994	EC	Under the *Migratory Birds Convention Act, 1994*, it is illegal to kill migratory bird species not listed as game birds or destroy their eggs or young. (it legal to kill game birds only during legislated hunting seasons). The *Act* also prohibits the deposit of oil, oil wastes or any other substance harmful to migratory birds in any waters or any area frequented by migratory birds
Species at Risk Act	DFO/EC/Parks Canada	The *Species at Risk Act* (SARA) is intended to protect species at risk in Canada and their ”critical habitat” (as defined by SARA). The main provisions of the Act are scientific assessment and listing of species, species recovery, protection of critical habitat, compensation, permits and enforcement. The Act also provides for development of official recovery plans for species found to be most at risk, and management plans for species of special concern. Under the Act, proponents are required to complete an assessment of the environment and demonstrate that no harm will occur to listed species, their residences or critical habitat or identify adverse effects on specific listed wildlife species and their critical habitat, followed by the identification of mitigation measures to avoid or minimize effects. Proponents are advised that all activities must be in compliance with *SARA*. For a complete list of prohibitions consult Section 32 of the Act.
Oceans Act	DFO	The *Oceans Act* provides for the integrated planning and management of ocean activities and legislates the marine protected areas program, integrated management program, and marine ecosystem health program. MPAs are designated under the authority of the *Oceans Act*.
Gully Marine Protected Area Regulations	DFO	Pursuant to the *Oceans Act*, these regulations establish management zones and prohibited activities within the MPA.
Navigable Waters Protection Act	Transport Canada	The *Navigable Waters Protection Act* (NWPA) is intended to protect navigable waters by regulating the construction of works on those waters and by providing the Minister of Transport with the power to remove obstructions to navigation.
Canada National Parks Act	Parks Canada	Sable Island was recently designated a National Park Reserve under the *Canada National Parks Act*. Since April 1, 2012, Parks Canada is the main point of contact for Sable Island National Park Reserve, and is coordinating all access to the island.

4.2.2 Stakeholder Engagement

Table 4.2 summarizes the regulatory agencies and stakeholder groups which were consulted during the preparation of the SEA either individually or through the CNSOPB Fisheries Advisory Committee (FAC) and key issues or interests raised during discussions. The SEAs (Phase 2A and 2B) will be presented during a FAC meeting in January 2013.

Table 4.2 Summary of Stakeholder Engagement During SEA Preparation

Name of Organization	Representative	Issues/Comments
Clearwater	Catherine Boyd	Provided additional background information on offshore clam industry in the Study Area. Requested that potential tainting impacts be specifically addressed as they relates to shellfish biology and the seafood industry.
Maritime Aboriginal Peoples Council	Roger J. Hunka	Expressed expectation for SEA to consider: Consultation with Aboriginal Peoples on their Aboriginal Communal Commercial Fisheries and effects of oil and gas exploration on those activities; applicability of the SOCP to WAZ surveys; gaps in information and “failings” which can contribute to emergencies; and the ecological and socio-economic significance of the Eastern Scotian Shelf and its biological resources.
Fisheries Advisory Committee (FAC)	FAC members	A presentation of the Phase 1A and Phase 1B SEAs was made in September 2012. Questions were asked by FAC members, focusing on differences between SEA and project-specific EA issues. FAC members were invited to provide comment on the scoping document and input to the SEAs. A presentation is planned to discuss the Phase 2A and Phase 2B SEAs in January 2013.
DFO (Maritimes Region)	Kristian Curran	Provided spatial and numerical data held by DFO regarding fisheries and other ocean uses.
Environment Canada	Michael Hingston	Provided communication with CWS to obtain an updated CWS seabird distribution map figure

4.2.3 Relevant Publications

In addition to relevant regulations and guidelines and stakeholder input, there are several key documents which were reviewed during the preparation of this SEA and informed issues scoping and effects analysis (refer to Section 10 for a complete list of references consulted):

- Strategic Environmental Assessment of Potential Exploration Rights Issuance for Eastern Sable Island Bank, Western Banquereau Bank, The Gully Trough and the Eastern Scotian Slope (CNSOPB 2003)
- Strategic Environmental Assessment - Laurentian Subbasin (JWEL 2003)

- Strategic Environmental Assessment – Petroleum Exploration Activities on the Southwestern Scotian Shelf (Hurley 2011)
- Environmental Assessment Biophysical Data Gap Study – Petroleum Exploration Activities on the Offshore Scotian Shelf and Slope (Hurley 2009)
- The Marine Environment and Fisheries of Georges Bank, Nova Scotia: Consideration of the Potential Interactions Associated with Offshore Petroleum Activities (DFO 2011a)
- A Synopsis of Nova Scotia's Offshore Oil and Gas Environmental Effects Monitoring Program Summary Report (CNSOPB 2011b)
- Deep Panuke Environmental Assessment Report (Encana 2006)
- Ecologically and Biologically Significant Areas of the Scotian Shelf and Environs: A Compilation of Scientific Expert Opinion (Doherty and Horsman 2007)
- The Scotian Shelf: An Atlas of Human Activities (DFO 2005)

4.3 SCOPE OF THE ACTIVITIES TO BE ASSESSED

The scope of the activities to be assessed in this SEA includes reasonably foreseeable offshore oil and gas exploration activities in the Study Area. In particular, the scope of activities to be considered includes:

- seismic surveying (2D, 3D, and 3D wide azimuth);
- seabed surveying (*i.e.*, geophysical, geotechnical data collection);
- vertical seismic profiling (VSPs);
- exploratory and delineation drilling and ancillary activities;
- vessel traffic (supply vessels, seismic vessels, helicopters); and
- well abandonment operations.

Section 2 provides a description of each of these activities.

Accidental spills, which may include a seismic streamer break, accidental large spill of diesel, blowout of condensate/oil or SBM release during drilling are considered separately from routine exploration activities.

4.4 SPATIAL AND TEMPORAL BOUNDARIES

Temporal assessment boundaries consider the temporal extent of project activities (*e.g.*, time of year, frequency and duration of project activities). Temporal boundaries for this SEA include consideration of all components and activities that may be associated with exploration programs as described in Section 2. Oil and gas production activities are not addressed in the SEA except to the extent that they may contribute to cumulative effects.

The spatial assessment boundary for exploration activities to be considered in the Phase 2A SEA is shown in Figure 1.2. This boundary is based on the 2012 Call for Bids and represents the area within which exploration activities could occur (*e.g.*, Project Area).

However, it is also important to consider the extent of zones of influence (spatial and temporal extent of effects) when defining assessment boundaries. As outlined in the Operational Policy Statement entitled “The Process for Defining the Spatial Boundary of a Study Area During an Environmental Assessment of Offshore Exploratory Drilling Projects” (CEA Agency 2003), defining a study area requires consideration of the cause-effect relationships between project components or actions and environmental components and the location at which the potential for environmental effects (including cumulative effects) becomes insignificant.

In order to define these extents of influence, it is necessary to consider ecological boundaries on a case by case basis. Ecological boundaries are determined by temporal and spatial scales over which environmental components or populations function. Temporal ecological boundaries take into consideration relevant characteristics of environmental components or populations including:

- trends in natural variation of a population;
- time required for a biological, physical and/or chemical response to an effect to become evident;
- effect recovery time ;
- timing of sensitive life history periods; and/or
- timing whereby the species or component remains in the Project zone of influence (Jacques Whitford 2004).

Spatial ecological boundaries are determined by the distribution and movement patterns of the environmental component in relation to the potential zones of influence of the project.

For the purpose of this SEA, the Study Area is defined as a 54 km buffer around the proposed Project Area (refer to Figure 1.1.). This buffer was determined primarily by the estimated zone of influence from the worst case scenario of an accidental spill modeled for the Deep Panuke

Offshore Gas Development (54 km predicted distance for dispersion of oil cloud from 100 barrel diesel spill) (Encana 2006). Additional details related to the development of this spill model are provided in Sections 5.2.15 and 5.3.15 (Accidental Spills), below. The project-specific spill modeling carried out for the Deep Panuke Offshore Gas Development utilized known ocean current data for the Sable Bank, where currents are the same magnitude as those documented for the Phase 2 Study Area (15-55 cm/s).

The Deepwater Horizon spill in the Gulf of Mexico has illustrated that worst case scenarios can result in spills extending much further than 54 km. However, the ocean current profile in the area affected by the Deepwater Horizon spill is very different than that known to occur on the Scotian Shelf. The Gulf of Mexico currents are much stronger than those documented for the Phase 2 Study Area, including the area of the strongest current speeds where the water exiting the Laurentian Channel wraps around Banquereau Bank. Ocean currents in the Gulf of Mexico can reach speeds of up to 2 m/s (Chang and Oey 2010) while the currents documented around the southeastern corner of the Banquereau Bank range from 15-55 cm/s (Brickman and Drozdowski 2012). The 54 km buffer established for the Phase 2 Study Area using the Deep Panuke Offshore Development spill modeling is considered sufficient to include other expected zones of influence (*e.g.*, blowout spills, and behavioral effects of marine mammals, sea turtles or fish associated with seismic noise), and also encompasses Special Areas in the vicinity of the proposed Project Area.

4.5 SELECTION OF VALUED ENVIRONMENTAL COMPONENTS

It is generally accepted that an environmental assessment should focus on those components of the environment that are valued by society and/or which can serve as indicators of environmental change and thus, which have the most relevance to the final decision regarding the environmental acceptability of a proposal (JWEL 2003).

Table 4.3 presents a preliminary screening of issues that was undertaken to identify appropriate Valued Environmental Components (VECs) for the assessment. In cases where an environmental component has not been carried forward as a VEC for assessment, it is generally because experience and research has shown that they are unlikely to be adversely affected by petroleum exploration activities, particularly given implementation of standard mitigation.

Table 4.3 Section of Valued Environmental Components

Environmental Component	Scoping Considerations	VEC Selected
Atmospheric Environment	It is anticipated that emissions from routine exploration-related operational activities will not cause an exceedence(s) of applicable air quality standards or guidelines. Since there are limited emissions sources and few receptors in the SEA Study Area, and given the short duration of exploration projects, assessment of potential effects on air quality can be excluded from the SEA provided that future licenses holders/operators adhere to: • MARPOL Annex VI, Regulations for the Prevention of Air Pollution	Not further assessed as a VEC. Considered in terms of accidental events for Special Areas VEC.

Table 4.3 Section of Valued Environmental Components

Environmental Component	Scoping Considerations	VEC Selected
	from Ships; and • Air Emissions provisions of the Offshore Waste Treatment Guidelines, including provisions for greenhouse gas emissions. However, malfunctions and accidental events (*i.e.*, blow-out) may have an environmental effect on air quality therefore potential effects of air quality as a result of a blow-out on Special Areas (*e.g.*, Sable Island) is considered.	
Water Quality	Assessment of the potential environmental effects of discharges from platforms/vessels on water quality during routine exploration activities can be excluded from the SEA provided that future leaseholders/operators adhere to: • Nova Scotia Offshore Area Petroleum Geophysical Regulations; • Offshore Waste Treatment Guidelines; • Offshore Chemical Selection Guidelines; • *Fisheries Act* (Section 36); and • MARPOL 73/78. Compliance with the above requirements involves implementation of standard mitigation and will prevent adverse environmental effects on water quality for routine operations. However, malfunctions and accidental events (*i.e.*, oil spills) may have an environmental effect on water quality. An environmental assessment of the potential effects on water quality as a result of oil spills is considered as applicable for other VECs.	Not assessed further as a VEC. Considered as applicable for accidental spills on other VECs.
Fish	Fish species of special status, important feeding, nursery, and/or spawning grounds for fish (*i.e.*, Middle Bank), and commercial and Aboriginal fisheries resources are addressed under relevant VECs (Species of Special Status, Special Areas, and Fisheries VECs). Fish species which are not species of special status, don't support fishery resources or other fish species of special status, and are not present in such abundance for a special area to be designated for that species, are excluded from the SEA provided that future licenses holders/operators adhere to: • Statement of Canadian Practice with Respect to the Mitigation of Seismic Noise in the Marine Environment (SOCP). The SOCP was developed as a result of an extensive review by federal and provincial government advisors and scientific experts of the most effective and appropriate mitigation measures used world-wide to minimize adverse environmental effects on marine life. Compliance with the SOCP will result in minimization and/or avoidance of adverse residual environmental effects on marine fish and other marine life.	Species of Special Status Special Areas Fisheries
Marine Benthos	Discharges of drilling mud and rock cuttings during exploration drilling can result in burial or toxic effects on the marine benthos. Based on past environmental effects monitoring results and other research studies, these effects are understood to be limited spatially and temporally. However, in recognition of sensitive and/or commercially important benthic species that may occur within the SEA Study Area (*e.g.*, sponges, corals scallop, clam, quahog, crab, shrimp, and sea	Special Areas Fisheries

Table 4.3 Section of Valued Environmental Components

Environmental Component	Scoping Considerations	VEC Selected
	cucumber), these effects will be assessed in the Special Areas and Fisheries VECs.	
Marine Mammals and Sea Turtles	The potential for environmental effects on marine mammal and/or sea turtle Species of Special Status that may occur within the SEA Study Area, as well as those species that may occur in nearby designated environmentally sensitive areas will be assessed under the Species of Special Status VEC and Special Areas VEC respectively. Provided that appropriate mitigation is applied for species of special status, it is not anticipated that exploration activities will have an adverse environmental effect at the population level for secure populations of marine mammals or sea turtles.	Species of Special Status Special Areas
Marine Birds	It is recognized that the attraction of any avian species to lights on platforms/vessels or to flares during drilling operations/well testing, may cause injury or death from collisions or may disrupt migrations. Increased vessel presence may also result in the physical displacement of marine bird species as well as increase the attraction and number of predator species as a result of waste disposal practices. Noise disturbance from seismic equipment may cause direct (*e.g.*, physiological) or indirect (*e.g.*, foraging behavior) effects on marine birds. There is also the potential for exposure to contaminants from accidental spills (*e.g*. fuel, oil, streamer fluids) and operational discharges (*e.g.* deck drainage, gray water, and black water). An environmental assessment of the potential adverse environmental effects on avian species of special status (including migratory birds) will be carried out under the Species of Special Status VEC. Population level effects on seabirds, however, are not anticipated. No further assessment of environmental effects on seabirds shall be required, provided that: • The SEA considers the potential impacts of vessel lights/flares and vessel presence on avian species of special status (including migratory birds) and identify any necessary mitigation measures (*i.e.*, should birds land on vessels involved with the project, then implementation of the Williams and Chardine handling protocol brochure entitled “The Leach’s Storm Petrel: General Information and Handling Instructions” should be carried out. A permit is required from the Canadian Wildlife Service of Environment Canada to implement this protocol).	Species of Special Status Special Areas
Species of Special Status	Species of Special Status includes consideration of the following species and their critical habitat which may be present in the SEA Study Area and determined to be potentially affected during exploration activities: species designated as at-risk under the *Species at Risk Act* (SARA); species assessed as endangered, threatened, or of special concern by the Committee on the Status of Endangered Wildlife of Canada (COSEWIC) and/or migratory birds protected by the *Migratory Birds Convention Act, 1994*.	Species of Special Status
Special Areas	Designated areas of special interest due to their ecological and/or conservation sensitivities (*i.e.*, marine protected areas, existing or future coral conservation zones, fish conservation areas, *etc.*) could be potentially affected by exploration activities in the SEA Study Area. This VEC includes consideration of the former Middle Bank and	Special Areas

Table 4.3 Section of Valued Environmental Components

Environmental Component	Scoping Considerations	VEC Selected
	Misaine Bank and Eastern Shoal Area of Interest candidates, the Sable Island Bank, including Sable Island National Park Reserve, the Gully MPA, St. Anns Bank AOI and Laurentian Channel AOI, Northern bottlenose whale Critical Habitat designations under SARA, and ecologically and biologically significant areas (EBSAs) (*e.g.*, nearby canyons, corals and sponges). The scope of the VEC also includes the inhabitants of the special areas which may not be covered under the Species of Special Status VEC.	
Fisheries	Commercial, recreational and aboriginal fisheries (including relevant fish species) that could be affected by exploration activities in the SEA Study Area will be considered. The focus of the assessment of this VEC is on potential disruptions to commercial fishing activities, including aboriginal fisheries interests as applicable, through environmental effects on fisheries resources, displacement from current or traditional fishing areas, or gear loss or damage resulting in a demonstrated financial loss to commercial fishing interests. Key fisheries to consider in the area include sea cucumber, shrimp, snow crab and other crab fisheries, large pelagics (*e.g.*, tunas, swordfish, sharks), halibut, and other groundfish, offshore scallop, offshore clam (surf clam on western Sable Island Bank), whelk, and quahog (western Banquereau).	Fisheries
Other Ocean Uses	Other ocean uses (*i.e.*, marine shipping, military use, research surveys, and other petroleum development activities, *etc.*) could potentially be affected by exploration activities. Other than petroleum development activities, other ocean users are expected to have intermittent overlap with potential exploration activities in the SEA Study Area, and effects can be minimized through liaison and early communication of activities to other ocean users. With respect to other petroleum activities in the area which would experience longer term occupation of the area, exploration activities are not expected to interfere with these uses. Communication of planned exploration activities would be considered sufficient mitigation. Other Ocean Uses is considered to be more appropriate for consideration of potential cumulative effects with exploration activities (refer to Section 3.3.4). To the extent that fisheries research surveys may interact with exploration activities, these interactions are addressed under the Fisheries VEC.	Not further assessed as a VEC. Other Ocean Uses considered in cumulative effects assessment (Section 7). Fisheries VEC used to capture interactions with fisheries research surveys.

In summary, the VECs to be assessed in this SEA include:

- Species of Special Status;
- Special Areas; and
- Fisheries.

4.6 POTENTIAL EXPLORATION ACTIVITIES - ENVIRONMENT INTERACTIONS

Table 4.4 considers potential interactions between selected VECs and exploration activities. These interactions are explored in greater depth for each VEC in Section 5, drawing on existing literature and professional knowledge of the Study Team to provide a current understanding of environmental effects and mitigation, indicating data gaps and uncertainties where applicable.

Table 4.4 Potential Environmental Interactions of Petroleum Exploration Activities and Selected VECs

Exploration Activity	VEC			Nature of Interactions
	Species of Special Status	Special Areas	Fisheries	
Seismic surveying	✓	✓	✓	• Interference with fisheries and other ocean uses during routine operations • Underwater noise issues (*e.g.*, hearing loss, behavioural effects, *etc.*) on species of special status, commercial fish species and spawning areas, and species which may be inhabiting Special Areas (*e.g.*, The Gully) • Underwater noise can also result in degradation of habitat quality of Special Areas
Seabed surveying (*i.e.*, geophysical, geotechnical data collection)	✓	✓	✓	• Localized disturbance to marine benthos, potentially affecting benthic species of special status and commercial fish species
Vertical Seismic Profiles (VSPs)	✓		✓	• Localized disturbance to marine benthos, potentially affecting benthic species of special status and commercial fish species
Exploratory/delineation drilling (*e.g.*, mobile offshore drilling unit (semi-submersible or drill ship)) and ancillary activities	✓	✓	✓	• Attraction (due to lights and/or flares) of bird species of special status and fish species (*e.g.*, swordfish) to platform structures or support vessels • Effects (*e.g.*, smothering, toxicity, reduced growth or reproductive potential) of operational discharges (*i.e.*, drill wastes) on species of special status and commercial fish species, particularly bottom-dwelling fish and invertebrates • Underwater noise issues (*e.g.*, hearing loss, behavioural effects, *etc.*) on species of special status and commercial fish species • Interference with fisheries and other ocean uses (*e.g.*, loss of access due to safety zone)
Vessel traffic (*e.g.*, supply vessels, helicopters)	✓	✓		• Noise disturbance to Special Areas and species of special status depending on proximity of traffic • Effects on fisheries and other ocean users expected to be negligible given infrequency and short-term nature of traffic
Well abandonment operations	✓		✓	• Localized disturbance to marine benthos, potentially affecting benthic species of special status and commercial fish species
Accidental events	✓	✓	✓	• Effects of accidental events (*e.g.*, large condensate or diesel spill) on all VECs (*e.g.*, contamination, oiling and mortality of biological VECs and fouling of other ocean users' gear)

5.0 Potential Effects of Exploration Activities

This section discusses potential effects of routine exploration activities with accidental events assessed as a separate component. Mitigation and planning considerations are proposed to address potential effects, and data gaps and uncertainties are acknowledged.

5.1 SPECIES OF SPECIAL STATUS

5.1.1 Potential Effects and Existing Knowledge

Potential effects of exploration activities on species of special status include effects on the change in mortality risk (*e.g.*, increases in mortality, impacts on species population level success) and effects on the change in habitat (*e.g.*, displacement from critical spawning, feeding, nursery areas) of fish, marine mammals, sea turtles, and birds of special status (as defined in Section 4.5).

5.1.1.1 Seismic and Seabed Surveys

Seismic surveys use seismic impulses created from a burst of compressed air composed of a positive pressure pulse followed by a negative pressure pulse to gather information about geological structures lying beneath the seafloor (Davis *et al.* 1998; DFO 2011a). The difference in pressure between the positive and negative pulse is peak-to-peak pressure. The average pressure recorded over the course of the pressure pulse is known as the root mean square (rms) or the average pressure. Typical zero-to-peak source levels for exploration seismic arrays are 245-260 dB relative to 1 µPa at 1m. Seismic emissions are categorized as pulsed noise (discharged approximately every 10 seconds at intervals of about 25 m along the survey track) (DFO 2011a).

The rise time is the amount of time required for a sound pulse to reach peak pressure from zero. Physical damage is caused by both peak pressures and rise time. The severity of damage is often related to peak pressure (Davis *et al.* 1998). The pressure of a seismic pulse diminishes as distance from the source increases, with most of the loss in intensity due to spreading. The diminishing of pressure with increasing distance is spherical in shape until the pressure waves reach the bottom or the distance equivalent to that of the water depth. As pressure spreads in a spherical shape, pressure decreases by approximately ½ with each doubling of the distance. At distances greater than that of water depth, the pressure waves travel horizontally through the water column, through a cylindrical channel governed by the bottom and surface of the water. As pressure spreads in a cylindrical shape, pressure decreases by approximately ¼ for each doubling of distance.

The speed of sound will vary with water temperature, salinity, and pressure (depth), resulting in reflection and/or refraction at water mass discontinuities such as thermoclines or haloclines (Davis *et al.* 1998). The ability to detect sounds produced by seismic exploration depends on the amount of natural or anthropogenic ambient background noise in the surrounding waters. If the background noise is high, the seismic noise will not be as detectable at greater distances than when compared to quieter background levels. In general the open ocean is a naturally noisy environment with sources including wind, surf, thermal noise, precipitation, ship traffic and biological sources contributing to background noise levels.

Key issues of concern related to effects of seismic and seabed surveys on species of special status include potential physiological and behavioral effects on fish and marine mammal species, which may affect mortality risk or have negative population level effects.

Physiological and Behavioral Effects on Fish Species

At very close range, seismic noise can affect the fitness and survival of fish and invertebrates causing abnormal development and possibly mortality to eggs and larvae (refer to Section 5.1.1.1). These acute effects have only been observed at distances less than 5 m from the air gun, with more frequent and severe effects occurring at the distances less than 1.5 m (Dalen *et al.* 2007, Payne 2004). Since the majority of the fish species of special status that are likely to be present in the Study Area are demersal, the likelihood of seismic sound impacting fish in the developmental stage due to close proximity is expected to be minimal due to large distance between the airgun and any young fish and or eggs/larvae. Although a large portion of the species at risk in the area have eggs and or larvae which are found on the sea floor or close to it, a few species have eggs and larvae which are pelagic in nature (DFO 2011a). Redfish species have eggs which are pelagic in nature and are usually found at mid-depths within the water column. Cod and cusk also have pelagic eggs which can be found in the mid to upper water column and have the potential, although slight, to be impacted by seismic exploration.

There is evidence that damage could be done to fish from lower sound levels. Damage to fish hearing organs in adult fish has been reported by McCauley *et al.* 2003 (DFO 2011a). McCauley experimented on caged fish and subjected them to repetitive firing of air guns (similar to seismic surveys), which resulted in damage of the sensory hair cells of the inner ear after 18 hours of exposure. Damage to these animals was severe, and they did not regain damaged cells after 58 days (DFO 2011a). The peak noise levels involved were 180-190 dB root mean square (RMS), which corresponds to sound levels that would be encountered less than 500 m from the source. The animals in this experiment were caged and could not act upon their natural avoidance response, which would reduce exposure levels. Due to the fact that most fish species will swim away from the sound source as a natural flight avoidance response, it is unlikely that any noise damage from seismic surveys would be permanent or severe.

To date, there have not been any documented cases of large-scale fish mortality due to exposure to seismic sound under regular operating conditions. Seismic noise does have the potential to elicit short term impacts on fish including startle responses, changes in swimming patterns, and changes in vertical distribution (Worcester 2006, cited in DFO 2011a). These short term effects have been observed up to a radius of 30 km. If these fish are swimming to a spawning ground or are spawning during the time of seismic exploration, spawning success could be impacted. If a seismic program is underway, fish may expend more energy on travel and avoidance than on spawning activities or may even delay spawning, which could impact year class sizes and recruitment.

Physiological and Behavioral Effects on Marine Mammals

The effects of seismic noise on marine mammals are not fully understood, although possible effects are thought to include: masking of conspecific sounds; increased stress levels; change in vocalizations; change in behavior which may include avoidance of affected habitat; and temporary and/or permanent hearing damage (Richardson *et al.*, 1995; Hildebrand 2005; Weilgart 2007; DFO 2011a; Dalen *et al.* 2007). Temporary Threshold shift (TTS) can occur when an animal is briefly exposed to loud sounds which temporarily increase the hearing threshold of an animal (Davis *et al.* 1998). Normally this effect is temporary and reversible. Prolonged exposure to continuous loud sound can cause permanent hearing damage. TTS is important to consider due to the fact that some marine mammals, particularly seals, do not avoid seismic arrays.

Alterations in swimming behaviour including diving and foraging behaviours could potentially produce acute physiological effects from gas exchange problems as a result of repetitive shallow dive patterns (Zimmer and Tyack 2007). The extent of each of these effects varies depending primarily on species type, noise level/proximity to seismic source, and pre-disturbance activity of the marine mammals when exposed to the seismic sound (Dalen *et al.* 2007).

Mysticetes (*e.g.*, blue, fin and North Atlantic right whales) produce a variety of communication sounds in the very low frequency range (<100 Hz) and can hear sounds in the low frequency range (<1000 Hz), which falls within the range of seismic activity (Clark and Gagnon 2006, cited in DFO 2011a). Low frequency noise associated with seismic activity may interfere with vocalizations in areas of ecological importance and/or biological significance. Blue whales have been documented changing vocalization patterns and frequencies during seismic surveys (Di Loro and Clark 2009, cited in DFO 2011a). Although little is known about the hearing of mysticetes (baleen) whales, it is assumed they are sensitive to low to medium frequency sounds (Dalen *et al.* 2007).

A study on the effects of seismic noise on humpback whales was conducted in which the distribution of whales was documented during seismic activity (McCauley *et al*. 2000b). Pods of humpbacks were monitored aerially and were found to be distributed uniformly across depth contours, with no evidence that whales were displaced by seismic activity. Recorded observation data showed no differences between the number of whales sighted per observation block with or without the air guns turned on. Although when this data is broken down by range, it was noted that there was an increased number of whales found within 3 km of the seismic ship when its guns were turned off than when they were turned on. As a result there seemed to be some avoidance of seismic ships when they were operational .This avoidance and displacement from continuously operating seismic vessels could have varying effects based on whether the animal is simply migrating or situated in important habitat (McCauley *et al*. 2000b). For example, if seismic activity is occurring in areas where calves are feeding when they are young as well as relatively weak and vulnerable, the avoidance response could be considerably more serious than when whales are simply migrating.

Odontocetes (toothed whales) (*e.g.*, long-finned pilot whale, Northern bottlenose whale, Sowerby’s beaked whale, and sperm whale) appear, in general, to be more sensitive than mysticetes to seismic sound and tend to show the strongest lateral distance/avoidance, moving out of the immediate area (Stone and Tasker 2006, cited in DFO 2011a) while mysticetes and killer whales demonstrated more localized avoidance to seismic noise (*i.e.*, orient themselves away from the noise but do not leave the area). However, there have also been observances of dolphins swimming close to airgun arrays (*e.g.*, 50 m and 2 km of seismic vessel during shooting) (Duncan 1985, Stonach 1993, cited in JWEL 2003). Davis *et al.* (1998) concluded the zone of behavioral effect on the Scotian Shelf for odontocetes may be approximately 1 km in radius.

The Study Area is home to resident populations of Northern bottlenose whales in the Gully, and Shortland and Haldimand Canyons. This population has been listed as endangered, in part due to the threat of noise caused by oil and gas exploration in the area (DFO 2011g). There is concern over the effect of anthropogenic noise on beaked, deep diving whales such as the Northern bottlenose and Sowerby’s beaked whale found within the canyons of the Study Area. Further study is needed on the responses to deep diving cetacean species such as the Northern bottlenose and Sowerby’s beaked whales in response to anthropogenic sound sources. There have been no documented cases of harm or mortality to Northern bottlenose whales in Canadian waters due to ocean noise (DFO 2011g). Given the presence of critical habitat for the endangered Northern bottlenose whale in the Study Area, there is potential that seismic noise could cause a change in swimming behavior and avoidance of this habitat, thereby potentially affecting the local population.

The maximum acoustic energy from seismic arrays is in the 20-160 Hz frequency range, which is substantially lower than the peak hearing range for Northern bottlenose whales. Seismic arrays produce significant acoustic energy in the 1-20 kHz range which overlaps with the hearing range of beaked whales (DFO 2010 c). Deep diving species may be more sensitive to seismic noise because due to the fact that sound may concentrated in water layers at depth and as a result travel farther.

An indirect effect on odontocetes in the Study Area, particularly the Northern bottlenose whale, and Sowerby’s beaked whale is the effect of seismic exploration on their main prey item, squid.

Trials with caged animals showed a startle and avoidance response in the squid (McCauley *et al*. 2000). When the airguns were activated, the squid emptied their ink sacs and jetted away from the sound source, staying in the furthest part of the cage from the source as possible (McCauley *et al*. 2000). The responses in caged squid suggest that behavioural changes and avoidance to seismic operations would occur at some range of sound pressure. As an important part of the food chain for many top predators in the Study Area, the avoidance of squid could have impacts on many whale populations in the area, depending on how long they avoid a given area (McCauley *et al*. 2000). If prolonged squid avoidance were to occur due to seismic surveying in the critical habitat for the Northern bottlenose whale (the Gully, Shortland and Haldimand Canyons), it could be considered destruction of critical habitat under the provisions of *SARA*.

In 2003 the Gully Seismic Research Program was undertaken by multiple Canadian and international agencies to observe marine mammals before, during and after exposure to seismic exploration in the Gully and adjacent shelf edge (Lee *et al.* 2005). There were no indications that marine mammals including endangered species such as the blue whale or Northern bottlenose whale were significantly affected by either the Marathon or EnCana seismic programs that took place during this study (Lee *et al.* 2005), although marine mammals avoided the seismic arrays at close ranges (<100 m) and appeared to be less vocal when seismic sources were active (Potter *et al.* 2005). It should be noted that that the results from Lee *et al.* (2005) provide data on species presence and behaviour during seismic surveys, however data was not collected before or after the seismic vessels were present. As a result, direct comparisons of cetacean behaviour before, during, and after the seismic operation could not be made. Several peer-reviewed papers resulted from this monitoring study (Cochrane 2007; Gosselin and Lawson 2004; Lee *et al*. 2005; McQuinn and Carrier 2005; Potter *et al.* 2007; Thomsen *et al.* 2011), although it remains that very little was learned about whale behavior in the presence of active seismic programs.

There have been no documented cases of marine mammal mortality or injuries as a consequence of seismic surveys (Dalen *et al.* 2007). However, as noted by DFO (2011a), detrimental effects suffered by one species at risk can translate into detrimental effects on the population therefore behavioral effects noted above should not be overlooked as inconsequential. To prevent species and population level effects on marine mammals, mitigation measures for any seismic activities in proximity of cetacean critical habitat (the Gully, Shortland/Haldimand Canyons) will be evaluated during project-specific EAs. Season-specific acoustic modeling and/or other enhanced mitigation measures at the project-specific level may be identified.

Physiological and Behavioral Effects on Sea Turtles

There is relatively little research on effects of seismic activities on sea turtles. Studies to date indicate that seismic surveys have short term effects such as a change in hearing sensitivity (Moein *et al.* 1994; McCauley *et al*. 2000), behavioural effects (*e.g.*, increased and erratic swimming behavior; McCauley *et al*. 2000) as well as physiological responses. Certain levels of exposure to low frequency sound may cause displacement from areas near the sound source and increased surfacing behaviour. This exposure could potentially lead to displacement from preferred foraging areas (Atlantic Leatherback Turtle Recovery Team 2006). There is little evidence to suggest that sea turtles would be more sensitive to seismic sound than cetaceans or fish. Therefore, mitigation implemented to protect those marine animals would also serve to protect sea turtles from harmful effects (DFO 2011a). There remains however, a lack of research on the acoustic sensitivity of sea turtles and on the importance of the acoustic environment on sea turtles. It should also be noted that sea turtles are slow swimmers, meaning that the time taken to avoid seismic exploration vessels is greater than other species in the Study Area.

As noted by DFO (2011a), an added risk for sea turtles is potential entanglement in seismic gear. Although some work has been conducted to develop mitigation measures (*e.g.*, turtle exclusion devices) the effectiveness of these measures is not well known.

Physiological and Behavioural Effects on Marine Birds

There is sparse baseline data available for the evaluation of effects of oil and gas activity on seabirds at sea in the Northwest Atlantic (Wiese *et al.* 2001). Available studies focus primarily on established drilling platforms, with a lack of data specific to exploration-based seismic surveys. The exploration phase of oil and gas activities is shorter than fixed platform operations and therefore, the effects are likely to be relatively short in duration. Additionally, seismic surveys use moving vessels, not stationary platforms. Therefore, the greatest potential for effects on marine birds from seismic and seabed surveys results from noise disturbance (*e.g.*, underwater noise from airguns).

The sound created by airguns is focused downward below the surface of the water. Above the water, the sound is reduced to a muffled shot that should have little or no effect on birds that have their heads above water or are in flight. The nature of a seismic and seabed survey program will result in only temporary incremental increases in ambient noise and disturbance from the vessel in any one area. While it is possible that diving birds within close range of the seismic activity associated with surveys could be startled by the sound, the presence of the ship and the associated seismic equipment in the water will have already indicated unnatural stimuli to any birds in the vicinity (LGL 2005b). As well, the airguns will undergo a ramping-up process, which encourages birds to move away from the noise source before it reaches maximum volume. It is unlikely that non-diving birds would be affected by the underwater noise of airguns.

There have been reports of no effects from seismic surveys on certain seabird behaviours. For example, a study on the effects of seismic surveys on moulting long-tailed ducks in the Beaufort Sea found no effects on their movement or diving behavior (Lacroix *et al*. 2003); however, the authors did note that their study did not have the ability to detect more subtle disturbance effects. Overall, a precautionary note must be applied to any environmental interactions and effects discussion with respect to the effects of sound emissions on marine birds. Scientific and data gaps associated with the environmental effects of sound emissions limit the degree of certainty associated with environment effects predictions.

There is a potential for attraction of seabirds to vessel lights during the relatively short operation period of seismic vessels. Birds stranded on seismic vessels as a result of attraction and/or disorientation should be handled using the instructions outlined in Williams and Chardine's protocol, "The Leach's Storm Petrel: General Information and Handling Instructions", including the associated permit. Adhering to the permit conditions and following the established stranded bird handling protocol should help to mitigate effects associated with vessel lighting. The potential interaction between seabirds and vessel lighting is further discussed in Section 5.1.1.2, below (Exploratory Drilling).

5.1.1.2 Exploratory Drilling

The main concerns related to routine exploratory drilling are related to: discharges of drilling mud and rock cuttings and their burial and toxic effects on seabed fauna; seabird attractions with highly-illuminated drilling rigs and incineration during flaring/well testing; and drilling noise effects on marine mammal species of special status (accidental spills are discussed separately). Project-specific EAs will take into consideration drill waste modeling and fate.

Potential effects of drilling discharges on fish relate to potential lethal or sublethal effects. Discharge of drilling muds and cuttings can result in smothering of benthic species and health effects as result of chronic exposure of bentonite, barite or other drilling fluid components. Effects of drilling waste discharges on commercial fish species are discussed in Section 5.3.1.2. There is predicted to be negligible effects of drilling waste discharges on fish species of special status which may occur within the Study Area.

Compliance with Section 36 of the *Fisheries Act* prohibits the deposition of a deleterious substance into waters frequented by fish, which also serves to protect seabirds in the marine environment. Further, Section 5.1 of the *Migratory Birds Convention Act* prevents the deposition of oil, oil wastes and other substances harmful to migratory birds. Attraction can result from food and sanitary discharge as birds are drawn by an increase in attracted prey (Burke *et al.* 2012).

Artificial light has also been known to attract and influence seabirds, which are highly visually oriented and can become disoriented at night in the presence of artificial light. Artificial light from drilling rigs and flares can attract birds depending on the weather, season, age of the birds and the lunar phase, which can lead to collisions, incineration and mortality (Montevecchi 2006). Night-flying birds such as storm-petrels can be particularly attracted to vessel lighting (LGL 2005b). Birds may become disoriented and fly into vessel or platform lights or infrastructure, injuring themselves and therefore becoming stranded. To help mitigate this effect, lighting can be limited primarily to nighttime operations, when lighting is used for both navigational purposes and for safety. Other low-light conditions will also prompt vessel lighting, leading to increased potential for seabird attraction. For example, it has been suggested that seabird disorientation occurs most frequently during periods of drizzle and fog (Wiese *et al*. 2001). Moisture droplets in the air, during conditions of drizzle and fog, refract the vessel's light and greatly increase the illuminated area, thus enhancing the attraction (Wiese *et al*. 2001).

A Norwegian study on bird impacts associated with offshore drilling has shown that the impact of flaring on flocks of birds is small and is only considerable at night during migration periods (Ospar Commission 2007). It was found that sound associated with drilling did not affect bird migrations and that 10% of birds were affected by light emitted from the main deck of offshore oil installations. With proper mitigation (minimization of flaring and reduction in horizontal light emission) the impacts of exploratory drilling on birds at risk is considered to be minimal. Seabird monitoring as part of the SOEP EEM has shown little to no effect on birds transiting to and from Sable Island or the Scotian Slope (CNSOPB 2011b). A standardized protocol for monitoring seabirds is provided in Appendix C.

Drilling noise can potentially cause a temporary avoidance of an area by marine species of special status. Continuous noise generated by a drill rig may cause prolonged avoidance by some demersal fish species from the immediate area (*e.g.*, up to 400 m) (ICES 1995, cited in JWEL 2003). Thompson *et al.* (2000) reports avoidance from a drill rig is expected to be limited beyond 100 m whereas avoidance from a drill ship may range from 1 to 10 km. The North Atlantic right whale is one species known to exhibit long distance avoidance behavior. The effect of drilling noise on marine mammals of special status is considered to be temporary and reversible (Davis *et al.* 1998). To prevent adverse effects on marine mammals, mitigation measures for any drilling activities in proximity of cetacean critical habitat (the Gully, Shortland and Haldimand Canyons) will be evaluated during project-specific EAs. Season-specific acoustic modeling at the project-specific level may be required on a case by case basis.

5.1.1.3 Vessel Traffic

Vessel traffic is likely to increase as a result of seismic and exploratory drilling operations. An increase in vessel traffic may have impacts on marine mammals and bird species.

An increase in vessel traffic has the potential to increase the amount of artificial light within the Study Area which could potentially attract migrating seabirds. Nocturnal disturbance from light may lead to increased opportunities for predators, collisions due to attraction to vessels, exposure to vessel based threats and the disruption of natural conditions (CWS, pers. comm., 2012). Increased vessel presence during seismic surveys and exploratory drilling may physically displace migratory birds from foraging grounds for short periods of time (CWS, pers. comm., 2012). Increased vessel presence may also lead to the increase in and/or the attraction of predator species due to waste disposal practices from vessels. Sanitary and food wastes disposed in the marine environment could attract species which prey on migratory birds. The number of additional vessels associated with exploration should not substantially affect mortality rates due to collisions with lit vessels as the vessel increase will be temporary and nominal compared to existing traffic in the Study Area. With proper mitigation, including adherence to CWS protocols for handling stranded birds (*e.g.*, *Migratory Birds Convention Act* permit conditions, and Williams and Chardine's protocol), the effect of additional vessels within the Study Area should be minimal on bird species of special status.

Historical data has been examined from 1885 to 2002 with regards to vessel strikes on marine mammals. Vessel strikes have been known to be a large cause of marine mammal mortality. As a result, an increase in vessel traffic due to oil and gas exploration could potentially increase the number of mortalities of marine mammals due to vessel impacts. The most frequent species affected by vessel strikes are:

- Fin whales;
- Humpback whales;
- Gray whales; and
- North Atlantic right whales.

The North Atlantic right whales are the species most affected by vessel strikes, with mortalities being twice as frequent as any other whale species (Vanderlaan and Taggart 2006). The North Atlantic right whale is the most endangered whale species with a population size of approximately 300 individuals and decreasing (Elvin and Taggart 2008). It is expected that the species will be extinct within 200 years unless anthropogenic induced mortalities are reduced. Right whales tend to be easily injured because they are slow moving, and have a low profile in the water. Results have shown that reducing vessel speed can reduce the number of deaths by vessel impact. As a result, speed limits may be warranted in highly populated and important habitat areas.

Increased vessel presence will increase levels of noise below the 1 kHz range (Wright 2008). Increased ambient noise can mask biologically significant sounds. For example, masking can result in the disruption of breeding in animals that use sound during mating and reproduction, and disruption of foraging in animals that use sound to detect prey. Increased noise can also mask important acoustic environmental cues that animals use to navigate and to detect predators (Wright 2008). The greatest potential for masking exists for marine mammals that produce and perceive sounds within the range produced from vessels. Baleen whales will be the most susceptible to increased levels of noise below the 1 kHz range. Recent studies on North Atlantic right whales indicate that these species will adjust their vocalizations in the presence of vessel noise (Wright 2008). Some species can alter their communications to avoid being masked by anthropogenic sounds, although these alterations are not optimal behaviour for these species. It is thought that these alterations are costly for the survival and reproductive success of marine mammals.

The Study Area falls within feeding and migratory paths of some marine mammal species; however, the increase in number of vessels due to exploratory operations is not expected to be substantial. With proper mitigation (marine mammal observers and avoidance of the Gully MPA) the impact of vessel traffic on marine mammals is not expected to be a major concern.

5.1.1.4 Well Abandonment

There is little predicted interaction with species of special status during the mechanical separation of wellheads from the seabed. However, if blasting is required for wellhead removal there could potentially be serious effects, including mortality, on fish, marine mammals, and sea turtles. However, these effects can be avoided with the implementation of mitigation which involves monitoring of the blast site and delay of detonation until observed marine mammals and sea turtles are more than 1 km away from the blast site. A charge detonated below the seafloor will have an initial rate of increased pressure that is more attenuated than an explosion in the water column. Most of the initial shock pulse and energy from the explosion will be absorbed by the seafloor. It is not expected therefore that well abandonment activities will have a substantial effect on species of special status in the Study Area.

5.1.1.5 Accidental Spills

Accidental spills, although unlikely to occur, are the most likely element of exploratory activities to result in significant adverse effects on marine life. Spill scenarios can include, but not necessarily be limited to: a spill from a broken streamer during a seismic survey; subsea or surface blowout during drilling; loss of drilling fluid during drilling; or batch spill of diesel or condensate from a drill rig or vessel. Although a batch spill of crude oil or diesel is most likely to have the most far-reaching detrimental effects, even a small spill can result in adverse effects on marine life, particularly for bird species of special status.

With respect to fish, alterations in fish larvae mortality have been documented with increasing concentrations of oil contaminants in the surface microlayer (DFO 2011a). Sublethal effects on fish can include changes in biochemical responses of enzyme systems, increased frequency of histopathological changes and diseases in bottom fish, and degradation of ichthyoplankton communities in response to oil contaminants. Spawning events of fish are generally restricted in time and place; as a result there can be impacts on year class strength if a spill coincides with a spawning event. A number of studies have shown that the presence of oil can have both lethal and sublethal effects (reduced growth and abnormal development) in eggs, larvae and juveniles. The effects of oil on mature fish are difficult to study in the field as they have the ability to avoid a spill, provided the area is small enough. As a result, fish can mainly be affected by spills from the egg stage until maturity and full mobility is reached.

Marine mammals can be affected by an accidental spill in several ways depending on the scale and nature of the spill (Marine Mammal Commission 2011) including:

- The oil (or other product), its metabolites or dispersants through direct contact, ingestion or inhalation;

- Injury and/or disturbance from spill response activities; and
- Short and long-term ecological changes resulting from the spill and response efforts.

The exposure to oil and its metabolites is known to be harmful to marine mammals. Inhalation of by-products can cause respiratory irritation, inflammation, or emphysema (Marine Mammal Commission 2011). The ingestion of oil may cause gastrointestinal inflammation, ulcers, bleeding, diarrhea, or maldigestion. Certain inhaled or ingested by-products may cause damage to organs such as the liver, kidneys, adrenal glands, spleen or cause reproductive failure. Chemical contact can cause skin and eye irritation, inflammation, burns to mucous membranes, mouth and nares, or increased susceptibility to infection. Oil can also physically foul the baleen of mysticetes whales, which can inhibit feeding.

Response activities to contain and remove oil can also impact marine mammals. The increased marine and air traffic associated with a large spill can disrupt foraging, habitat use, daily and migratory movements and behavior. The increased vessel traffic as mentioned above can have the potential to increase vessel strikes. Oil spills can indirectly affect marine mammals in the area by altering the marine ecosystem and the key features of their habitat such as contamination, shifts and reduction in prey biomass (Marine Mammal Commission 2011).

Marine birds are extremely vulnerable to the effects of oil pollution. Feathers readily absorb oil, decreasing their ability to insulate birds from the cold, and reduce their waterproofing and buoyancy abilities. Contact with a small amount of oil can lead to death through hypothermia and starvation. Seabirds can also die from ingesting petroleum products while preening their feathers. During certain times of year large numbers of birds congregate while migrating. If an oil or fuel spill were to occur in these locations at times where large numbers of birds are congregated, the global population of the species could be greatly impacted. As discussed in Section 5.2.1.5, if a spill were to reach the coastline of Sable Island it could have severe adverse effects on species of special status (*e.g.*, Roseate Tern and Ipswich Sparrow) nesting on the Island.

Site specific spill probability and fate modeling would be required for a project-specific EA to determine the risk of potential effects on species of special status (including risk of potential interaction with Sable Island).

5.1.2 Mitigation and Planning Considerations

Table 5.1 summarizes mitigation and planning considerations to mitigate potential effects of exploration activities on species of special status such that residual effects would be considered to be minor, short-term and localized.

An important mitigation measure is adherence to the SOCP for seismic surveys. However, it should be noted that the SOCP specifies minimum requirements and enhanced mitigation may be required, particularly with regard to protection of species of special status. Furthermore, DFO has indicated that the SOCP will be reviewed in 2013, with specific attention to be paid to beaked whales.

Project-specific EAs will need to address the issue of potential “harassment” of listed species under SARA and include mitigation specific to their proposed exploratory activities and/or location to prevent these effects. DFO may be consulted to help assess this risk and identify appropriate mitigation.

Table 5.1 Mitigation and Planning Considerations for Species of Special Status

Seismic and Seabed Surveys	• Adherence (at minimum) to the Statement of Canadian Practice with Respect to Mitigation of Seismic Noise in the Marine Environment and consideration of additional enhanced measures for seismic activities planned in proximity to critical habitat for Northern bottlenose whale (the Gully, and Shortland and Haldimand Canyons). • Use of trained wildlife observers, with experience in identifying beaked whales listed on Schedule 1 of *SARA*, to visually monitor and record marine mammal, sea turtle and marine bird interactions and help enforce safe operating distances. • Continuous passive acoustic monitoring (PAM) in combination with marine mammal observers, provides the best probability of detecting beaked whales present in the seismic program study area prior to ramp-up. • If beaked whales listed on Schedule 1 of *SARA* are observed at the sea surface prior to ramp up, the 30 minute observation period outlined in the Statement of Canadian Practice with Respect to Mitigation of Seismic Noise in the Marine Environment will be extended to 60 minutes. • Seabird monitoring to be completed following the CWS pelagic seabird monitoring protocol provided in Appendix C. • Detailed acoustic modeling as input to any project-specific EAs for seismic projects in the Phase 2A Project Area. These modeling results may be used to define appropriate buffer zones around the Gully, and Shortland and Haldimand Canyons.
Exploratory Drilling	• Conduct a pre-spud survey to verify characterization of benthic habitat, in particular the absence of coral formations. • Adherence to the OWTG with regard to waste streams such as drilling muds and cuttings, deck drainage, desalinization brine, sewage and grey water. • Chemicals will be screened through the most recent version of the CNSOPB “Offshore Chemical Selection Guidelines (OSCG) for Drilling and Production Activities on Frontier Lands.” • Adherence to CNSOPB Drilling and Production Regulations. • Environmental Protection Plans will be required for exploratory drilling activities. • Bulk transfer and hose handling procedures as per best management practice. • Minimize flaring and ensure the use of high efficiency igniters as per best available practice. • Focus all area lighting on the work areas of offshore platforms and down shade lights as feasible to minimize marine bird attraction. • Conduct a post-drilling ROV survey to verify that the muds and cuttings are within the predicted zone of influence. • Emergency contingency measures and response plans will be developed to address significant weather scenarios. • A code of conduct will be developed for operations near the Gully MPA and Sable Island that specifies the minimum safe working distances for aircraft and vessels.
Vessel Traffic	• Adherence to Transport Canada Guidelines for the Control of Ballast Water Discharge from Ships in Waters under Canadian Jurisdiction. • Use of existing vessel routes to the extent practical.

Table 5.1 Mitigation and Planning Considerations for Species of Special Status

	• Avoidance of the Gully MPA and a buffer zone around Sable Island.
Well Abandonment	• Mechanical separation of wellhead to the extent practical. • If use of explosives is necessary, delay until no marine mammals or sea turtles observed within the area as indicated by PAM and visual observations.
Accidental Spills	• Detailed spill probability and behavior modeling as input to any project-specific EAs for drilling project in the Phase 2A Project Area. • Implement Emergency and Oil Spill Response Plan to address spill prevention and response, including routine spill response exercises. • Engineering design and protocols to prevent spills from occurring and/or reaching the marine environment including but not limited to secondary containment, inspection and maintenance, spill response kits, and blowout safeguards. • Development of EEM Plan to address post-spill monitoring effects. • Use of non-fluid filled streamers for seismic surveys where possible.

5.1.3 Data Gaps and Uncertainties

The specific distribution of species of special status in the Study Area is a data gap in this assessment. While some species have been studied extensively, with critical habitat known to exist in the Study Area (*e.g.*, Roseate Tern, Northern bottlenose whale), less is known about other species and how they may be using the Study Area. Although Lee *et al.* (2005) provide information on species presence and behavior during seismic surveys on the Scotian Shelf, data on cetacean presence and behavior was not collected prior to the seismic vessels operating in the study area nor after they left, therefore comparisons of cetacean behavior before, during and after the seismic operations could not be made. Concerns regarding potential effects of seismic on beaked whales (*e.g.,* Northern bottlenose whale and Sowerby's beaked whale) remain a data gap.

Continued research and wildlife monitoring during oil and gas activities may further knowledge in this area, particularly if monitoring surveys are standardized and data is shared for future use. The effects of seismic noise on Northern bottlenose whales will not be fully understood until more studies are conducted. The most relevant studies are those that are conducted while the species are exposed to actual seismic surveys. Future seismic surveys on the Eastern Scotian Shelf would present a research opportunity to fill knowledge gaps regarding seismic noise and Northern bottlenose whales. The use of a trained marine mammal observer onboard during seismic and drilling activities is particularly important in this Project Area given the proximity of species at risk and critical habitat for these species. Similarly, use of a trained marine bird observer onboard during seismic and drilling activities should be considered to address the substantial gap in quantified effects on seabird distribution from oil and gas exploration activities. A recent study on the Grand Banks determined that systematic observations by independent biologists on vessels and platforms are needed to generate reliable assessments of risks to marine birds as opposed to the industry-based self-reporting of seabird monitoring currently undertaken (Burke *et al.* 2012). Seabirds are relatively easy to survey, given that they are conspicuous marine organisms (Wiese *et al*. 2001). As such, an onboard marine bird observer program could work well to address the existing data gap related to quantifiable effects on seabird behavior from exploration activities.

With respect to effects of exploration activities on species of special status, most of the data gaps and uncertainties are related to effects and monitoring of seismic noise. This gap in knowledge is widely recognized and seismic related research is the focus of various research funding initiatives including the Exploration and Production (E&P) Sound and Marine Life Joint Industry Programme (JIP) and Environmental Studies Research Fund (ESRF) Program. In particular, these research programs have studies underway which are addressing sound source characterization and propagation; physical and physiological effects and hearing; behavioral reactions and biologically significant effects; and mitigation and monitoring.

Site-specific acoustic and spill modeling as input to project-specific EAs will further inform potential effects analysis and appropriate mitigation (including delineation of buffers from critical habitat) as necessary. Seismic operators will adhere to the SOCP, which includes a shutdown zone of 500 m and use of Passive Acoustic Monitoring (PAM) under conditions of low visibility.

5.2 SPECIAL AREAS

Exploratory oil and gas activities may have long or short term effects on Special Areas, affecting biodiversity, abundance and/or presence of species within these areas, as well as cultural or aesthetic values (Hurley 2011).

Several Special Areas have been identified in this report and cover an extensive portion of the Phase 2A area and 54 km buffer zone. In cases where Special Areas overlap with each other or with EBSAs, information on these areas are consolidated under one overarching area, using the boundaries that cover the largest surface area. For example, the Gully MPA overlaps with the Gully EBSA (EBSA 24). Information pertaining to the Gully EBSA is included in the description of the Gully MPA.

All Special Areas within this report are not equally ecologically significant or sensitive. A higher degree of caution and enhanced mitigation should be exercised in Special Areas that have been recognized through formal designations, particularly where there may be regulatory consequences: the Gully MPA, Sable Island National Park Reserve, Shortland Canyon, Haldimand Canyon, St Anns Bank AOI and Laurentian Channel AOI.

The former AOI candidates, Middle Bank and Misaine Bank and Eastern Shoal, have also been recognized for their ecological importance, as demonstrated in a public consultation to select the new AOI for MPA designation on the Eastern Scotian Shelf (DFO 2011e). There is some uncertainty regarding the ecological importance of some EBSAs (*e.g.*, EBSA 33, The Noodles: "possible snow crab retention"). DFO is in the process of identifying a network of MPAs in the Scotian Shelf / Bay of Fundy region (DFO 2009a) building on past efforts to identify EBSAs (Doherty and Horsman 2007) using a data-driven approach, which will help confirm the ecological significance of certain EBSAs and may also result in the identification of different EBSAs than those identified in this report. Certain EBSAs are better understood and recognized for their ecological significance, particularly *Lophelia* Conservation Area as well as the Stone Fence and Laurentian Environs (EBSA 36) which is a well-known area of importance for a community of cold water coral species (Cogswell *et al.* 2009) and is considered to be particularly sensitive to bottom fishing activities.

Some of the Special Areas have regulations that prohibit oil and gas exploration within and in the vicinity of their boundaries, namely the Gully MPA and Sable Island National Park Reserve.

5.2.1 Potential Effects and Existing Knowledge

Table 5.2 provides a summary of this assessment, identifying the Special Areas and their key ecological features that may be affected by oil and gas activities. Each of these interactions is discussed below.

Table 5.2 Special Areas and Ecological Features Potentially Affected by Oil and Gas Activities

Oil and Gas Activity	Special Areas Potentially Affected	Particularly Sensitive Ecological Feature(s
Seismic and Seabed Surveys	**The Gully MPA**	• Northern bottlenose whale Critical Habitat • Sowerby's beaked whale • Other whales (*e.g.*, blue whale)
	Shortland and Haldimand Canyons (and corridors connecting these canyons to the Gully)	• Northern bottlenose whale Critical Habitat • Sowerby's beaked whale and other whales
	Sable Island National Park Reserve	• Globally significant grey seal colony • Harp, hooded, ringed seals • High concentrations of juvenile fish (haddock)
	St Anns Bank AOI	• Migration corridor for whale species • Leatherback turtle forage area • Several whale sightings
	***Lophelia* Conservation Area**	• Contains only known living *Lophelia pertusa* reef in Atlantic Canada • May contain high diversity of dolphins and deep diving whales
	Laurentian Channel AOI	• Migration corridor for whale species • Only pupping grounds for black dogfish off Canada
	Middle Bank	• Important spawning and nursery area for Atlantic cod
	Misaine Bank and Eastern Shoal	• Migration and feeding area for whales and fishes
	EBSA 27 Gully Trough	• Common foraging area for seals and marine mammals
	EBSA 31 – Scotian Slope/Shelf Break	• Inhabited by whales and leatherback turtles

Table 5.2 Special Areas and Ecological Features Potentially Affected by Oil and Gas Activities

Oil and Gas Activity	Special Areas Potentially Affected	Particularly Sensitive Ecological Feature(s
Exploratory Drilling	The Gully MPA	• Northern bottlenose whale Critical Habitat • Habitat for Sowerby's beaked whale • Other whales (*e.g.*, blue whale)
	Shortland and Haldimand Canyons	• Northern bottlenose whale Critical Habitat • Sowerby's beaked whale and other whales
	Sable Island National Park Reserve	• High concentrations of juvenile fish (haddock) (identified as part of the Sable Island EBSA)
	St Anns Bank AOI	• Migration corridor for whale species • Leatherback turtle forage area • Several whale sightings
	***Lophelia* Conservation Area**	• Contains only known living *Lophelia pertusa* reef in Atlantic Canada • May contain high diversity of dolphins and deep diving whales
	Stone Fence	• High abundance of cold water corals • May contain high diversity of dolphins and deep diving whales
	Laurentian Channel AOI	• Migration corridor for whale species • Only pupping grounds for black dogfish off Canada
	Middle Bank	• Important spawning and nursery area for Atlantic cod • Significant habitat for winter skate and Atlantic cod
	EBSA 31 – Scotian Slope/Shelf Break	• Overwintering area for a number of shellfish species (including lobster) • Halibut overwintering area • Inhabited by corals
	Shortland and Haldimand Canyons	• Northern bottlenose whale Critical Habitat • Sowerby's beaked whale and other whales
Vessel Traffic	**Sable Island National Park Reserve**	• Migratory Bird Sanctuary • Presence Roseate Tern (endangered, SARA) and Ipswich Sparrow (special concern, SARA)
	The Gully MPA	• Northern bottlenose whale • Sowerby's beaked whale • Other whales (*e.g.*, blue whale)
	Shortland and Haldimand Canyons	• Northern bottlenose whale Critical Habitat • Sowerby's beaked whale and other whales
	St Anns Bank AOI	• Migration corridor for whale species • Leatherback turtle forage area • Several whale sightings
	EBSA 27 Gully Trough	• Common foraging area for seals and marine mammals
	EBSA 31 – Scotian Slope/Shelf Break	• Inhabited by whales and leatherback turtles • Seabird feeding/overwintering area
Well Abandonment	Sable Island National Park Reserve	• High concentrations of juvenile fish (haddock)

Table 5.2 Special Areas and Ecological Features Potentially Affected by Oil and Gas Activities

Oil and Gas Activity	Special Areas Potentially Affected	Particularly Sensitive Ecological Feature(s
	Laurentian Channel AOI	• Migration corridor for whale species • Only pupping grounds for black dogfish off Canada
	Middle Bank	• Important spawning and nursery area for Atlantic cod • Significant habitat for winter skate and Atlantic cod
	EBSA 31 – Scotian Slope/Shelf Break	• Overwintering area for a number of shellfish species (including lobster) • Halibut overwintering area • Inhabited by corals
	EBSA 32 – Deep holes north of Banquereau	• Very productive snow crab bottom
	EBSA 34 – Deep Holes of Canso Area	• Deep water reserve for lobster which may serve as larval supply downstream
	EBSAs 37 & 38 - Laurentian Channel and Slope	• Overwintering area for various groundfish species
Accidental Spills	All Special Areas, especially: • Gully MPA • Sable Island National Park Reserve • Shortland and Haldimand Canyon • St Anns Bank AOI • EBSA 31 – Scotian Slope/Shelf Break • *Lophelia* Conservation Area	
Note**: Bolded** areas indicate a higher degree of sensitivity		

5.2.1.1 Seismic and Seabed Surveys

Although seismic surveys will not affect the physical structure of the Special Areas themselves, they may affect the quality of habitat (*e.g.*, noise emissions) and affect the species that are found within these areas, thereby affecting the biodiversity and integrity of these areas. Seismic surveys have a greater impact on some species than others (particularly marine mammals) and the effects can vary according to oceanographic conditions (DFO 2007a cited in DFO 2011a). For example, depth is an important consideration where sound attenuates more rapidly with range in shallower water depths.

Effects of Seismic Noise on Areas of Significance for Fish and Invertebrates

As described in the assessment of Species of Special Status (Section 5.1.1.1), seismic noise can affect the fitness and survival of fish and invertebrates at very close range, although this is not determined to be significant compared to natural mortality.

Considering the limited knowledge on these effects of seismic noise, a precautionary approach should be applied by exercising caution in spawning and juvenile areas for fish or invertebrates when conducting seismic surveys, in particular, those that occur in the water column. Long-term effects on larvae and eggs have been observed at close range only, however larvae and eggs for some species are found in the water column where seismic surveying occurs (*e.g.*, redfish, American plaice, Atlantic cod (upper water column) (refer to Table 3.8) and potentially others. In addition to effects on larvae and eggs, seismic surveys may displace adult fish from their spawning grounds (Worcester 2006, cited in DFO 2011a). The Middle Bank is a well-known nursery/spawning for cod as well as other species and may be affected by seismic activity during important life cycle stages for these species. Stone Fence and Laurentian Environs (EBSA 36) may also be vulnerable to seismic activities due to the presence of several juvenile fish species (Doherty and Horsman 2007); however less is known about the importance of this area as a nursery ground. In particular juvenile haddock can be found around the shoals of Sable Island. Horsman and Shackell (2009) provides an in-depth overview of important areas for fish, particularly larval distribution within the Study Area. Important larval areas for witch flounder, silver hake, American plaice, Atlantic cod, redfish, yellowtail flounder and monkfish can be found within the Study Area (Horsman and Shackell 2009).

Effects of Seismic Noise on Areas of Significance for Marine Mammals and Sea Turtles

Section 5.1.1.1 describes potential effects of seismic noise on marine mammals and notes that although mysticetes (*e.g.*, fin and blue whales) are assumed to be sensitive to sound frequencies similar to those emitted by seismic surveys, odontocetes (*e.g.*, Northern bottlenose whales and Sowerby's beaked whales) appear to be more sensitive, particularly within a 1 km radius of the array. The Gully MPA, Shortland Canyon, and Haldimand Canyon are identified as "critical habitat" under *SARA* for the endangered Northern bottlenose whale. The Sowerby's beaked whale (special concern, *SARA*) and blue whale (endangered, *SARA*) has also been observed in the Gully MPA.

Although monitoring of marine mammals was conducted during seismic programs in the vicinity of the Gully (Cochrane 2007; Gosselin and Lawson 2004; Lee *et al*. 2005; McQuinn and Carrier 2005; Potter *et al.* 2007; Thomsen *et al.* 2011), very little was learned about whale behavior in the presence of active seismic programs and therefore precautionary measures should be undertaken when seismic operations are planned to occur in the vicinity of the aforementioned Special Areas.

Consideration of potential effects on seals should be given to Sable Island which provides important habitat for grey and harbour seals, and to some extent hooded and harp seals (Hurley 2011). The Gully Trough (EBSA 27) may also be affected by seismic exploration as it is a common foraging area for seals and other marine mammals; however less is known about the importance of this area.

The importance of the Scotian Slope/Shelf Break (EBSA 31) for whales and leatherback turtles is uncertain, however their presence has been observed and it is likely that these species are transiting this area during the summer months. Sea turtles have also been documented migrating within the area during September and October. As mentioned in Section 5.1.1.1, turtles may become entangled in seismic gear. As seabirds do not appear to be affected by seismic surveys (refer to Section 5.1.1.1), this activity is not likely to affect any Special Areas containing seabirds.

Effects of Seabed Surveys on Sensitive Benthic Areas

Seabed surveys involve localized disturbance of seabed substrate and benthos, using a variety of tools and techniques such as 2D high-resolution digital seismic (low-energy) using air gun arrays surveying 2-4 m below the surface of the seabed, multi-beam echo-sounders, and seabed core sampling (Hurley 2011). The most sensitive benthic communities are those with high vulnerability and low recovery rate (*e.g.*, deep-sea coral communities) and the least sensitive benthic communities have a low vulnerability and high recovery rate, for example communities dominated by scavengers and mobile species (Burbidge 2011).

Irreversible damage including mortality to corals and sponges by removal of entire organisms or physical alteration may be caused by seabed surveys. Sensitive benthic areas include those that contain high densities or diversity of corals and sponges and should be avoided when conducting seabed surveys (*e.g.* the *Lophelia* Conservation Area). Similar to seismic surveys, seismic noise from seabed surveys may affect juvenile fish and invertebrates near the seabed. Special Areas of importance for juvenile fish species within or immediately adjacent to the Phase 2A Study Area include: Sable Island National Park Reserve, Middle Bank, the Laurentian Channel AOI, and the Stone Fence and Laurentian Environs (EBSA 36).

Misaine Bank and Eastern Shoal and the Deep Holes of Canso Area (EBSA 34) may also be sensitive to seabed surveys and other direct exploration activities. Misaine Bank and Eastern Shoal is an area of high species diversity and contain sensitive deep-sea corals (DFO 2009a). Although less is known about the Deep Holes of Canso Area, the area serves as a deep water reserve for lobster (Doherty and Horsman 2007) which likely supports an important fishery in Chedabucto Bay. The Scotian Slope/Shelf Break (EBSA 31) contains corals and overwintering areas for shellfish which may be affected by seabed surveys, however more detailed information regarding their distribution and abundance is not known.

5.2.1.2 Exploratory Drilling

Special Areas containing sessile benthic species (corals and sponges) and other benthic species (haddock, Atlantic cod, wolffish, surf-clam, winter skate, and others) are more susceptible than pelagic species to be affected by exploratory drilling (Hurley 2011). These effects could potentially include direct physical impact or mortality (see above regarding relative sensitivity and recoverability of benthic environments). Drilling mud and cuttings discharges can smother benthic species and result in toxic effects, causing acute and chronic long-term impacts such as reduced growth or reproductive potential (see Section 5.1.1.2). However, Environmental Effects Monitoring (EEM) results at drilling sites off Atlantic Canada have demonstrated that changes in the diversity and abundance of benthic organisms have been generally limited to within 1000 m of the drill site and returned to baseline conditions within 12 months of cessation of drilling discharges using SBM or Enhanced Mineral Oil Based Mud (EMOBM) in combination with WBM (Hurley 2011; CNSOPB 2011b). Special Areas potentially affected by exploratory drilling are also those that tend to be vulnerable to seabed surveys: Sable Island National Park Reserve, the *Lophelia* Conservation Area, Middle Bank, the Laurentian Channel AOI, the Scotian Slope/Shelf Break (EBSA 31), and the Stone Fence and Laurentian Environs (EBSA 36).

Migratory birds including the Roseate Tern (endangered under SARA) and the Ipswich Sparrow (special concern under SARA) that travel to Sable Island may interact with illuminated vessels or platforms and become exposed to contaminants from waste disposal, operational discharges, and spills or be incinerated by flaring (Hurley 2011; DFO 2011a). The risk of these interactions is expected to be low due to a low number of migrating individuals within the area and short periods of flaring during well testing (8-24 hours) when hydrocarbons are present (Hurley 2011).

Noise from exploratory drilling may impact marine mammals at close range, as noted in Section 5.1.1.2. The Gully MPA contains whales that feed at depths that may be in range of noise from seabed surveys. Noise could also affect eggs and larvae of fish and invertebrates found on the seafloor, such as those of wolffish and winter skate (at-risk species) found on Misaine Bank and Eastern Shoal.

5.2.1.3 Vessel Traffic

Pressures on marine habitats and communities resulting from the high volume of shipping activity and vessel traffic on the Scotian Shelf include ship-source pollution, shipboard wastes, noise and collisions between vessels and marine life (Burbidge 2011). Vessel traffic from oil and gas exploration activities is expected to be minimal with minor effects on Special Areas in the Study Area (refer to Section 5.1.1.3).

Although the Northern bottlenose whale generally avoids ships (DFO 2009b), other whales may be more vulnerable and efforts should be made to reduce the intensity and duration of vessel traffic in areas where whales are present, particularly the Gully MPA, Shortland Canyon, Gully

Trough, St Anns Bank, and Laurentian Channel during peak migratory periods for other whale species seen in these areas (summer and fall).

Surveys conducted under the Cohasset-Panuke Project (COPAN) and Sable Offshore Energy Project (SOEP) EEM programs suggest that offshore oil and gas activities have had little to no impact on benthic communities, fish health, or seabird populations (CNSOPB 2011b). However, it is estimated that ship-source oil pollution results in the oiling of thousands of seabirds in the Scotian Shelf region each year, and the number of oiled seabirds in the region increased 3.2% annually between the early 1970s and 2000 (Coffen-Smout *et al.* 2001; DFO 2009c; Burbidge 2012). Beached bird surveys have been conducted on Sable Island by a resident researcher since 1993 and have become part of the EEM program for the Sable Island Bank region. Between 1993 and 2002, more than 7000 seabird corpses were recovered, 40% of which had experienced some oiling. Most of the contamination was weathered crude and heavy fuel oil mixed with varying amounts of lubricants and diesels (Sable Island Green Horse Society 2004). While most of these fatalities were primarily attributable to large ocean-going vessels and not petroleum exploration and development on the Scotian Shelf, these results do demonstrate the vulnerability of bird species in the area and prevalence of hydrocarbon contamination. Due to its importance for migratory birds, precautions should be taken when conducting oil and gas activities in the vicinity of Sable Island National Park Reserve.

5.2.1.4 Well Abandonment

The effects of well abandonment on Special Areas are similar to those of other exploration activities that can affect benthic organisms through physical alteration, mortality or contamination, with impacts being worse on juvenile fish and invertebrates (JWEL 2003). There is typically little interaction with fish and fish habitat during the mechanical separation of wellheads from the seabed; however, in cases where blasting is required for well-abandonment there would be mortality at the site of blasting, mainly to the infauna community (JWEL 2003). Effects of well abandonment are not expected to extend beyond the previous zone of influence affecting the marine benthos during drilling unless blasting is required in which case there would be increased mortality over a larger area.

5.2.1.5 Accidental Spills

Accidental spills can range from small to large-scale resulting in short or long-term contamination and toxicity of the water column, sediments, and biota causing both lethal and sub-lethal effects depending on the severity. Although the risk of accidental spills is low due to several mitigation measures in place by the oil and gas industry, the consequences of an accidental spill can be severe and/or far reaching as evident in the 2009 Deepwater Horizon blowout in the Gulf of Mexico. The severity of an accidental spill depends on the site and well-specific characteristics, oceanographic conditions, location and timing of the spill, and particularly the hydrocarbon product and quantity being released: gas, gas condensate, or crude oil, with crude oil being the most severe (DFO 2011a; JWEL 2003).

Spill trajectory modeling conducted for the Deep Panuke Offshore Gas Development Project on the Sable Bank predicted spill probabilities and dispersion behavior for various spill scenarios. Although project-specific spill modeling would be conducted for each EA of an exploration project in the SEA Study Area, the Deep Panuke modeling results gives an indication of the potential extent of a spill on the Sable Bank. As indicated above, the severity of spill effects will vary depending on a variety of factors, although the worst case predicted scenario would involve a 100-barrel batch spill of condensate which could persist as a slick for about 19 hours and travel about 18 km prior to the complete loss of surface oil, with a dispersed oil cloud in the water column potentially extending up to 54 km. It is predicted that subsea or surface blowouts would result in a much smaller area of influence (1-2.5 km) (Encana 2006).

Depending on the relative proximity and nature of the spill, Special Areas within the SEA Study Area could be adversely affected. The Gully MPA has unique oceanographic conditions including retention that may make it susceptible to accumulation of contaminants (DFO 2009c). However, sampling sites on the western boundary of the Gully MPA have shown no elevated concentrations of total petroleum hydrocarbons since monitoring began in 1998 (Burbidge 2012). Sediment samples taken within the Gully contained low concentrations of total alkanes (C10-C35) ranging in concentrations from 966 to 6486 nanograms per gram (dry weight) and PAHs were not detected (DFO 2009c). The composition and concentrations of these samples are consistent with observations of hydrocarbon concentrations in mostly uncontaminated sandy shelf sediments elsewhere, but also suggest an anthropogenic source is likely. Where only few samples have been taken from a limited number of sites within the Gully, very little can be concluded regarding the source of contamination within the Gully and the degree to which oil and gas activities have impacted the Gully (Burbidge 2012). To date, there have not been any large spills in the Gully; it is therefore uncertain how a large oil spill would actually affect the Gully ecosystem.

Due to the vulnerability of birds to oil spills, Sable Island is considered to be highly sensitive to accidental spills, given the presence of endangered Roseate Terns (SARA) which breed on the island from May to July and forage in nearby waters (Hurley 2011). During a blowout event, there could potentially be atmospheric discharges which would temporarily result in adverse effects on air quality of Sable Island, potentially affecting species and humans residing on the Island.

All Special Areas in the SEA Study Area are considered to be vulnerable to accidental spills that may occur as a result of exploration activities due to potential far-reaching effects. Special Areas considered the most vulnerable are those that are within or adjacent to the Phase 2A Project Area and are well-recognized as areas of high ecological importance, containing several important ecological features or single unique or sensitive features. These include: Sable Island National Park Reserve, the Gully MPA, Shortland Canyon and the *Lophelia* Conservation Area. Sable Island National Park Reserve is the most vulnerable to impacts due to its importance for birds that are easily (and often lethally) impacted by direct contact with oil.

The Laurentian Channel and the St Anns Bank AOI are also considered important areas, as they were considered for Area of Interest (AOI) selection for MPA establishment during a public consultation (DFO 2009a).The Laurentian Channel AOI is the only pupping ground for black dogfish in Canadian waters and also contains the highest concentration of the species. The area is also a nursery for juvenile smooth skate and is the only migratory cooridor for marine mammals travelling to and from the Gulf of St. Lawrence. St. Anns Bank is also part of a migratory corridor for fish and marine mammals migrating to and from the Gulf of St. Lawrence (DFO 2009a). The bank is an important foraging area during the summer months for the endangered leatherback turtle and is also an overwintering area for the at risk populations of Atlantic cod. Although the Scotian Slope/Shelf Break (EBSA 31) is not well studied and covers a very large area, it is thought to be an area of high biodiversity, containing several ecologically important features including corals, pelagic species such as sharks and tuna, whales, seabirds, and many others. Given the potential ecological importance of this area, it is likely highly vulnerable to an accidental spill. The Misaine Bank and Eastern Shoal former candidate AOI (DFO 2009a) could be vulnerable to the effects of a large scale spill given its high biodiversity, presence of several species at risk and COSEWIC assessed species, and sensitive coral and sponge communities among others (DFO 2009a).

5.2.2 Mitigation and Planning Considerations

Avoidance is the most effective mitigation measure in consideration of Special Areas in the Study Area that are deemed to be highly sensitive to oil and gas activities (the Gully MPA, Sable Island National Park Reserve, Shortland Canyon, Haldimand Canyon, and the *Lophelia* Conservation Area). Limiting or minimizing the extent of exploration activities within a Special Area may be considered should application of the suite of other mitigation measures described in Table 5.3 not significantly reduce the potential risk of adverse environmental effects to an acceptable level.

In consideration of the presence of identified critical habitat for the endangered Northern bottlenose whale in the Study Area, operators should be reminded that the minimum mitigative requirements specified in the SOCP may not be sufficient and that enhanced measures may be required in order to avoid effects on listed species and critical habitat to avoid contravention of *SARA.*

Regulations ensure avoidance of the Gully MPA for all oil and gas activities within the MPA boundaries, including in *the vicinity* of the MPA (DFO 2007b). Similarly, in the Sable Island National Park, the *Canada National Parks Act* and *Amending Agreement of Significant Discovery Licence 2255E* (signed December 21, 2011) prohibits drilling from the surface of Sable Island and one nautical mile seaward of the low water mark of Sable Island as defined by the Canadian Hydrographic Service.

A Code of Conduct can be an important and useful mitigation measure for operating in proximity to or within protected or Special Areas. For example, industry codes of conduct exist for the

Gully MPA and Sable Island, which specify minimum safe working distances for aircraft and vessels near these areas, among other mitigation measures. Other operators who may wish to conduct activities in the vicinity of these designated Special Areas should also be expected to develop and implement codes of conduct which would be reviewed by, at a minimum, the CNSOPB, DFO, Environment Canada, and Parks Canada.

Special Areas that are particularly important and/or sensitive to oil and gas activities are those that provide important habitat for Species of Special Status and are important for life cycle stages (spawning, breeding, nursery areas, *etc.*) of fish, invertebrates, and marine and migratory birds. Avoiding these areas during these critical lifecycle stages is an appropriate mitigation measure, especially in spawning and juvenile areas. Current spatial and temporal information of these critical life history stages will be required for the application of most mitigation measures.

It is advised to maintain regular communication with DFO to obtain up to date information on Special Areas and the MPA network, as related to project-specific EAs. It is further recommended to work collaboratively with DFO on mitigation measures regarding Special Areas identified in this report. Parks Canada and the Canadian Wildlife Service are also important departments to consult regarding activities around Sable Island National Park Reserve and areas that may be identified as important areas for birds.

Table 5.3 summarizes mitigation and planning considerations for Special Areas for each of the key exploration activities.

Table 5.3 Mitigation and Planning Considerations for Special Areas (additional to those identified in Section 5.1.2)

Seismic and Seabed Surveys	*Seismic Surveys* • Apply mitigation measures required as per the Statement of Canadian Practice with Respect to Mitigation of Seismic Sound in the Marine Environment (at minimum) such as increasing safety zones near gun arrays and shut down when whales are present or during limited visibility. Enhanced mitigation measures may be required. • If beaked whales are observed at the sea surface prior to ramp up, the 30 minute required observation period outlined in the Statement of Canadian Practice with Respect to Mitigation of Seismic Noise in the Marine Environment will be extended to 60 minutes. • Use of trained wildlife observers, with experience in identifying beaked whales listed on Schedule 1 of *SARA*, to visually monitor and record marine mammal, sea turtle and marine bird interactions and help enforce safe operating distances. • Detailed acoustic modeling as input to any project-specific EAs for seismic projects in the Phase 2A Project Area. These modeling results may be used to define appropriate buffer zones around the Gully, and Shortland and Haldimand Canyons). *Seabed Surveys* • Avoid areas with known concentrations and/or high diversity of corals or sponges.
Exploratory Drilling	• Avoid the Gully MPA, Sable Island National Park, *Lophelia* Conservation Area, and Shortland and Haldimand Canyons. • Known aggregations of deep sea coral shall be avoided during oil and gas drilling

Table 5.3 Mitigation and Planning Considerations for Special Areas (additional to those identified in Section 5.1.2)

	activities. If aggregations of deep sea coral are found to occur as the result of an environmental assessment or seabed survey, the Board requires mitigation to avoid harming these aggregations (DFO 2006). • Conduct pre-drilling ROV investigation to determine presence of corals, sponges, or other sensitive features as required by the CNSOPB. • Follow Canadian Wildlife Service instructions outlined in Williams and Chardine's protocol, "The Leach's Storm Petrel: General Information and Handling Instructions", including the associated permit when finding a dead or injured bird. • Adhere to regulatory guidelines (MARPOL and Offshore Waste Treatment Guidelines) for the treatment and disposal of various operational waste streams and emissions.
Vessel Traffic	• Adhere to The Statement of Canadian Practice with Respect To Mitigation of Seismic Sound in the Marine Environment. • DFO issues a notice to mariners annually within the Gully MPA that calls for voluntary measures to protect the Gully MPA, which include slowing down and avoiding the area. • Minimize discharges in accordance with the *Canada Shipping Act* and other relevant regulations and apply best practices when transiting through or in the vicinity of all Special Areas.
Well Abandonment	• Apply standard mitigation measures during well abandonment (*e.g.*, mechanical separation of wellhead whenever possible).
Accidental Spills	• Avoid oil and gas exploration in the Gully MPA, Sable Island National Park, *Lophelia* Conservation Area (drilling). • Detailed spill probability and behavior modeling as input to any project-specific EAs for drilling project in the Phase 2A Project Area. • Develop codes of conduct to guide new exploratory activities in the vicinity of Special Areas including St. Anns Bank and Laurentian Channel AOIs. • Apply standard preventative measures to avoid accidental spills. • Use of non-fluid filled streamers during seismic surveys where possible. • Implement Emergency and Oil Spill Response Plan accepted by the CNSOPB, which includes routine spill response exercises.

5.2.3 Data Gaps and Uncertainties

Several data gaps and uncertainties have been identified in this section and for the other VECs identified in this assessment. Despite the uncertainties pertaining to environmental effects from oil and gas activities it is important to take a precautionary approach in the vicinity of Special Areas, particularly those of well-known ecological importance, while research continues.

The key source of uncertainty pertaining to the Special Areas VEC is the identification of areas within the Scotian Shelf / Bay of Fundy MPA Network planning process being led by DFO. This planning process may result in the identification of EBSAs other than those discussed in this report. Some of the EBSAs presented in this section require further investigation of their ecological importance (The Noodles, Canso Bank, and the Deep Holes of Canso). Although the Scotian Slope/Shelf Break appears to have ecological significance, it is a very large area with few surveys to confirm its ecological importance. More research should be conducted to investigate the importance of this area and to more accurately delineate key areas of ecological importance within this large area. Given the convergence of distinct ecologically important areas in the Phase 2A Study Area, it is expected that parts of this region will likely emerge as priority areas in the future MPA network plan for the Scotian Shelf bioregion (DFO pers. comm. 2013). Attention should therefore be given in project-specific EAs to review and update the knowledge and status of these Special Areas as additional mitigation and planning may be required.

Consultation with scientific and special interest groups that may be involved in the protection of special areas (*e.g.*, Sable Island Preservation Trust, Sable Island Green Horse Society) is also important to provide up to date information on the ecological importance and status of special areas.

Predicting received sound levels in Special Areas is a significant data gap, in which more definitive modeling requirements are required. Until such time that more definitive sound propagation modeling requirements are establish for activities in and near sensitive areas, proponents are directed to relevant sections of the Scoping Documents prepared for environmental assessments on past Exploration Licenses 2409, 2415, and 2416 (available from the CNSOPB Public Registry Archive).

5.3 FISHERIES

5.3.1 Potential Effects and Existing Knowledge

Potential effects of exploration activities on fisheries include effects on the fisheries resource (*e.g.*, direct effects on fished species indirectly affecting fishing success) and effects on fishing activity (*e.g.*, displacement from current or traditional fishing areas, gear loss or damage resulting in a demonstrated financial loss to commercial fishing interests). Although this VEC focuses primarily on commercial fisheries (including Aboriginal), research-related fishing activities are also considered as applicable. As stated in Section 3.3.3, there is no offshore recreational fishery.

5.3.1.1 Seismic and Seabed Surveys

Key issues of concern related to effects of seismic and seabed surveys on fisheries include:

- potential physiological and behavioral effects on fisheries resources (*i.e.*, commercial and recreational fish species) which may affect catchability; and
- fisheries gear loss and damage due to an interaction with seismic equipment.

Physiological Effects on Fisheries Resources

The effects of seismic exploration on fish and invertebrates have been the subject of numerous studies around the world. Injuries and mortality of fish and invertebrates will occur within immediate proximity of an operating air gun (*e.g.*, 1.5 to 5 m depending on species and development stage), with eggs and larvae being the most vulnerable (Payne 2004; Dalen *et al.*

2007; DFO 2011a). Effects of seismic-induced mortality on eggs and larvae at the population level are considered to be insignificant compared to natural morality (Saetre and Ona 1996; Dalen *et al.* 1996). To date, there have not been any well-documented cases of acute post-larval fish or invertebrate mortality as a result of exposure to seismic sound under normal seismic operating conditions (DFO 2011a). Likewise, studies on physiological effects of seismic noise on fish and invertebrates have not revealed significant adverse effects. While sublethal effects (*e.g.*, reduction in feeding, growth or reproduction rate, histochemical changes) have been measureable in some studies (*e.g.*, Payne *et al.* 2007; Lagardere 1982), other studies have detected no significant differences between exposed and control individuals (*e.g.*, McCauley *et al.* 2000a, 2000b; Esso Norge AS 2001; Christian *et al.* 2003; Payne *et al.* 2009; Harrington *et al.* 2010), or effects have been shown to be measurable but temporary (*e.g.*, DFO 2004b; Sverdrup *et al.* 1994).

Of particular concern by fishery stakeholders are potential effects of seismic exploration on snow crabs in the Phase 2 Study Area. Various studies conducted by Christian *et al.* (2003 and 2004), and DFO (2004b) on the effects of seismic noise on snow crab indicated that the impact of seismic noise at typical operating conditions had no impact on the health of crabs as indicated by histological and histochemical sampling techniques. There were no differences in biochemical indicators prior to or after a seismic shooting event (Christian *et al.* 2003, 2004). In the same study (Christian *et al.* 2003), 4000 snow crab eggs were exposed to high levels of sound (221 dB at 2m). Some eggs showed impacts to development under these exposure conditions (Christian *et al. 2003*), which has also been observed in other fish and invertebrate species at close distances to a high level sound source. An alternate study by Pearson *et al.* (1994) indicated no immediate or long-term effects on larvae exposed to seismic energy at close distances to the source (1 m). Physiological effects have not been demonstrated to occur at the population level in the open ocean environment such that fisheries resources would be affected.

Behavioural Effects of Fisheries Resources Affecting Catchability

Effects of seismic noise on invertebrate and fish behavior (*e.g.*, startle response, changes in swimming speed and direction and changes in vertical distribution (Worcester 2006) can affect catchability. Several studies have been conducted, most notably in the North Sea, demonstrating behavioral responses of fish to seismic noise leading to catch reductions. Scare effects can entail catch reductions that will vary from species to species and between various types of fishing gear (Dalen *et al.* 2007).

Dalen and Raknes (1985) observed a change in the distribution of fish at 100-300 m depth along the course lines of a seismic vessel, with the averaged measured volume of bottom fish (mainly cod and pollock), reduced by 36% after seismic shooting compared with measured values prior to shooting. Quantity of small pelagic species was reduced by 13%. It was concluded in this research study, as in others, that some fish move to greater depths during seismic exposure. A study of seismic exploration effects on cod and haddock behavior in the

Barents Sea found that seismic shooting severely affected fish distribution, local abundance, and catch rates. Trawl catches of cod and haddock and longline catches of haddock declined approximately 50% after shooting started and longline catches of cod were reduced by approximately 21%. Reductions in catch rates were observed 18 nautical miles from the seismic shooting area with most pronounced effects observed within the shooting area (3 x 10 nautical miles) where trawl and longline catches of cod and haddock ranged from a reduction of 45% to 70%. Abundance and catch rates did not return to preshooting levels during the 5-day period after seismic shooting ended. Conversely, Gausland (2003) reported higher catches in the immediate track of a seismic survey where bottom trawling was used. Løkkeborg *et al.* (2009) demonstrated that differences in species reactions with Greenland halibut, redfish and ling increasing their level of swimming activity thus making them more liable to be taken in gillnets and reducing efficiency of longline catch.

Sedentary benthic species (*e.g.*, snow crab) are not likely to disperse, therefore catch rates are less likely to be affected (DFO 2011a). LGL and Oceans Ltd. (2003) monitored snow crab on the ocean bottom, 50 m below seismic airgun arrays. One set included crab in a trap located below the air guns, which showed no visible reaction to seismic activity. Another group of crab was tagged with telemetric tags and did not demonstrate large scale movement out of the study area. In summary, it can generally be concluded that seismic survey activity is likely to affect fish behavior but if or how it affects catchability remains uncertain.

Depending on the relative location of the seismic survey airgun, the fish being harvested and the fishing gear, effects on fish behavior can vary. Effects of seismic noise in displacing fish from their usual habitat is of most concern during spawning season, on nursery and foraging grounds and possibly during seasonal migrations.

Gear Loss and Damage

Damage to fishing gear or vessels can occur as a result of physical contact with seismic vessels and equipment. In general, fixed gear (*e.g.*, crab pots, longlines, gill nets) pose a greater potential for conflict with seismic surveys since it is hard to detect and can be set out over long distances in the water (LGL 2005). Groundfish and pelagic longline fisheries can have gear that can extend more than 60 km in length behind the vessel. Both seismic and longline fishing activities result in large areas of influence associated with each activity as well as the turning radii associated with each type of vessel. Changing wind, waves and tides can also result in considerable drift of longline fishing gear (DFO 2011a). Mobile gear (*e.g.*, trawls, seines) is towed behind vessels and has a lower risk of conflict since the activity is more visible and seismic survey ships and fishing vessels can communicate with each other and exchange information about operating areas and activities (LGL 2005).

If WAZ seismic exploration methods are chosen, the path and length of time of the possible interaction between seismic vessels and fishers will be expanded. Multiple seismic vessels are used in parallel to tow sound arrays, resulting in a much greater vessel footprint. These seismic programs also run for longer periods of time as compared to traditional 2D and 3D seismic programs.

As discussed in Section 3.3.1, the greatest potential for interaction with fisheries exists with the invertebrate and groundfish fisheries in the Study Area (primarily north of Sable Island). As of 2011, there have been no seismic/longline gear entanglements offshore Nova Scotia (DFO 2011a).

5.3.1.2 Exploratory Drilling

Exploratory and delineation drilling and ancillary activities can affect fisheries primarily through potential effects on fisheries resources and loss of access.

Physiological Effects on Fisheries Resources

Potential effects of drilling discharges on fisheries relate to potential lethal or sublethal effects on fisheries species. Discharge of drilling muds and cuttings can result in smothering of benthic species and health effects as result of chronic exposure of bentonite, barite or other drilling fluid components. Laboratory studies have linked prolonged exposure of bentonite and barite to sublethal effects affecting scallop growth and reproduction at bentonite concentrations as low as 2 ppm (Cranford and Gordon 1992; Cranford *et al.* 1999, 2001; Barlow and Kingston 2001). However, these studies did not take into account active wind and tidal mixing and changes in biophysical benthic conditions. Laboratory studies involving exposure of snow crabs (Andrews *et al.* 2004) and lobster (Hamoutene *et al.* 2004) demonstrated minor metabolic differences between experimental and control group individuals, neither of which would be expected to impact fisheries success. It is noted that all of these experiments involved exposure concentrations much higher than would be realized in an open ocean environment where drilling fluids and cuttings would be diluted and dispersed.

The concentration of drilling mud constituents as well as metals were monitored in surf clams near exploratory drill rigs in cold water environments (Neff 2010). It was found that there was no correlations between the concentration of drill mud constituents and metals in surf clams near drill rigs and in those found in reference sites. The concentration of PAHs were measured in tissues of invertebrates and fish species in a drilling area in the Alaskan Beaufort Sea. It was found that there were no regional differences in PAH levels in amphipod, clam, and fish tissues (Neff 2010). There is no predicted effect on fishing success in the Study Area due to routine drilling discharges.

A review of environmental effects resulting from offshore exploratory drilling in Canada determined that changes in diversity and abundance of benthic organisms were most common within 50 to 500 m of drill sites and that benthic communities typically returned to baseline conditions within one year after drilling operations ceased (Hurley and Ellis 2004). Sediment quality monitoring and toxicity testing as part of the SOEP Environmental Effects Monitoring

(EEM) program found above background concentrations of total petroleum hydrocarbon (TPH) and barium associated with drill waste and cuttings piles at all drilling platforms in 1999. Since then these concentrations have decreased at different rates at different locations with the greatest persistence at Thebaud showing elevated barium concentrations out to 250 m in 2007. No toxic responses (as demonstrated by amphipod mortality testing) have been observed at any site since 2003 (CNSOPB 2011b). Benthic habitat monitoring as part of the SOEP EEM demonstrated no obvious effect on fauna or habitat beyond the drill waste piles. Each year since 1998 the EEM program has demonstrated an increase in biomass and potential growth related to maturing communities of marine species (CNSOPB 2011b). Taint and body burden monitoring demonstrated no tainting effects between the 250 m and 1000 m sampling sites. Tainting was only encountered once in Jonah crabs collected directly from the platform structure at Venture (within safety zone). The results of the SOEP EEM program are consistent with EEM programs conducted elsewhere in Atlantic Canada (*e.g.*, Hibernia, White Rose, Terra Nova) concluding no significant effects on fish health and fish habitat. Fisheries are therefore not expected to be affected by drilling discharges.

Loss of Access

Drilling programs generally last one to three months, during which time access to marine space by fishers or other ocean users is excluded from a 500 m radius (0.8 km^2) safety exclusion zone around the drilling project. For certain fisheries that use longline gear, a larger exclusion zone would be in effect to ensure gear did not drift into drilling rigs (Thompson *et al.* 2000).

The issue of safety zone and loss of access is not so much a project-specific issue as it is a cumulative effects issue whereby cumulative loss of access due to drilling (and production activity where applicable) could potentially result in a displacement and demonstrated financial loss to fishing interests. There is typically no more than two exploratory wells drilled per parcel and exploration licenses generally last for five years.

The SOEP, a development project, has a safety zone with a 500 m radius from each surface structure. Safety zones are established to prevent damage to oil and gas infrastructure, minimize likelihood and effects of environmental incidents, and maintain the safety and security of industry personnel (Stantec 2010). However, they may also represent lost fishing opportunity, particularly for sedentary species (*e.g.*, surf clam) or migratory species with a well-defined area and timing. The Arctic surf clam fishery in particular will be vulnerable to loss of access. The commercial concentrations of clams that make the offshore arctic surf clam fishery viable are fixed. Any drilling program activities that displace fishing activity in these concentrated areas will result in a temporary direct loss of access to the fishery. Commercial fishers cannot move to alternative fishing grounds if exploration activities prevent them from accessing the key clam beds. Restrictions on invertebrate, pelagic or demersal fishing activity in certain areas can also potentially result in overcrowding of other areas and can potentially affect net income of commercial fishers.

Given the temporary and localized nature of exploration and delineation drilling programs, loss of access from safety exclusion zones is expected to be minimal on a project-by-project basis. However, given the potential for cumulative loss of access on Banquereau Bank, particularly where this area represents key fishing grounds for specific fisheries (*e.g.*, surf clam, snow crab, sea cucumber), it will be important to consider timing of drilling programs relative to fishing seasons.

5.3.1.3 Vessel Traffic

The interaction of vessel traffic (*e.g.*, supply vessels, helicopters) is predicted to have a negligible effect on fisheries given the limited frequency and intermittency of trips associated with an exploration program. Interactions with seismic vessels and drilling equipment are discussed above.

5.3.1.4 Well Abandonment

Well abandonment may involve mechanical means (*i.e.*, well is plugged and well casing is cut and removed just below the surface of the seafloor) or explosive means (explosive charge set in the well casing and detonated approximately 1 to 10 m below the seabed floor). If mechanical means are used for well abandonment, there is not predicted to be any interaction with fisheries. If explosive means are used, there could potentially injury or mortality of fish, particularly in juvenile fish and invertebrates due to shock waves produced by the explosion. Effects from underwater explosions range from light hemorrhaging of juvenile body cavities to temporary disbursement of adults in the immediate vicinity of an explosion, with tissue damage occurring up to 600 m from a blast site (Nedwell 2001, cited in JWEL 2003). Goertner (1981) found that for a 25 kg severance explosion buried at 4.6 m in a mud bottom in 61 m water depth, measurable fish kills can occur near the surface out to a horizontal range of 27 m, with larger fish considered less vulnerable to injury. Near the bottom, significant fish kills of all sizes of fish were predicted to be limited to a maximum horizontal range of approximately 21 m. As water depth increases, the hazard is reduced. There is no predicted interaction with fisheries following well abandonment.

5.3.1.5 Accidental Spills

Accidental releases through a streamer break, well blowout, batch spill, or SBM release during drilling could potentially occur during exploration activities and affect fisheries through effects on fisheries resources, fishing exclusion (*e.g.*, during spill and clean-up), fouling of gear (*e.g.*, through oiling), or reduced marketability (*e.g.*, perceived taint) . The severity of effects of a spill on fish (including eggs, larvae, juvenile and adult fish) depends on the properties of the spilled product, and magnitude (*e.g.*, volume), timing, and location (*e.g.*, water depth, temperature, wind and wave energy; proximity to sensitive locations) of the spill.

Although spills can result in biophysical effects on fish which could in turn result in a subsequent loss of fish catch or fish value, there is higher potential for effects on fisheries to occur as a result of perceived fish taint. Following the Uniacke blowout (involving condensate) near Sable Island in 1984, a no-fishing zone was established in spite of no evidence of taint (Zitko *et al.* 1984). Negative public perception of fisheries resources in the event of a spill could affect marketability and therefore result in reduced income for commercial fishers harvesting in proximity to the affected area.

The only hydrocarbons currently produced on the Scotian Shelf are natural gas and condensate, both of which are highly volatile and have reduced impacts compared with crude oil (Zwanenburg *et al.* 2006). A diesel spill would be more likely to occur than a blowout and would have greater potential for environmental effects.

Spill modelling conducted for the Deep Panuke Offshore Gas Development Project on the Sable Bank predicted spill probabilities and dispersion behavior for various spill scenarios. Although project-specific spill modeling would be conducted for each environmental assessment of an exploration project in the SEA Study Area, the Deep Panuke modeling results gives an indication of the potential extent of a spill on the Sable Bank, where currents are in the same magnitude as the Phase 2A Study Area (refer to Section 3.1 for a detailed overview of currents in the Study Area). As indicated above, the severity of spill effects will vary depending on a variety of factors, although the worst case predicted scenario would involve a 100-barrel batch spill of condensate which could persist as a slick for about 19 hours and travel about 18 km prior to the complete loss of surface oil, with a dispersed oil cloud in the water column potentially extending up to 54 km. It is predicted that subsea or surface blowouts would result in a much smaller area of influence (1-2.5 km). All fisheries operating in these areas of influence could be affected through effects on fisheries resources (particularly sessile or slow moving benthic species), fishing exclusion, fouling of gear, or reduced marketability of seafood.

5.3.2 Mitigation and Planning Considerations

Table 5.4 summarizes mitigation and planning considerations to mitigate potential effects of exploration activities on fisheries such that residual effects would be considered to be minor, short-term and localized. Mitigation as presented below is primarily intended to be implemented by individual operators. The CNSOPB will also take into account, when considering work authorization applications, potential cumulative effects associated with concurrent exploration activities, particularly where safety (exclusion) zones are established. Many fisheries occurring in the Phase 2A Study Area are quota-based and can be fished almost any time of year therefore it is difficult to prescribe specific seasonal avoidances. Stakeholder consultation early in project planning is crucial to mitigating effects of exploration activities on fisheries and other ocean users.

Table 5.4 Mitigation and Planning Considerations for Fisheries

Seismic and Seabed Surveys	• Fisheries Liaison Officer familiar with NS offshore fisheries to be present on seismic survey vessel to communicate with fishing vessels in the area to avoid potential conflict with fishing activities/gear. • Adherence (at minimum) to the Statement of Canadian Practice with Respect to Mitigation of Seismic Noise in the Marine Environment and other regulatory guidelines. Enhanced mitigation may be required. • Adherence to the CNSOPB Compensation Guidelines Respecting Damages Relating to Offshore Petroleum Activity. • Issuance of "Notice to Shipping" on location and scheduling of survey activities. • Commencement of seismic data acquisition in daylight hours and only if survey area confirmed to be clear of fixed fishing gear (*e.g.*, snow crab traps) or floating longline gear (*e.g.*, for large pelagics such as porbeagle shark, swordfish). • Consultation with key organizations representing fishing interests (including commercial and Aboriginal) in the area during the EA planning stage and just prior to activity start. • Consultation with DFO Science Branch to ensure survey area and timing does not overlap with research vessel programs. • Coordination of seismic program activities with fishing industry to reduce potential conflict with commercial fishing activity and DFO survey vessels. • Coordination of program activities with fishing industry to reduce potential conflict during peak fishing times.
Exploratory Drilling	• Adherence to the CNSOPB Offshore Waste Treatment Guidelines and Offshore Chemical Selection Guidelines to minimize effects of drill waste discharges. • Issuance of Notice to Shipping on location and scheduling of drilling activities. • Consultation with key organizations representing fishing interests (including commercial and Aboriginal) in the area during the EA planning stage. • An Environmental Protection Plan must be submitted prior to drilling activity.
Vessel Traffic	• Use of common routes by supply vessels and alternate routes around key fishing grounds particularly when fishing is at its peak.
Well Abandonment	• Design of wells and casings to facilitate effective mechanical cutting and removal of the wellhead; avoiding explosive means of separation where possible.
Accidental Spills	• Preparation and implementation of an Emergency Response Plan to address spill prevention and response including interactions with fishers and other ocean users. • Engineering design and protocols to prevent spills from occurring and/or reaching the marine environment including but not limited to secondary containment, inspection and maintenance, spill response kits, and blowout safeguards. • Operator to establish ongoing communication with key fisheries stakeholders and other ocean users in the event of a spill and during spill response activities, including but not limited to issuance of a Notice to Shipping/Mariners. • Outline an EEM Plan to address post-spill monitoring effects. • Adherence to CNSOPB Compensation Guidelines Respecting Damages Relating to Offshore Petroleum Activity. • Use of non-fluid filled streamers during seismic surveys where possible.

5.3.3 Data Gaps and Uncertainties

There are no crucial data gaps identified with respect to effects on fisheries. As noted above, ongoing consultation with the fisheries stakeholders is important to confirm specific fishing locations and seasons. Potential areas for future research pertain to sublethal physiological effects of seismic sound and drilling discharges on invertebrates that are fished in the area (*e.g.*, clam, sea cucumber, crab). The majority of research on physiological effects has been primarily laboratory based so measurement of effects in the dynamic open water conditions on the

Scotian Shelf could prove to be beneficial to increasing the understanding of significance of these effects.

6.0 Potential Effects of the Environment on Exploration Activities

Offshore exploration activities require careful consideration of environmental conditions in the operating area. Aspects of the environment potentially affecting offshore exploration activities include:

- Fog and ice;
- Seismic events and tsunamis;
- Hurricanes, winds and extreme weather events;
- Marine life (biofouling and presence of species of special status);
- Climate change; and
- Sediment and seafloor stability.

The interactions between these physical forces and exploration activities need to be considered in both normal and extreme circumstances. Extreme conditions may affect program schedule and operations including the timing of seismic and drilling programs and provisions of supplies and service support.

Detailed analyses of meteorology and oceanographic conditions are included in operators' engineering feasibility and design to ensure safety of personnel, and protection of equipment, vessels and the natural environment. The Offshore Physical Environment Guidelines (NEB *et al*. 2008) provide detailed requirements for operators regarding the observation, forecasting and reporting of physical environment data to ensure safe and prudent conduct of operations, emergency response, and spill countermeasures (NEB *et al.* 1994). It is important to note that a more comprehensive analysis would be required to adequately address the risks presented by these physical factors on a project specific basis.

An overview of potential environmental conditions which could potentially affect exploration activities is provided below.

Fog and Ice

Sea ice typically forms in the western and northern coastal zones of the Gulf of St. Lawrence during December; by the end of January the sea ice starts to flow through the Cabot Strait under the influence of surface currents and wind. Some year's ice, as a mixture of drift ice and locally formed ice may extend as far as Halifax and to the southwest towards Sable Island, although this is rare. The spring breakup of ice normally commences in March and recedes to patches within the Gulf of St. Lawrence by mid-April. In severe years, ice may stay longer on the Scotian Shelf until May or June. In the event that ice does migrate to the Scotian Shelf, it is not anticipated to result in significant adverse effects since structures are now designed with ice protection systems able to withstand impacts of up to a 6 million tonne iceberg (CAPP 2012).

Icebergs generally degrade by the time they reach the Scotian Shelf but ships will track and maneuver to avoid any icebergs that may be present and drilling platforms would likely be evacuated. The extent of ice coverage and ice movements can be tracked through the Canadian Ice Service (Environment Canada 2012c). Ice accumulation on equipment and vessels from sea spray can also affect exploration activities. Sea spray can form for a large portion of the year (Nov-Apr) as it only requires air temperatures below -2°C, wind speeds of 10 km/h and water temperatures below 6°C (JWEL 2003).If working under these conditions, Operators would need to have proper de-icing equipment available for use as necessary.

Fog is often present on the Scotian Shelf, with approximately 35% of days reporting fog with a visibility less than 1 km. This jumps to 65% of days in July as warm tropical air masses move north and cause large fog banks and stratiform clouds (Hurley 2011). Impacts of fog on exploration activities pertain primarily to delay due to poor visibility and inability to detect species of concern for avoidance.

Seismic Events and Tsunamis

The Scotian Shelf is an area of known seismic activity with recorded earthquakes, and fault zones occurring on the Shelf. While the area is seismically active, events tend to be of a low magnitude and given the short duration of exploration activities the probability of a significant seismic event or tsunami occurring during an exploration program is low. Guidance on planning and designing for seismic activity and other geological instabilities can be found in the American Petroleum Institute’s design document “Recommended Practice for Planning, Designing and Constructing Fixed Offshore Platforms – Working Stress Design” (API 2005).

Hurricanes, Wind and Extreme Weather Events

The Scotian Shelf lies in the path of occasional hurricanes and tropical storms that travel up the eastern coast of North America in the late summer and fall. These large storm events pose many risks to exploration activities including reduced visibility, increased wave height, increased wind speeds and heavy precipitation. Winter storm events are also an important consideration as they have the potential to add significant weight to any equipment or vessels very quickly in the form of ice or snow.

Average wind speeds range from 17.5 km/h in September to 31.5 km/h in January while wind speeds can be sustained at 130 km/h during severe storm events. A detailed analysis of meteorological and oceanographic conditions should always be maintained to ensure storm events and high wind and wave events are anticipated and avoided.

Marine Life

The biological environment could impact exploration activities in several ways, including;

- Biofouling of instrumentation or equipment;
- Structure colonization by barnacles, urchins or sea grasses; and
- Presence or migration of species of special status could halt or delay work.

Given the timeframe anticipated for exploratory work (*e.g.*, 30 – 90 days for drilling), it is unlikely that biofouling or colonization of structures or equipment would occur. Presence of species of special status could delay seismic or drilling activities, particularly if they are present within the 500 m safety zone. Planning of programs should take into consideration known distribution of species of special status including known migration routes and timing.

Climate Change

While many of the effects of climate change are expected to be realized over extended time scales (increased temperatures, rising sea levels), others such as large storm events could occur over shorter time scales. Climate models predict an increase in large storm events both in terms of storm intensity and frequency. The Scotian Shelf lies in the path of occasional tropical storms and hurricanes and is thus directly exposed to any increases in storm intensity attributed to climate change. A detailed analysis of meteorological and oceanographic conditions should always be maintained to ensure storm events and high wind and wave events are anticipated and avoided to the extent practical.

Sediment and Seafloor Stability

A variety of sediment types exist on the Scotian Shelf with silty sediments having settled in deep basins while sand and gravel cover the shallow banks and tend to slump over the shelf edge. The Sable Island and Banquereau Banks are considered a region of active sediment transport with the intensity of transport increasing with decreasing water depth. The Shelf contains numerous canyons, most notably the Gully, which create steep banks, possible areas of slope instability and provide avenues for sediment transport between the Shelf and the deep ocean. Sediment scour, liquefaction of sediments from seismic events and slope failure could all adversely affect exploration drilling activities. In particular, scour and/or deposition could occur around footings of jack-up drilling rigs. Periodic monitoring of footings (where applicable) should be carried out, particularly during the winter storm season, to avoid adverse effects associated with sediment transport and seabed stability.

Summary

In summary, it is expected that vessels and equipment would be designed and installed (where applicable) based on appropriate environmental design criteria to ensure integrity of facilities and safety and protection of workers and the natural environment. Although effects of the environment require consideration in project-specific design and environmental assessment and monitoring plans, these effects are not expected to be significant assuming appropriate planning and design criteria are followed.

7.0 Potential Cumulative Effects

"Cumulative environmental effects" is generally used to describe environmental change resulting from several anthropogenic alterations with environmental effects overlapping in both time and space. These effects could result from the activities of several large-scale developments or the combined effects of multiple developments. SEA allows for cumulative effects assessment (CEA) at a broad scale before individual project development to assist with planning and environmental management on a regional basis and to inform project specific assessments

7.1 CUMULATIVE EFFECTS ASSESSMENT SCOPING

An important component of assessing cumulative effects involves the identification of past, present and likely future projects and activities that could interact in combination with proposed activities. Section 4.3 describes the other ocean uses in the Study Area. These ongoing activities can potentially result in effects that can overlap spatially and temporally with effects associated with petroleum exploration and thus have been considered in terms of potential cumulative environmental effects (*i.e.*, military training, shipping, oil and gas developments). The cumulative effects of commercial fishing activity have also been considered.

7.2 CUMULATIVE EFFECTS ANALYSIS

Table 7.1 presents a summarized analysis of cumulative effects for Species of Special Status, Special Areas, and Fisheries in consideration of residual effects discussed in Section 5 of this SEA and potential cumulative effects from other ocean uses and/or other contributing factors which could affect the resilience of a VEC. Data gaps and uncertainties at the SEA level of analysis limit the confidence of cumulative effects predictions; however this constraint should not prevent identification of potential mitigation and planning considerations to reduce potential cumulative effects.

In consideration of the other ocean uses in the Study Area, the greatest potential for cumulative effects comes from other petroleum exploration and development on the nearby Sable Island Bank (*e.g.*, SOEP, Deep Panuke developments and ongoing exploration). Given the proximity of these activities to the Study Area and the Gully and the importance of Misaine and Banquereau Banks for groundfish and invertebrate fisheries, there is potential for cumulative effects on Special Areas (and Species of Special Status which inhabit these areas) and fisheries.

The CNSOPB is responsible for authorizing all petroleum related activities in the Nova Scotia Offshore and therefore has the authority to reduce spatial and temporal overlap of activities and associated environmental effects. For example, all applications for seismic programs are reviewed by the CNSOPB to determine potential overlap with historic seismic surveys, reducing unnecessary overlap in data acquisition. Project-specific EAs should consider temporal overlaps, program timing, survey logistics and cumulative sound fields to the extent possible.

Of particular relevance to cumulative effects on the Scotian Shelf is the Eastern Scotian Shelf Integrated Management (ESSIM) Initiative which was a collaborative ocean planning process led by the Oceans and Coastal Management Division (OCMD) of DFO under the *Oceans Act*. The ESSIM planning process involved a broad range of interests, including government, Aboriginal groups, ocean industry and resource users, environmental conservation groups, coastal communities, and university researchers. The primary aim of the ESSIM Initiative was to develop and implement a strategic long-term Integrated Ocean Management Plan for integrated, ecosystem-based and adaptive ocean management (DFO 2010b). Key interests in ocean use and activities included fisheries, offshore oil and gas, shipping, maritime defence operations, submarine cables, science research and development, recreation and tourism, potential offshore minerals development, and marine conservation (DFO 2002).

Intergovernmental cooperation and collaboration around management of ocean resources has allowed ocean users and regulators to better understand the nature of cumulative effects on the marine ecosystem and identify applicable adaptive management strategies. For example, EEM programs conducted by the offshore petroleum industry are designed in cooperation with various regulators, scientific experts and interested stakeholders so that data on ecosystem effects can be shared with other interested parties to inform future mitigation and environmental management decisions. Continued cooperation and information sharing among ocean users and applicable regulators will help to manage potential cumulative effects on the marine environment.

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Table 7.1 Cumulative Effects Assessment

Environmental Component and Associated Residual Effects of Exploration Activities	Residual Effects of Other Past, Existing or Future Projects/Activities	Potential Cumulative Effects	Mitigation Measures	Residual Cumulative Effects
Species of Special Status	Existing marine activities in the Study Area (including military training, shipping, oil and gas developments) result in a noisy underwater environment which can potentially affect marine mammal and sea turtle behavior. Entrapment and entanglement in fishing gear (including bycatch) and collision with ships contribute to adverse effects on Species of Special Status.	Potential increase in underwater noise. Potential increase in mortality risk.	Adherence to SOCP, including soft ramp-up and use of Marine Mammal Observer with experience in identifying beaked whales when near critical habitat for beaked whales listed on Schedule 1 of *SARA*. In the event that beaked whales are observed at the sea surface prior to ramp up, the 30 minute required observation period will be extended to 60 minutes. Use of established vessel routes for supply vessels and avoidance of known sensitive areas.	Cumulative effect not likely to be significant given implementation of mitigation.

Table 7.1 Cumulative Effects Assessment

Environmental Component and Associated Residual Effects of Exploration Activities	Residual Effects of Other Past, Existing or Future Projects/Activities	Potential Cumulative Effects	Mitigation Measures	Residual Cumulative Effects
Special Areas	Other ocean uses generate noise and traffic in and around special areas although residual effects are expected to be limited given implementation of codes of practice for operating in proximity to some special areas (*e.g.*, Sable Island, the Gully). Chronic hydrocarbon discharges from vessels result in oiling of species (particularly diving birds) and Special Areas (*e.g.*, shoreline of Sable Island). Fishing activities, particularly bottom trawling, can adversely affect areas of benthic ecological significance.	Potential increase in underwater noise. Potential increase in hydrocarbon contamination as a result of chronic or accidental spills.	Development and implementation of Codes of Practice to minimize interaction with Special Areas.	Cumulative effect not likely to be significant given implementation of mitigation.
Fisheries	Past and existing petroleum exploration and development projects have resulted in loss of fishing access due to establishment of safety zones (typically 500 m) around operational survey vessels and/or platforms.	Potential cumulative effect of loss of access and gear conflict with addition of new drilling and/or seismic programs.	Use of Fisheries Liaison Officer (seismic programs) and ongoing communication with stakeholders and coordination of program activities with fishing industry to reduce potential conflict during peak fishing times. Financial compensation for damage to fishing gear.	Cumulative effect not likely to be significant given implementation of mitigation.

8.0 Data Gaps and Recommendations

Hurley (2009) presents an evaluation of environmental assessment biophysical data gaps for the offshore Scotian Shelf and Slope. The majority of these gaps, some of which have been identified through previous environmental assessments or research reports, remain valid for this SEA. Table 8.1 summarizes data gaps and recommendations specifically relevant to potential exploration activities in the SEA Study Area. Many of these gaps have been previously identified by others and relate to ongoing research being conducted by E&P Sound and Marine Life JIP and ESRF programs. In light of these data gaps and uncertainties, a precautionary approach to oil and gas exploration should be taken in the vicinity of sensitive areas and presence of species at risk. This precautionary approach may mean enhanced mitigation and monitoring until understanding of potential interactions and effects can be improved and appropriate mitigation developed accordingly.

JIP and ESRF programs are largely funded by the petroleum industry and are expected to continue. Project specific EEM is also expected to provide a continuing source of valuable environmental information.

The following is a summary of data gaps and recommendations specific to the Phase 2A SEA.

Table 8.1 Summary of Data Gaps and Recommendations

Data Gap/Uncertainty	Implications/Recommendations
General lack of site-specific information on the distribution of species of special status including migratory birds in the Study Area.	Monitoring and observation programs of species of special status during operator-specific exploration programs can increase knowledge, particularly if the data can be collected and analyzed using standardized methods.
Uncertainty regarding MPA Network planning process – additional AOIs/MPAs could be identified; the boundaries of existing AOIs/MPAs could be changed; some EBSAs require further investigation of their ecological importance and sensitivity to petroleum exploration activities; management approaches have not been finalized (*e.g.*, allowable and prohibited activities).	Additional MPAs may be identified in the Study Area thereby requiring additional planning and mitigation considerations. The CNSOPB is committed to reviewing and updating SEAs on a regular basis to ensure validity; therefore it is likely that any change to EBSA and/or MPA designations would be addressed in these updates accordingly.
Uncertainty around sublethal effects of seismic sound on marine animals.	Research programs have studies underway to address sound source characterization and propagation; physical and physiological effects and hearing; behavioral reactions and biologically significant effects; and mitigation and monitoring. The most relevant studies are those that are conducted while the species are exposed to actual seismic surveys. Future seismic surveys on the Eastern Scotian Shelf would present an important research opportunity to fill knowledge gaps regarding seismic noise and Northern bottlenose whales.

Table 8.1 Summary of Data Gaps and Recommendations

Data Gap/Uncertainty	Implications/Recommendations
Consequences of seismic exploration (sound levels) and accidental spills on special areas in the Study Area.	Site-specific acoustic and spill fate modeling should be conducted for project-specific EAs for exploration projects proposed in Phase 2A Project Area with mitigation and monitoring plans implemented as appropriate.
Consequences and lessons learned from past oil and gas accidents and malfunction incidents.	Project-specific EAs for exploratory drilling should include discussions on lessons learned from the Gulf of Mexico oil spill (Macondo incident) that may be relevant to the specific project.
Detection of presence and behavioral effects of marine mammals (particularly beaked whales) and sea turtles.	Continuous use of PAM (and trained marine mammal observers as well as adherence to (and in some cases enhancement of) the Statement of Practice with Respect to the Mitigation of Seismic Sound in the Marine Environment. The use of a marine mammal observer with experience in identifying beaked whales is an important factor for increasing probability of sighting these whales. Trained observers and improved data will enhance understanding of distribution and behavior of species of special status.

In recognition of mitigation and monitoring measures and ongoing research to address these data gaps, it is expected that adverse environmental effects from oil and gas exploration activities can be managed to acceptable levels within the Phase 2A Project Area.

9.0 Summary and Conclusions

This report is an SEA of potential impacts of petroleum exploration activities on the Eastern Scotian Shelf – Misaine and Banquereau Banks and is intended to assist the CNSOPB and potential developers with respect to future applications and environmental management planning within the Misaine and Banquereau Banks Phase 2A Project Area. This SEA has focused on VECs and interactions of concern as identified in the Scoping Document (Appendix A). Mitigation measures to reduce environmental effects and address data gaps and uncertainties are summarized in Table 9.1.

Table 9.1 Summary of Key Mitigation for Exploration Activities in Phase 1A Project Area

Exploration Activity	Proposed Mitigation
Seismic and Seabed Surveys	• Adherence (at minimum) to the “Statement of Canadian Practice with Respect to Mitigation of Seismic Noise in the Marine Environment” and other regulatory guidelines. Enhanced mitigation may be required for seismic surveys. • If beaked whales are observed at the sea surface prior to ramp up, the 30 minute required observation period outlined in the Statement of Canadian Practice with Respect to Mitigation of Seismic Noise in the Marine Environment will be extended to 60 minutes. • Use of trained wildlife observers, with experience in identifying beaked whales listed on Schedule 1 of *SARA*, to visually monitor and record marine mammal, sea turtle and marine bird interactions and help enforce safe operating distances. • Detailed acoustic modeling as input to any project-specific EAs for seismic projects in the Phase 2A Project Area. These modeling results may be used to define appropriate buffer zones around the Gully, and Shortland and Haldimand Canyons). • Fisheries Liaison Officer (FLO) familiar with NS offshore fisheries to be present on seismic survey vessel to communicate with fishing vessels in the area to avoid potential conflict with fishing activities/gear. FLOs may be trained as marine wildlife observers and perform both tasks. • Use of Passive Acoustic Monitoring (PAM) as per the “Statement of Practice with Respect to the Mitigation of Seismic Sound in the Marine Environment”. • Detailed acoustic modeling as input to any project-specific EAs for seismic project in the Phase 2A Project Area. These modeling results may be used to define appropriate buffer zones around the Gully, and Shortland and Haldimand Canyons). • Schedule surveying to minimize interaction in Special Areas known as significant habitat for species at risk (*i.e.* The Gully, Shortland, and Haldimand Canyons). • Adherence to legislations/regulations, policies and codes of practice specific to protected candidate areas such as St Anns Bank and Laurentian Channel AOIs, and Sable Island National Park Reserve. • Adherence to the CNSOPB “Compensation Guidelines Respecting Damages Relating to Offshore Petroleum Activity”. • Issuance of “Notice to Shipping” on location and scheduling of survey activities. • Commencement of seismic data acquisition only if survey area confirmed to be clear of fixed fishing gear (*e.g.*, snow crab traps) or floating longline gear (*e.g.*, for large pelagics such as porbeagle shark, swordfish). • Consultation with key organizations representing fishing interests (including commercial and Aboriginal) in the area during the EA planning stage and just prior to

Table 9.1 Summary of Key Mitigation for Exploration Activities in Phase 1A Project Area

Exploration Activity	Proposed Mitigation
	activity start to coordinate seismic program activities with fishing industry to reduce potential conflict with fishing activity during peak fishing times. • Consultation with DFO Science Branch to ensure survey area and timing minimizes potential for conflict with research vessel program plans.
Exploratory Drilling	• Conduct pre-drilling ROV investigation to determine presence of corals, sponges, or other sensitive features as required by the CNSOPB. • Areas with known aggregations of deep sea coral shall be avoided during oil and gas drilling activities. If aggregations of deep sea coral are found to occur as the result of an environmental assessment that is conducted following an application for drilling or production, the Board requires mitigation to avoid harming these aggregations (DFO 2006). • Follow Canadian Wildlife Service mitigation measures when finding a dead or injured bird (*i.e.*, Williams and Chardine handling protocol). • Adherence to the CNSOPB “Offshore Waste Treatment Guidelines” and “Offshore Chemical Selection Guidelines” to minimize effects of drill waste discharges. • Adherence to CNSOPB Drilling and Production Regulations. • Bulk transfer and hose handling procedures as per best available practice. • Minimize flaring and ensure the use of high efficiency igniters as per best management practice. • Focus all area lighting on the work areas of offshore platforms and down shade lights it to minimize marine bird attraction. • Conduct a post-drilling ROV survey to verify that the muds and cuttings are within the predicted zone of influence. • Emergency contingency measures and response plans will be developed to address significant weather scenarios. • Monitor seabird interactions with the drilling rig/platform. • Enhanced mitigation and EEM programs may be required for activites within or adjacent to special areas, such as Shortland and Haldimand Canyons, St. Anns Bank AOI or the Laurentian Channel AOI. • Avoidance of oil and gas exploration in the Gully MPA, and the *Lophelia* Coral Conservation Area. • Develop codes of conduct to guide new exploratory activities in the vicinity of Special Areas including Sable Island, St. Anns Bank and Laurentian Channel AOIs. • Issuance of “Notice to Shipping” on location and scheduling of drilling activities. • Consultation with key organizations representing fishing interests (including commercial, Aboriginal and recreational) in the area during the EA planning stage.
Vessel Traffic	• Adherence to Transport Canada Guidelines for the Control of Ballast Water Discharge from Ships in Waters under Canadian Jurisdiction. • Use of existing vessel routes to the extent practical. • Avoidance of the Gully MPA and a buffer zone around Sable Island. • Use of common routes by supply vessels and alternate routes around key fishing grounds particularly when fishing is at its peak.
Well Abandonment	• Design of wells and casings to facilitate effective mechanical cutting and removal of the wellhead; avoiding explosive means of separation where possible. • If use of explosives is necessary, delay until no marine mammals or sea turtles observed within the area as indicated by PAM and visual observations.
Accidental Spills	• Enhanced mitigation and EEM programs may be required for activities within or adjacent to Special Areas, such as Shortland and Haldimand Canyons, St. Anns Bank AOI or the Laurentian Channel AOI. • Detailed spill probability and behavior modeling as input to any project-specific EAs for

Table 9.1 Summary of Key Mitigation for Exploration Activities in Phase 1A Project Area

Exploration Activity	Proposed Mitigation
	drilling project in the Phase 2A Project Area. • Implement Emergency and Oil Spill Response Plan accepted by the CNSOPB to address spill prevention and response including interactions with fishers and other ocean users, and includes spill response exercises. • Engineering design and protocols to prevent spills from occurring and/or reaching the marine environment including but not limited to secondary containment, inspection and maintenance, spill response kits, and blowout safeguards. • Outline an EEM Plan to address post-spill monitoring effects. • Develop codes of conduct to guide new exploratory activities in the vicinity of Special Areas including St. Anns Bank and Laurentian Channel AOIs. • Operator to establish ongoing communication with key fisheries stakeholders and other ocean users in the event of a spill and during spill response activities, including but not limited to issuance of a Notice to Shipping/Mariners. • Adherence to CNSOPB “Compensation Guidelines Respecting Damages Relating to Offshore Petroleum Activity”. • Use of non-fluid filled streamers during seismic surveys where possible.

Stakeholder consultation will play an important role in mitigating effects on fisheries and other ocean users. Assuming adherence to applicable standards and regulations and implementation of mitigation and monitoring as recommended, the issuance of exploration rights in the Phase 2A Project Area is not expected to result in unacceptable adverse environmental effects (including cumulative effects) such that populations of species of special status or integrity of special areas would be compromised beyond sustainable levels. Effects of exploration on fisheries are also not expected to result in unacceptable effects provided the implementation of recommended mitigation and ongoing communication with fishery stakeholders.

10.0 References

Andrews, C.D., French, B., Fancey, L., Guiney, J., and Payne J.F. 2004. Chronic toxicity study on snowcrab exposed to drilling fluid being used on the Grand Banks. IN Proceedings of the 31st Annual Toxicity Workshop: October 24-27, 2004, Charlottetown, Prince Edward Island. Burridge, L.E., Haya K., and Niimi, A.J. (eds.). Can. Tech. Rep. Fish. Aquat. Sci. 2562. 138pp.

API (American Petroleum Institute). 2005. Recommended Practice for Planning, Designing and Constructing Fixed Offshore Platforms – Working Stress Design. Available at oc.its.ac.id/ambilfile.php?idp=1765.

Atlantic Leatherback Turtle Recovery Team. 2006. Recovery Strategy for Leatherback Turtle (*Dermochelys coriacea*) in Atlantic Canada. *Species at Risk Act* Recovery Strategy Series. Fisheries and Oceans Canada, Ottawa, vi + 45 pp.

Barlow, M.J. and P.F. Kingston. 2001. Observations on the effect of barite on gill tissues on the suspension feeder *Cerastoderma edule* (Linné) and the deposit feeder *Macoma balthica* (Linné). Mar.Poll. Bull. 42: 71-76.

Bonnell, S., and K. Storey. 2000. Addressing Cumulative Effects through Strategic Environmental Assessment: A Case Study of Small Hydro Development in Newfoundland, Canada. *Journal of Environmental Assessment Policy and Management* 2,4 (2000): 477-99.

Breeze, H., Fenton, D., Rutherford, R.J., and Silva, M.A. 2002. The Scotian Shelf: An ecological overview for ocean planning. Ca. Tech. Rep. Fish. Aquat. Sci. 2393

Breeze, H. 2004. Review of Criteria for Selecting Ecologically Significant Areas of the Scotian Shelf and Slope: A Discussion Paper. Oceans and Coastal Management Report 2004-04. 88p.

Breeze, H. and T. Horsman. 2005. The Scotian Shelf: An Atlas of Human Activities. Fisheries and Oceans Canada. 120 pp. Available online: http://www.mar.dfo-mpo.gc.ca/e0009630.

Brickman, D., and A. Drozdowski. 2012. Canadian Technical Report of Hydrography and Ocean Sciences: Atlas of Model Currents and Variability in Maritime Canadian Waters. Vi+ 64 pp.

Brown, R.G.B. 1986. Revised Atlas of Eastern Canadian Seabirds. Bedford Institute of Oceanography, Dartmouth, NS, and Canadian Wildlife Service, Ottawa, ON.

Burbidge, C. 2011. Marine Habitats and Communities. State of the Scotian Shelf Report. Fisheries and Oceans Canada and the Atlantic Coastal Zone Information Steering Committee. 36p. Available at http://coinatlantic.ca/docs/marine-habitats-and-communities.pdf (accessed June 30, 2012).

Burbidge, C. 2012. Water and Sediment Quality. State of the Scotian Shelf Report. Fisheries and Oceans Canada and the Atlantic Coastal Zone Information Steering Committee. 50p. Available at http://coinatlantic.ca/docs/water-and-sediment-quality.pdf (accessed June 30, 2012).

Burke, C.M., Montevecchi, W.A., and F.K. Wiese. 2012. Inadequate Environmental Monitoring Around Offshore Oil and Gas Platforms on the Grand Bank of Eastern Canada: Are Risks to Marine Birds Known? Journal of Environmental Management. 104 (2012): 121 – 126.

Campbell, J.S. and Simms, J.M. 2009. Status Report on Coral and Sponge Conservation in Canada. Fisheries and Oceans Canada: vii + 87 p.

Canadian Coast Guard. 2012. Visitors Guide to Sable Island. Available at: http://www.ccg-gcc.gc.ca/e0003806 (accessed June 26, 2012).

CAPP (Canadian Association of Petroleum Producers). 2012. Marine Environment: Ice Management. Available at: http://www.capp.ca/environmentCommunity/water/Pages/MarineEnvironments.aspx.

CEAA (Canadian Environmental Assessment Agency). 2003. CEAA Operational Policy The Process for Defining the Spatial Boundary of a Study Area During an Environmental Assessment of Offshore Exploratory Drilling Projects. Available at: http://www.ceaa.gc.ca/013/0002/drilling_ops_e.htm.

Chang, Y.L. and Oey, L.Y. 2010. Loop Current Cycle: Coupled Response of the Loop Current with Deep Flows. Journal of Physical Oceanography (41) 458-471.

Christian, J.R., A. Mathieu, D.H. Thomson, D. White and R.A. Buchanan. 2003. Effects of Seismic Energy on Snow Crab (*Chionoecetes opilio*). Environmental Research Funds Report No. 144.106 pp.

Christian, J.R., A. Mathieu, and R.A. Buchanan. 2004. Chronic effects of seismic energy on snow crab (*Chinoecetes opilio*). Environmental Studies Research Funds Report No. 144. Calgary Alberta, Canada.

Clark, C.W. and Gagnon, G.C. 2006. Considering the Temporal and Spatial Scales of Noise Exposures from Seismic Surveys on Baleen Whales. IWC/SC/58/E9 (Submitted to Scientific Committee, International Whaling Commission). 9pp.

CNLOPB (Canadian Newfoundland and Labrador Offshore Petroleum Board) and CNSOPB (Canadian Nova Scotia Offshore Petroleum Board) 2002. Compensation Guidelines Respecting Damages Relating to Offshore Petroleum Activity. Available at: http://www.cnlopb.nl.ca/pdfs/guidelines/compgle.pdf

CNLOPB (Canadian Newfoundland and Labrador Offshore Petroleum Board), CNSOPB (Canadian Nova Scotia Offshore Petroleum Board), and NEB (National Energy Board) 2011. Environmental Protection Plan Guidelines. Avalable at: http://www.cnlopb.nl.ca/pdfs/guidelines/env_pp_guide.pdf

CNSOPB (Canadian Nova Scotia Offshore Petroleum Board) 2003. Strategic Environmental Assessment of Potential Exploration Rights Issuance for Eastern Sable Island Bank, Western Banquereau Bank, The Gully Trough and the Eastern Scotian Slope. Available at: http://0-fs01.cito.gov.ns.ca.legcat.gov.ns.ca/deposit/b10098392.pdf

CNSOPB (Canadian Nova Scotia Offshore Petroleum Board) 2011a. Amending Agreement of Significant Discovery Licence 2255E. Available at: http://www.cnsopb.ns.ca/pdfs/IAs/Registry/Notice_9203.pdf (accessed July 3, 2012).

CNSOPB (Canadian Nova Scotia Offshore Petroleum Board). 2011b. A synopsis of Nova Scotia’s offshore oil and gas environmental effects monitoring programs: summary report. Available at: http://www.cnsopb.ns.ca/pdfs/EEM_Summary_Report.pdf (accessed July 2, 2012).

CNSOPB (Canadian Nova Scotia Offshore Petroleum Board). 2012. Marine Protected Area: The Gully. Available at: http://www.cnsopb.ns.ca/marine_protected_area.php (accessed July 4, 2012).

Cochrane, N.A. 2007. Ocean Bottom Acoustic Observations in the Scotian Shelf Gully During an Exploration Seismic Survey- A Detailed Study. Canadian Technical Report of Fisheries and Aquatic Sciences. 2747: viii +73 p.

Coffen-Smout S, Halliday RG, Herbert G, Potter T and Witherspoon N. 2001. Ocean Activities and Ecosystem Issues on the Eastern Scotian Shelf: An Assessment of Current Capabilities to Address Ecosystem Objectives. Canadian Science Advisory Secretariat Research Document 2001/095. 44 pp.

Cogswell, A.T., E.L.R. Kenchington, C.G. Lirette, K. MacIsaac, M.M. Best, L.I. Beazley and J. Vickers. 2009. The current state of knowledge concerning the distribution of coral in the Maritime Provinces. Can. Tech. Rep. Fish. Aquat. Sci. 2855: v + 66 p.

Corridor Resources. 2010. Project Description for a Proposed Geo-Hazard survey over a part of the Old Harry Prospect in the Gulf of St. Lawrence. Corridor Resources Inc. Halifax, Nova Scotia.

COSEWIC (Committee on the Status of Endangered Wildlife in Canada). 2002. COSEWIC Assessment and Update Status Report on the Northern Bottlenose Whale *Hyperodon ampullatus* Scotian Shelf population in Canada. Available at: http://www.baleinesendirect.net/pdf/erapsitHa.pdf (accessed July 3, 2012).

COSEWIC 2004. COSEWIC assessment and status report on the porbeagle shark Lamna nasus in Canada. Committee on the Status of Endangered Wildlife in Canada. Ottawa. viii + 43 pp.

COSEWIC (Committee on the Status of Endangered Wildlife in Canada). 2009. COSEWIC Assessment and Status Report on the Savannah Sparrow *princeps* subspecies *Passerculus sandwichensis* in Canada. Committee on the Status of Endangered Wildlife in Canada. Ottawa. vi + 21 pp. Available at www.sararegistry.gc.ca/status/status_e.cfm.

Cranford, P.J. and Gordon, D.C.Jr. 1992. The influence of dilute clay suspensions on sea scallop (*Placopecten magellanicus*) feeding activity and tissue growth. Netherlands Journal of Sea Research. 30:107-120.

Cranford, P.J., Gordon, D.C.Jr., Lee, K., Armsworthy, S.L., and Tremblay, G.-H. 1999. Chronic toxicity and physical disturbance effects of water- and oilbased drilling fluids and some major constituents on adult sea scallops (*Placopecten magellanicus*). Marine Environmental Research. 48:225-256.

Cranford, P.J., Lee, K., Loder, J., Milligan, T.G., Muschenheim, D., and Payne, J. 2001. Scientific considerations and research results relevant to the review of the 1996 Offshore Waste Treatment Guidelines. Can. Tech Rep. Fish. Aquat. Sci. 2364. vi + 25 pp.

Dalen, J. and Raknes, A. 1985. Scaring effects on fish from three-dimensional seismic surveys. Report No. FO 8504. Institute of Marine Research, P.O. Box 1870, N.5024 Bergen, Norway.

Dalen, J., Dragsund, E., and Næss, A. 2007. Effects of seismic surveys on fish, fish catches and sea mammals. Report for Cooperation group - Fishery Industry and Petroleum Industry, Norway. DNV Energy Report - 2007-0512 rev 01. 33pp.

Dalen, J., Ona, E., Vold Soldal, A., and og Sætre, R. 1996. Seismiske undersøkeleser til havs: En vurdering av konsekvenser for fisk og fiskerier.

Davis, R.A., D.H., Thompson and C.I., Malme. 1998. Environmental Assessment of Seismic Exploration on the Scotian Shelf. TA2205. Report 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.

DFO (Fisheries and Oceans Canada). 2002. Canada's Ocean Strategy Our Oceans, Our Future: Canada's Ocean Strategy. Fisheries and Oceans Directorate: Ottawa, Ontario. 39pp.

DFO (Fisheries and Oceans Canada). 2004a. Identification of Ecologically and Biologically Significant Areas. DFO Can. Sci. Advis. Sec. Ecosystem Status Rep. 2004/006.

DFO (Fisheries and Oceans Canada). 2004b. Potential impacts of seismic energy on snow crab. DFO Can. Sci. Advis. Sec. Habitat Status Report 2004/003.

DFO (Fisheries and Oceans Canada). 2005. The Scotian Shelf: An Atlas of Human Activities. Available at http://intra.ent.dfo-mpo.ca/e0009630

DFO (Fisheries and Oceans Canada). 2006. Coral Conservation Plan (2006-2010). Oceans and Coastal Management Report 2006-01. ESSIM Planning Office, Fisheries and Oceans Canada (Maritimes Region).

DFO (Fisheries and Oceans Canada). 2007a. Statement of Canadian Practice with Respect to the Mitigation of Seismic Sound in the Marine Environment: Background Paper. Fisheries and Oceans Canada. Available at www.dfompo.gc.ca/oceans-habitat/oceans/im-gi/seismic-sismique/information_e.asp (cited 15 October 2010). 9pp.

DFO (Fisheries and Oceans Canada). 2007b. The Gully Marine Protected Area Management Plan. Available at http://www.dfo-mpo.gc.ca/Library/333121.pdf (accessed June 29, 2012).

DFO (Fisheries and Oceans Canada). 2007C. Placentia Bay-Grand Banks Large Ocean Management Area Ecologically and Biologically Significant Areas. Canadian Science Advisory Secretariat Research Document 2006/030: iv + 60 p.

DFO (Fisheries and Oceans Canada). 2008a. Marine Protected Area. Available at: http://www.dfo-mpo.gc.ca/oceans/marineareas-zonesmarines/mpa-zpm/atlantic-atlantique/factsheets-feuillets/gully-eng.htm (accessed July 3, 2012).

DFO (Fisheries and Oceans Canada). 2008b. DFO. 2008. Aboriginal Fisheries Strategy. Available at: http://www.dfo-mpo.gc.ca/fm-gp/aboriginal-autochtones/afs-srapa-eng.htm. (accessed July 24, 2012).

DFO (Fisheries and Oceans Canada). 2009a. Marine Protected Areas on the Eastern Scotian Shelf: Selecting the next Area of Interest. Available at http://www.mar.dfo-mpo.gc.ca/oceans/e/ocmd/mpa/booklet-e.html (accessed June 29, 2012).

DFO (Fisheries and Oceans Canada). 2009b. Recovery Strategy for the Northern Bottlenose Whale (Hyperoodon ampullatus), Scotian Shelf population, in Atlantic Canadian Waters [Proposed]. Species at Risk Act Recovery Strategy Series. Fisheries and Oceans Canada. vi + 60p.

DFO (Fisheries and Oceans Canada). 2009c. Contaminant monitoring in the Gully Marine Protected Area. Canadian Science Advisory Secretariat Science Advisory Report 2009/002. 15 pp.

DFO (Fisheries and Oceans Canada). 2010a. Atlantic Canadian Loggerhead Turtle Conservation Action Plan. Fisheries and Oceans Canada. Maritimes Region. Available at http://www.dfo-mpo.gc.ca/fm-gp/policies-politiques/log-turtle-tortue-caouane/index-eng.htm.

DFO (Fisheries and Oceans Canada). 2010b. The Eastern Scotian Shelf Integrated Management (ESSIM) Initiative. http://www.dfo-mpo.gc.ca/oceans/publications/essim-giepne-eng.asp.

DFO (Fisheries and Oceans Canada). 2010c. Recovery Strategy for the northern bottlenose whale (*Hyperoodon ampullatus*), Scotian Shelf population, in Atlantic Canadian waters. Species at Risk Act Recovery Strategy Series. Vi + 61 p.

DFO (Fisheries and Oceans Canada). 2010d. Northern Bottlenose Whale, Scotian Shelf population: Critical Habitat Protection Statement. Available at: http://www.sararegistry.gc.ca/virtual_sara/files/chs_northern_bottlenose_whale_1110_e.pdf

DFO (Fisheries and Oceans Canada). 2011a. The Marine Environment and Fisheries of Georges bank, Nova Scotia: Consideration of the Potential Interactions Associated with Offshore Petroleum Activities. Can. Tech. Rep. Fish. Aquat. Sci. 2945:xxxv + 492pp.

DFO (Fisheries and Oceans Canada) 2011b. The Scotian Shelf in Context. State of the Scotian Shelf Report. 67 pp.

DFO (Fisheries and Oceans Canada). 2011c. The Gully – Introduction. Available at. http://www.mar.dfo-mpo.gc.ca/Gully-MPA (assessed July 3, 2012).

DFO (Fisheries and Oceans Canada). 2011d. Recovery Potential Assessment for Northern Bottlenose Whales (*Hyperoodon ampullatus*) in Canada. DFO Can. Sci. Advis. Sec. Sci. Advis. Rep. 2011/031.

DFO (Fisheries and Oceans Canada). 2011e. What We Heard: Summary of DFO's Public Consultation to Select an Area of Interest on the Eastern Scotian Shelf for Marine

Protected Area Designation. Available at http://www.mar.dfo-mpo.gc.ca/folios/00263/docs/WhatWeHeard-eng.pdf (accessed July 2, 2012).

DFO (Fisheries and Oceans Canada). 2011f. Subdivision 3Ps offshore Whelk: A preliminary assessment of male size at maturity. DFO Can. Sci. Advis. Sec. Sci. Advis. Rep. 2011/023.

DFO (Fisheries and Oceans Canada) 2011g. Recovery Potential Assessment for Northern Bottlenose Whales (*Hyperoodon ampullatus*) in Canada. DFO Can. Sci. Advis. Sec. Sci. Advis. Rep. 2011/031.

DFO (Fisheries and Oceans Canada). 2011h. The St Anns Bank Area of Interest within the Eastern Scotian Shelf Integrated Management Area. Available at: http://www.mar.dfo-mpo.gc.ca/e0020675 (accessed November 15, 2012).

DFO (Fisheries and Oceans Canada). 2011i. Corals of Nova Scotia. Available at: http://www.mar.dfo-mpo.gc.ca/e0010596 (accessed November 19, 2012).

DFO (Fisheries and Oceans Canada). 2011j. Laurentian Channel Area of Interest-Introduction . Available at: http://www.nfl.dfo-mpo.gc.ca/LC-CL (accessed November 20, 2012).

DFO (Fisheries and Oceans Canada). 2011k. Laurentian Channel Area of Interest-Background . Available at: http://www.nfl.dfo-mpo.gc.ca/e0013515 (accessed November 20, 2012).

DFO. 2012. Terms of Reference: Marine Protected Areas Network Planning in the Scotian Shelf Bioregion. Available at http://www.dfo-mpo.gc.ca/csas-sccs/Schedule-Horraire/2012/03_05-07b-eng.html (accessed July 10, 2012).

DFO (Fisheries and Oceans Canada). 2012b. State of the Scotian Shelf Report: Fish Stock Status and Commercial Fisheries.

Di Iorio, L. and Clark, C.W. 2009. Exposure to seismic survey alters blue whale acoustic communication. Biology Letters. 6:51-54.

Doherty, P. and Horsman, T. 2007. Ecologically and Biologically Significant Areas of the Scotian Shelf and Environs: A Compilation of Scientific Expert Opinion. Can. Tech. Rep. Fish.Aquat.Sci. 2774:57+ xii pp.

Drinkwater, K.F., Mountain, D.B., Herman, A. 1998. Northwest Atlantic Fisheries Organization (NAFO) Scientific Council Meeting – June 1998: Recent Changes in the Hydrography of the Scotian Shelf and Gulf of Maine – A Return to Conditions of the 1960s? NAFO SCR Doc. 98/37, 16 pp.

Duncan, P M. 1985. Seismic sources in a marine environment. Pp. 56-58. In: Proceedings of the Workshop on the Effects of Explosive Use in the Marine Environment. January 1985. Halifax, NS. Technical Report 5. Environmental Protection Branch, Ottawa, ON.

Elvin, S. and C.T. Taggart. 2008. Right whales and vessels in Canadian waters. 2008. *Marine Policy.* 32: 379-386.

EnCana 2006. Deep Panuke Environmental Assessment Report. Available at http://www.cnsopb.ns.ca/pdfs/1.pdf and http://www.cnsopb.ns.ca/pdfs/2.pdf

EnCana 2005. CEAA Environmental Assessment. Vertical Seismic Profiles on Lower Musquodobit, Margaree, Huckleberry, Grand Pre, and Cohasset. 18p.

Environment Canada 2012a. Climate Normals or Averages 1971-2000. Available at http://www.climate.weatheroffice.gc.ca/climate_normals/index_e.html.

Environment Canada 2012 b. List of Protected Areas in Nova Scotia. Available at http://www.ec.gc.ca/ap-pa/default.asp?lang=En&n=35D97114-1.

Environment Canada 2012c. Canadian Ice Service. Available at http://www.ec.gc.ca/glaces-ice/.

Environment Canada. 2006. Recovery Strategy for the Roseate Tern (*Sterna dougallii*) in Canada. *Species at Risk Act* Recovery Strategy Series. Environment Canada. Ottawa. vii + 37 pp.

Environment Canada. 2010. Amended Recovery Strategy for the Roseate Tern (*Sterna dougallii*) in Canada. *Species at Risk Act* Recovery Strategy Series. Environment Canada. Ottawa. vii + 36 pp.

Exxon Norge AS. 2001 Coexisting with the Fishing Industry. Available at www.exxonmobil.com/Files/PA/Norden/Coexisting_with_Fishing_Industry. pdf. 19pp.

Fifield, D.A., Lewis, K.P., Gjerdrum, C., Roberston, G.J., and R. Wells. 2009. Offshore Seabird Monitoring Program. Environment Studies Research Funds Report No. 183. St. John's, NL. 68 p.

Frantzis, A. 1998. Does acoustic testing strand whales? Nature, 392:29.

Gausland, I. 2003. Seismic Surveys Impact on Fish and Fisheries. Norweigian Oil Industry Association (OLF). 41pp. Available at http://ebookbrowse.com/gausland-2003-seismic-surveys-impact-on-fish-and-fisheries-pdf-d344170381.

Gjerdrum, C., Head E.J.H., and D.A. Fifield 2008. Monitoring Seabirds at Sea in Eastern Canada. AZMP Bulletin PMZA 7: 52-58.

Goertner, J.F. 1981. Fish Kill Ranges for Oil Well Severance Explosions. Naval Surface Weapons Centre Dahlgren, VA. NSWC TR 81-149.

Gosselin, J.F. and J. Lawson. 2004. Distribution and abundance indices of marine mammals in the Gully and two adjacent canyons of the Scotian Shelf before and during nearby hydrocarbon seismic exploration programs in April and July 2003. Canadian Science Advisory Secretariat Research Document 2004/133: ii+ 24 p

Gunn, J. and B.F. Noble 2011. Conceptual and Methodological Challenges to Integrating SEA and Cumulative Effects Assessment. Environmental Impact Assessment Review, 31: 154-160.

Han, G. and Loder, J.W. 2003. Three-dimensional seasonal-mean circulation and hydrogrophy on the eastern Scotian Shelf. J Geophys. Res., 108(C5), 3136.

Hamoutene D., Payne, J.F., Andrews, C., and Guiney, J. 2004. Effect of a synthetic drilling fluid (IPAR) on antioxidant enzymes and peroxisome proliferation in the American lobster, *Homarus americanus*. Can. Tech. Rep. Fish. Aquat. Sci. 2554. iii + 12pp.

Harrington, J.J., McAllister, J., and J.M. Semmens. 2010. Assessing the short-term impact of seismic surveys on adult commercial scallops (Pecten fumatus) in Bass Strait. Tasmanian Aquaculture and Fisheries Institute, University of Tasmania.

Hildebrand, J.A. 2005. Impacts of anthropogenic sound. IN Marine Mammal Research: Conservation Beyond Crisis. Reynolds, J.E., Perrin, W.F., Reeves, R.R., Montgomery, S., and Ragen, T.J. (eds). John Hopkins University Press, Baltimore, Maryland. 101-124.

Horsman, T.L. and Shackell, N.L. 2009. Atlas of Important Habitat for Key Fish Species of the Scotian Shelf Canada. Can. Tech. Rep. Fish. Aquatic Sci. 2835 viii + 82 p.

Horsman, T.L., Serdynska, A., Zwanenburg, K.C.T., and N.L. Shackell. 2011. Report on the Marine Protected Area Network Analysis in the Maritimes Region, Canada. Can. Tech. Rep. Fish. Aquat. Sci. 2917: xi + 188 p.

Hurley Environment Ltd. and Stantec. 2010. Environmental Assessment Seabed Survey – Potential Sable Subsea Satellites Development. Prepared for ExxonMobil Properties. 34p.

Hurley, G.V. 2009. Environmental assessment biophysical data gap study – petroleum exploration activities on the offshore Scotian Shelf and Slope. Report prepared for the Canada-Nova Scotia Petroleum Board, Halifax, Nova Scotia (Report prepared by Hurley Environment Ltd., Dartmouth, Nova Scotia). 122p.

Hurley, G.V. and Ellis, J. 2004. Environmental effects of exploratory drilling offshore Canada: EEM data and literature review. Final Report Prepared for the Canadian Environmental Assessment Agency's Regulatory Advisory Committee (RAC). 61pp. + App.

Hurley, Geoffrey V. (2011) Strategic Environmental Assessment – Petroleum Exploration Activities on the Southwestern Scotian Shelf. Consultant report was prepared by Hurley Environment Ltd. for the Canada-Nova Scotia Offshore Petroleum Board November, 2011. 94 p. + appendices.

Husky Energy. 2010. Labrador Shelf Seismic Program – Environmental Assessment. 267 pp + appendices.

ICES (International Council for the Exploration of the Sea) 1995. Underwater Noise of Research Vessels: Review and Recommendations. Report No. 209.

Jepson, P.D., Arbelo, M., Deaville, R., Patterson, I.A.P., Castro, P., Baker, J.R., Degollada, E., Ross, H.M., Heraez, P., Pocknell, A.M., Rodriguez, F., Howell, F.E., Espinosa, A. Reid, R.J., Jaber, J.R., Martin, V., Cunningham, A.A., and Fernandez, A. 2003. Gas-bubble lesions in stranded animals: was sonar responsible for a spate to whale deaths after an Atlantic military exercise? Nature, 452: 575-576.

JWEL (Jacques Whitford Environment Limited) 2004. Environmental Assessment Report to BEPCo Canada Company on Exploration Drilling on EL2407.

JWEL (Jacques Whitford Environment Limited). 2003. Strategic Environmental Assessment Laurentian Subbasin. Prepared for the Canada-Newfoundland Offshore Petroleum Board, St. John's, Newfoundland. November 2003. 250p +appendices.

JWEL (Jacques Whitford Environment Limited). 2005. Seismic Exploration Program for Environmental Assessment for Exploration Lease EL. 1069. Jacques Whitford. St. John's Newfoundland and Labrador. 295pp.

Kenchington, E., Lirette, C., Cogswell, A., Archambault, D., Archambault, P., Benoit, H., Bernier, D., Brodie, B., Fuller, S., Gilkinson, K., Lévesque, M., Power, D., Siferd, T., Treble, M., and Wareham, V. 2010. Delineating Coral and Sponge Concentrations in the Biogeographic Regions of the East Coast of Canada Using Spatial Analyses. DFO Can. Sci. Advis. Sec. Res. Doc. 2010/041. vi + 202 pp.

Lacroix, Deborah L., Lanctot, Richard B., Reed, John A., and McDonald, Trent L. 2003. Effect of Underwater Seismic Survyes on Molting Male Long Tailed Ducks in the Beaufort Sea, Alaska. NRC Research Press Web site at http://cjz.nrc.ca.

Lagardere, J.P. 1982. Effects of noise on growth and reproduction of *Crangon crangon* in rearing tanks. Marine Biology 71: 177-185.

Lee, K., H. Bain, and G.V. Hurley. Editors. 2005. Acoustic Monitoring and Marine Mammal Surveys in The Gully and Outer Scotian Shelf before and during Active Seismic Programs. Environmental Studies Research Funds Report No. 151, 154 p + xx.

LGL. 2005a. Orphan Basin Exploration Drilling Program Environmental Assessment. LGL Rep. SA825. 353 p.

LGL Limited. 2005b. Western Newfoundland and Labrador Offshore Area Strategic Environmental Assessment, prepared for C-NLOPB.

LGL Limited. 2012. Environmental assessment of Shell Canada Ltd's Shelburne Basin 3-D Seismic Survey in Exploration Licenses 2423, 2424, 2425, and 2426. LGL Rep. SA1175. Rep by LGL Limited St. John's, NL and Mahone Bay, NS, for Shell Canada Limited, Calgary, AB. 122 p + Appendices.

Li, Z. and King, E.L. 2007. Multibeam bathymetric investigations of the morphology of sand ridges and associated bedforms and their relation to storm processes, Sable Island Bank, Scotian Shelf. Marine Geology 243 200-228.

Li, Z., Platt, T., Tang, C., Sathyendranath, S., and Walls R.W. 2011. Phytoplankon Phenology on the Scotian Shelf. ICES Journal of Marine Science 68(4) 781-791.

Lock, A.R., Boates, S., Cohrs, S., D'Eon, T. C., Johnson, B. and LaPorte, P. 1993. Canadian Roseate Tern recovery plan. Recovery of Nationally Endangered Wildlife Report No. 4. Canadian Wildlife Federation, Ottawa.

Locke, A. 2002. The ichthyoplankton and invertebrate zooplankton of the coastal waters of Cape Breton Island: a review. Canadian Manuscript Report of Fisheries and Aquatic Sciences 2606.

Løkkeborg, S., Ona, E., Vold, A., Pena, H., Salthaug, A., Totland, B., Øvredal, J.T., Dalen, J., and Handegard, N.O. 2010. Effects of seismic surveys on fish distribution and catch rates of gillnets and longlines in Vesterålen in summer 2009. Institute of Marine Research. Report 2. Website <www.imr.no/filarkiv/2010/01/fh_2009-5_til_web.pdf/nb-no> (cited 27 October 2010). 50pp.

Kulka, D.W., Antle, M.C., and Simms, J.M. 2003. Spatial analysis of 18 demersal species in relation to petroleum license areas on the Grand Bank (1980-2000). Can. Tech. Rep. Fish. Aquat. Sci. 2473.

Kulka, D.W. 2006. Abundance and distribution of demersal sharks on the Grand Banks with particular reference to the NAFO regulatory area. NAFO SCR Doc. 06/20.

Marine Mammals Commission 2011. Available at http://mmc.gov/.

McCauley, R.D., Duncan, A.J., Penrose, J.D., Fewtrell, J., Jenner, C., Prince, R.T., Murdoch, J., and Adhitya, A. 2000b. Marine Seismic Surveys - a study of environmental implications. Australian Petroleum Production Exploration Association Journal.

McCauley, R.D., Fewtrell, J., and Popper, A.N. 2003. High intensity anthropogenic sound damages fish ears. Journal of the Acoustical Society of America. 113:638-642.

McCauley, R.D., Fewtrell, J., Duncan, A.J., Jenner, C., Jenner, M-N., Penrose,J.D., Prince, R.I.T., Adhitya, A., Murdoch, J., and McCabe, K. 2000a.Seismic surveys: analysis and propagation of air-gun signals; and effects of air-gun exposure on humpback whales, sea turtles, fishes and squid.Australian Petroleum Production Exploration Association, Western Australia.

McCauley, R.D., Fewtrell, J., Duncan, A.J., Jenner, C., Jenner, M-N., Penrose,J.D., Prince, R.I.T., Adhitya, A., Murdoch, J., and McCabe, K. 2000c. Marine Seismic Surveys – A Study of Environmental Implications. APPENA Journal: 692-706.

McKenzie, R.A. 1956. Atlantic cod tagging off the Southern Canadian mainland. Bull. Fish. Res. Board Can. 105: 1–93.

McQuinn, I.H. and D. Carrier. 2005. Far-field Measurments of Seismic Airgun Array Pulses in the Nova Scotia Gully Marine Protected Area. Canadian Technical Report of Fisheries and Aquatic Sciences 2615: v + 20 p.

Montevecchi, W.A., 2006. Influences of artificial light on marine birds. In: Rich, C., Longcore, T. (Eds.) Ecological Consequences of Artificial Night Lighting. Springer, Berlin, pp. 94-113.

Moein, S.E., J.A. Musick, J.A. Keinath, D.E. Barnard, Lenhardt, M., and George, R. 1994. Evaluation of seismic sources for repelling sea turtles from Hopper dredges. Final report submitted to the U.S. Army Corps of Engineers Waterways Experiment Station (Report prepared by the Virginia Institute of Marine Sciences, Gloucester Point, Virginia).

Moors. H.B. 2012. Acoustic monitoring of Scotian Shelf northern bottlenose whales (*Hyperoodon ampullatus*). PhD thesis. Dalhousie University. Available online: http://dalspace.library.dal.ca/handle/10222/15238.

NEB (National Energy Board), CNLOPB (Canadian Newfoundland and Labrador Offshore Petroleum Board) and Canadian Nova Scotia Offshore Petroleum Board. 2008. Guidelines Respecting Physical Environmental Programs during Petroleum Drilling and Production Activities on Frontier Lands. Minister of Public Works and Government Services Canada. September 2008.

NEB (National Energy Board), CNLOPB (Canadian Newfoundland and Labrador Offshore Petroleum Board) and Canadian Nova Scotia Offshore Petroleum Board. 2009. Offshore Chemical Selection Guidelines for Drilling and Production Activities on Frontier Lands.

NEB (National Energy Board), CNLOPB (Canadian Newfoundland and Labrador Offshore Petroleum Board) and Canadian Nova Scotia Offshore Petroleum Board. 2010. Offshore Waste Treatment Guidelines. December 15, 2010. 24p + appendices.

Neff, J.M. 2010. Fates and effects of Water Based Drilling Muds and Cuttings in Cold-Water Environments. Prepared for Shell Exploration and Production Company, Houston, Texas, x + 287 pp.

Newell, J, K. Neeham J. Gordon, C. Gorders and T. Gordon 2001. The Effects of Underwater Blasting During Wellhead Severance in the North Sea. Report No. 469 R 0202. Research by Subacoutech Ltd. And Ecological for Coflexip Stena Offshore Ltd, BP Exploration Oi. Company Ltd., Talisman Ltd, Enterprise Ltd and Marathon Oil UK Ltd.

Noble, B.F. 2003 Auditing strategic environmental assessment practice in Canada J Environ Asses Policy Management, 5 (2) pp. 127–147

Normandeau Associates, Inc. 2012. Effects of Noise on Fish, Fisheries, and Invertebrates in the U.S. Atlantic and Arctic from Energy Industry Sound-Generating Activities. A Literature Synthesis for the U.S. Dept. of the Interior, Bureau of Ocean Energy Management. Contract # M11PC00031. 153 pp.

NOAA Fisheries Service’s Southwest Fisheries Science Center. (SWFSC). 2007. What are Ichthyoplankton? Available at: http://swfsc.noaa.gov/textblock.aspx?Division=FRD&id=6210.

NSM (Nova Scotia Museum). 1997. Theme Regions. Offshore/Continental Shelf. Available at http://museum.gov.ns.ca/mnh/nature/nhns2/. (accessed July 10, 2012).

OSPAR Commission 2007. Assessment of the impact on the marine environment of offshore oil and gas activity – an overview of monitoring results in the United Kingdom, the Netherlands and Norway.

Parks Canada 2009. World Heritage: Canada Site Considered. Available at: http://www.pc.gc.ca/eng/progs/spm-whs/itm3/page7.aspx (accessed June 26, 2012).

Parks Canada 2010. Sable Island What We Heard: A summary of Public Input. Available at: www.pc.gc.ca/progs/np-pn/cnpn-cnnp/sable/~/.../SI-IS_e.ashx (accessed July 4, 2012).

Parks Canada 2011. Canada and Nova Scotia Reach Historic Agreement to designate Sable Island as a National Park Reserve. Available at: http://www.pc.gc.ca/apps/cp-nr/release_e.asp?id=1785&andor1=nr (accessed June 26, 2012).

Payne, J.F. 2004. Potential effect of seismic surveys on fish eggs, larvae and zooplankton. DFO Can. Sci. Advis. Sec. Res. Doc. 2004/125. 12pp.

Payne, J.F. 2007. A population approach to fish monitoring: too much blind trust? Integrated Environmental Assessment and Management. 3:299-301.

Pearson, W., J. Skalski, S.Sulkin, and C. Malme. 1994. Effects of seismic energy releases on the survival and development of zoeal larvae of Dungeness crab (*Cancer magister*). Mar. Environ. Res. 38:93-113.

Petrie, B. 2007. Does the North Atlantic Oscillation Affect Hydrographic Properties on the Canadian Atlantic Continental Shelf? Atmosphere-Ocean 45 (3), 141-151.

Potter, J.R., M. Chitre, P. Seekings and C. Douglas. 2005. Marine mammal monitoring and seismic gun signature analysis: Report on EnCana’s Stonehouse 3D seismic survey 2003. Seamap Pte. Ltd report for EnCana Corporation, Calgary, Alberta, Canada.

Potter, J.R., M. Thillet, C. Douglas, M.A Chitre, Z. Doborzynski and P.J. Seekings. 2007. Visual and Passive Acoustic Marine Mammal Observations and High Frequency Seismic Source Characteristics Recorded During a Seismic Survey. IEEE Journal of Oceanic Engineering, Vol. 32, No. 2, pp. 469-483.

Region Framework for an Ecosystem Approach to Management. Fisheries and Oceans Canada, Maritimes Region: Dartmouth, Nova Scotia. 9pp.

Richardson, W.J., Greene, C.R.Jr., Malme, C.I., and Thomson, D.H. 1995. Marine Mammals and Noise. Academic Press, San Diego, California. 576pp.

Rodger, R.W.A., and von Zharen, W.M. 2011. Introduction to the Commercial fisheries of the United States and Canada: Illustrated 2012 edition. Canadian marine Publications.

Sable Island Green Horse Society. 2004. Beached Seabird Surveys on Sable Island. Available at http://www.greenhorsesociety.com/Beached_Birds/beached_birds.htm.

Sætre, R., og Ona, E. 1996. Seismiske undersøkelser og skader på fiskeegg og -larver; en vurdering av mulige effekter på bestandsnivå. Havforskningsinstituttet. Fisken og Havet 1996(8), 25 pp. Institute of Marine Research, Bergen, Norway. (In Norwegian with English abstract.)

SARA (Species at Risk Act). 2011. SARA Public Registry. Available at: http://www.sararegistry.gc.ca/default_e.cfm

Scott, W.B. and M.G. Scott. 1988. Atlantic Fishes of Canada. Canadian Bulletin of Fisheries and Aquatic Sciences, 219: 731 pp.

Shell Canada Ltd. 2012 Project Description: Shelburne 3-D Seismic Survey Exploration Licenses EL 2423; EL 2424; EL 2425; EL 2426. Shell Canada Ltd.

Song, H.J. Stock, C., and Wang, Z. 2010. Phenology of Phytoplankton Blooms in the Nova Scotia Shelf-Gulf of Maine Region Remote Sensing and Modeling Analysis. Journal of Phytoplankton Research 32(11) 1485-1499. Stantec Consulting Ltd. 2010. A Preliminary Review of Environmental and Socio-economic Issues on Georges Bank. Prepared for Offshore Energy Environmental Research Association. June 2010.

Stone, C.J. and Tasker, M.L. 2006. The effects of seismic airguns on cetaceans in UK waters. Journal of Cetacean Research and Management. 8:255-263.

Stronach, A. 1993. Observations in Cardigan Bay of the Effects of Seismic Surveys on Seabirds and Cetaceans, 28 Oct. – 11 Nov 1993. A Report for Arco British Ltd.

Sverdrup, A., Kjellsby, P.G., Krüger, P.G., Floysand, R., Knudsen, F.R., Enger, P.S., Serck-Hanssen, G. and Helle, K.B. 1994. Effects of Experimental Seismic Shock on Vasoactivity of Arteries, Integrity of the Vascular Endothelium and on Primary Stress Hormones of the Atlantic Salmon. Fish Biol., 45:973-995.

Templeman, N.D. 2007. Placentia Bay-Grand Banks Large Ocean Management Area Ecologically and Biologically Significant Areas. Canadian Science Advisory Secretariat Research Document 2007/052: iv + 21 p.

Therivel, R., Wilson, E., Thompson, S., *et al*. (1992). *Strategic Environmental Assessment*, Earthscan Publication Ltd.

Thompsen, F., S.R. McCully, L.R. Weiss, D.T. Wood, K.J. Warr, J. Barry, R.J. Law. 2011. Cetacean stock assessments in relation to exploration and production industry activity and other human pressures: Review and data needs. Aquatic mammals 37 (1): 1-93.

Thomson DH, Davis RA, Belore R, Gonzalez E, Christian J, Moulton VD, and Harris RE. 2000. Environmental Assessment of Exploration Drilling Off Nova Scotia. LGL Report No. TA 2281. xxvii + 280.

Vanderlaan, A.S.M. and C.T. Taggart. 2007. Vessel collisions with whales: the probability of lethal injury based on vessel speed. *Marine Mammal Science.* 23: 144-156

Weilgart, LS. 2007. The impacts of anthropogenic ocean noise on cetaceans and implications for management. Canadian Journal of Zoology. 85:1091-1116.

Wiese, F.K., Montevecchi, W.A., Davoren, G., Huettman, F., Diamond, A.W., and J. Linke. 2001. Seabirds At Risk Around Offshore Oil Platforms in the Northwest Atlantic. Marine Pollution Bulletin. 42 (12): 1285-1290.

Worcester, T. 2006. Effects of seismic energy on fish: a literature review. DFO Can. Sci. Advis. Sec. Res. Doc.2006/092*.* 66pp.

Worcester, T. and M. Parker. 2010. Ecosystem Status and Trends Report for the Gulf of Maine and Scotian Shelf. DFO Can. Sci. Advis. Sec. Res. Doc. 2010/070. vi + 59 p.

Wright, A.J. 2008. International Workshop on Shipping Noise and Marine Mammals, Hamburg, Germany. 21st-24th April 2008. Okeanos- Foundation for the Sea, Auf der Marienhohe 15, D-64297 Darmstadt. 33+ v .

WWF (World Wildlife Fund). 2009. An Ocean opf Diversity. The Seabeds of the Canadian Scotian Shelf and Bay of Fundy. 24 pp.

Zimmer, W.M.X. and Tyack, P.L. 2007. Repetitive shallow dives pose decompression risk in deep-diving beaked whales. Marine Mammal Science 23(4) 888-925.

Zitko, V, L.E. Burridge, M. Woodside, and H. Akagi. 1984. Low contamination of fish by hydrocarbons from the Uniacke *G-72* (Shell Oil, Vinland) wellsite blowout in February 1984. Can. Tech. Rep. Fish. Aquat. Sci. 1305. iii + 43 p.

Zwanenburg, K.C.T., A. Bundy, P. Strain, W.D. Bowen, H. Breeze, S.E. Campana, C. Hannah, E. Head, and D. Gordon. 2006. Implications of ecosystem dynamics for the integrated management of the Eastern Scotian Shelf. Can. Tech. Rep. Fish. Aquat. Sci. 2652: xiii +91 p.

Personal Communication

Boyd, C. 2012. Clearwater, Manager of Sustainability and Public Affairs. Letter of response re: Draft Scoping Document (Phase 2). November 27, 2012

Coughlan, G. 2012 Fisheries and Oceans Canada, Newfoundland and Labrador Region. November, 2012

Curran, K. 2012. Fisheries and Oceans Canada. Ongoing email and telephone conversations, July 2012.

DFO 2013. Fisheries and Oceans Canada. DFO Maritimes Region Comments on Canada-Nova Scotia Offshore Petroleum Board Draft Strategic Environmental Assessment Reports for

Misaine and Banquereau (Area 2A) and Eastern Scotian Slope and Laurentian Fan (Area 2B). March 2013

Eagles, M. 2012. Fisheries and Oceans Canada, Maritimes Resource Management. September 2012.

EC 2013. Environment Canada. Comments on Draft Strategic Environmental Assessments (SEAs) for the Misaine and Banquereau Banks, and Eastern Scotian Slope and Laurentian Fan (Phases 2A and 2B). February 2013.

McCuaig, J. 2012. Fisheries and Oceans Canada, Maritimes Aboriginal Affairs. September 2012.

Sheppard, J. 2012. Parks Canada. Email correspondence June 28, 2012.

APPENDIX A

Scoping Document

CNSOPB
CANADA-NOVA SCOTIA
OFFSHORE PETROLEUM BOARD

Scoping Document for the Strategic Environmental Assessment for the Eastern Scotian Slope (Eastern Portion) and Laurentian Fan (Western Portion)

November 2012

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SCOPING DOCUMENT FOR THE STRATEGIC ENVIRONMENTAL ASSESSMENT FOR THE EASTERN SCOTIAN SLOPE (EASTERN PORTION) AND LAURENTIAN FAN (WESTERN PORTION)

1.0 Introduction

This document describes the scope of two strategic environmental assessments (SEAs) for offshore petroleum exploration activities in the marine area on the Misaine and Banquereau Banks on the Eastern Scotian Shelf and on the adjacent Eastern Scotian Slope. The Phase 2A SEA will address seismic and exploratory drilling on the Eastern Scotian Shelf - up to water depths of 1000 m, and the Phase 2B SEA will address seismic and exploratory drilling on the adjacent Eastern Scotian Slope in water depths up to 4,500 m (refer to Figure 1 for the SEA Proposed Project Areas). This Scoping Document outlines the factors to be considered in the SEAs, the scope of those factors, and guidelines for the preparation of the SEA reports.

The Canada-Nova Scotia Offshore Petroleum Board (CNSOPB) has the responsibility pursuant to the *Canada-Nova Scotia Offshore Resources Accord Implementation Act* and the *Canada-Nova Scotia Offshore Resources Accord Implementation Act (Nova Scotia)* (the Accord Acts) to ensure that offshore oil and gas activities proceed in an environmentally responsible manner. The CNSOPB conducts SEAs in those areas offshore Nova Scotia that may have the potential for offshore petroleum exploration activity but that were not subject to a recent SEA nor to recent and substantial project-specific environmental assessments, such as a Comprehensive Study or Panel Review under the *Canadian Environmental Assessment Act* (CEAA). In addition, the CNSOPB endeavours to review SEAs within five years of completion to determine validity.

2.0 Background

SEA incorporates a broad-based approach to environmental assessment (EA) that proactively examines the environmental effects that may be associated with a plan, program or policy proposal and that allows for the incorporation of environmental considerations at the earliest stages of program planning. SEA typically involves a broader-scale (*i.e.*, regional, sectoral) assessment that considers the larger ecological setting, rather than a project-specific EA that focuses on site-specific issues with defined boundaries.

In this particular case, information from these SEAs will assist the CNSOPB in its determination in respect to the potential issuance of future exploration rights within the Misaine and Banquereau Banks Eastern Scotian Shelf and Slope SEA areas and may identify general restrictive or mitigative measures that should be considered for application to consequent exploration activities.

An exploration license confers:

- The exclusive right to explore, drill and test for petroleum;

- The exclusive right to develop those portions of the offshore area in order to produce petroleum; and

- The exclusive right, subject to compliance with the other provisions of the Accord Acts, to apply for a production license.

Activities associated with exploration licenses may include: conduct of seismic surveys, other geophysical surveys and geotechnical surveys; drilling of wells (either exploration or delineation); and well abandonment.

Each of these activities requires the specific approval of the CNSOPB, including a project-specific assessment of its associated environmental effects. Petroleum exploration activities may also be subject to review and approval pursuant to other federal legislation, such as the *Fisheries Act*, *Species at Risk Act*, *Canadian Environmental Protection Act (1999)* and/or other legislations and regulations depending on the activity. The SEA does not replace this requirement for a project-specific EA. However, the SEA assists in focusing these EAs by providing an overview of the existing environment, discussing in broader terms the potential environmental effects associated with offshore oil and gas exploration activities in a large area or region, identifying knowledge and data gaps, highlighting issues of concern, and making recommendations for mitigation and planning.

3.0 Geographic Scope

The SEA proposed project areas encompass the areas shown on Figure 1. Projects areas shown could be included in any potential Call for Bids lands or resulting Exploration Licence lands. As per guidance from the Canadian Environmental Assessment Agency[1], the spatial domain of the SEA study areas may extend beyond the boundaries of the project areas where relevant, to include potential project interactions with the Valued Environmental Components (*i.e.*, within zones of influence of certain project discharges/emissions). Lands within the Gully Marine Protected Area (MPA) would not be included in a Call for Bids and therefore not include any potential resulting Exploration Licence lands. Therefore assessment of potential impacts on the Gully MPA is included in the SEA study area, but the Gully MPA is excluded from the Phase 2 Project Areas (see boundary lines defined in Figure 1). Within the entire Phase 2 SEA study area, water depths range from 50 m to 4500 m. The Phase 2A SEA encompasses the Misaine and Banquereau Banks on the Eastern Scotian Shelf and extends just east into the Laurentian Channel. The Phase 2B SEA extends off the Banks on the Eastern Scotian Slope, encompassing Shortland and Haldimand Canyons and a portion of the Laurentian Fan.

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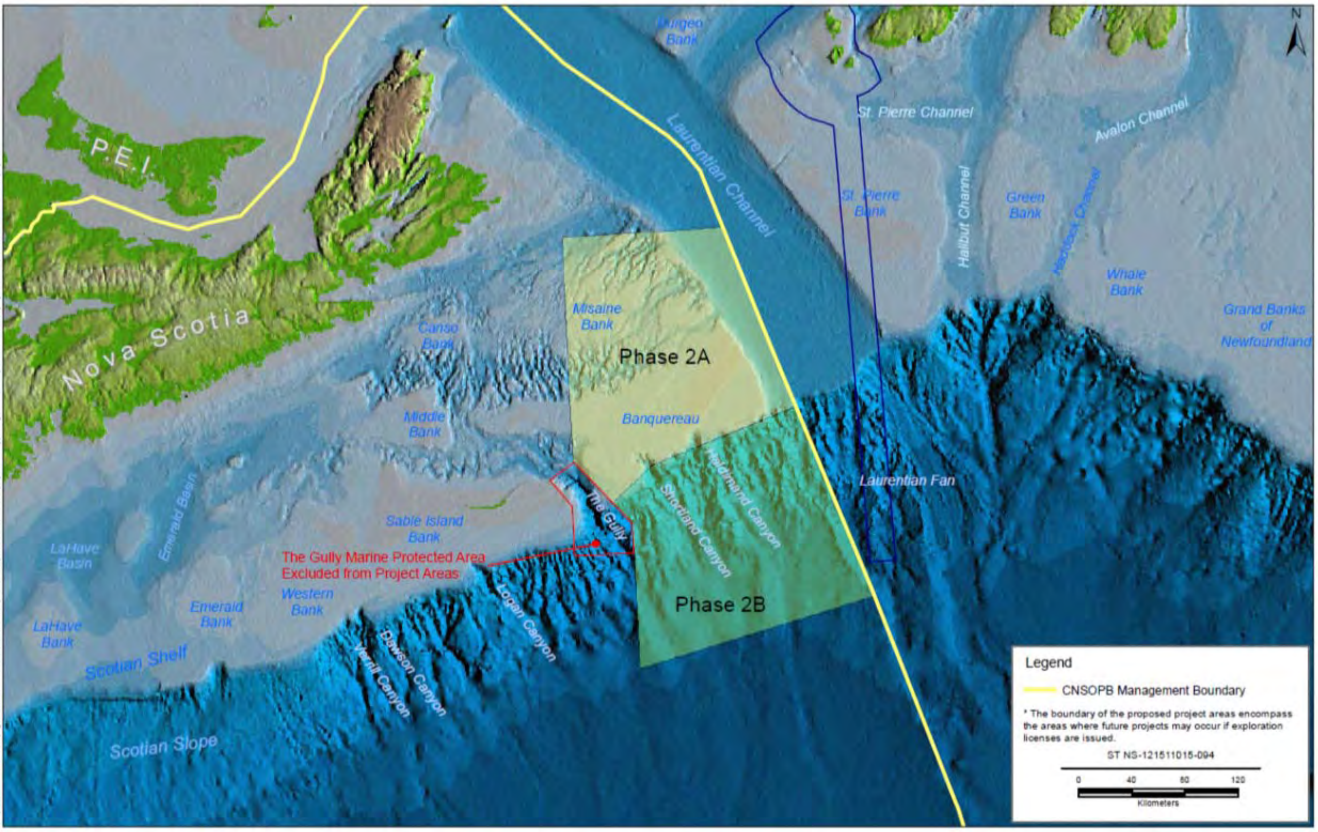
[1] Operational Policy Statement entitled “The Process for Defining the Spatial Boundary of a Study Area During an Environmental Assessment of Offshore Exploratory Drilling Projects” (CEA Agency 2003).

Figure 1 SEA Proposed Project Areas for Phase 2A and Phase 2B



* The boundary of the proposed project areas encompass the areas where future projects may occur if exploration licenses are issued.

PREPARED BY: M. Huskins-Shupe

REVIEWED BY: C. Shupe

CLIENT: Canada - Nova Scotia Offshore Petroleum Board

Banquereau and Misaine Banks Eastern Scotian Shelf and Slope Strategic Environmental Assessment

Strategic Environmental Assessment Proposed Project Areas*

FIGURE NO.: 1

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4.0 Objectives

Each SEA will:

- Provide an overview of the existing environment;
- Generally describe typical offshore oil and gas exploration activities (production activities are excluded);
- Describe and evaluate potential adverse environmental effects associated with offshore oil and gas exploration, including cumulative effects from existing production projects near the study areas, if any;
- Identify knowledge and data gaps;
- Identify species of special status and special areas that may interact with exploration activities;
- Make recommendations for general mitigation measures that should be employed during offshore petroleum exploration activities;
- Identify, where appropriate, activities/areas requiring enhanced levels of mitigation; identify, if feasible, the level of enhanced mitigation required;
- Identify follow-up measures (*i.e.*, environmental effects monitoring), as appropriate, that may be required to verify environmental assessment predictions related to future offshore petroleum exploration activities; and
- Assist the CNSOPB in its determination in respect to the potential issuance of future exploration rights within the SEA areas of the Misaine and Banquereau Banks Eastern Scotian Shelf and Slope.

5.0 Past and Current Petroleum Activity

There is no current petroleum activity in the SEA Project Areas. Several exploratory wells have been drilled on the Banquereau Bank, all of which have been plugged and abandoned. ExxonMobil Canada holds a Significant Discovery License in the Phase 2A Project Area, centered on a plugged and abandoned gas well Banquereau C-21 that was drilled by PetroCan in 1981. ConocoPhilips Canada Resources Corp. holds an exploration license which is located at the edge of the Phase 2B Project Area. This license (EL 1119) is across the jurisdictional boundary, in the Canada-Newfoundland and Labrador Offshore Petroleum Board jurisdiction. A

SEA was prepared for petroleum exploration in the Laurentian Subbasin in 2003 and on the Misaine Bank in 2005.

6.0 Scope of SEA

6.1 SCOPE OF THE PROJECT

The SEAs (for Phases 2A and 2B) will describe all foreseeable offshore oil and gas exploration activities in the study area. It will examine potential environmental interactions associated with these petroleum exploration activities. Exploration activities to be considered in the SEA include exploratory and delineation drilling, seismic survey activities (2D, 3D, Wide Angle Azimuth surveying, vertical seismic profiling, geohazard surveys), geotechnical surveys, and wellsite abandonment. The focus of the SEA will be on offshore exploration activities (and interactions with the environment of those activities) which are under the jurisdiction of the CNSOPB. The SEA will describe where data and information are lacking, or limited. Suggestions for strategies to address data gaps will be identified.

6.2 SPATIAL AND TEMPORAL BOUNDARIES

The spatial boundary for exploration activities to be considered in the Phase 2A and Phase 2B SEAs is shown in Figure 1. The boundaries for the study areas will take into consideration the Operational Policy Statement entitled “The Process for Defining the Spatial Boundary of a Study Area During an Environmental Assessment of Offshore Exploratory Drilling Projects” (CEA Agency 2003).

The SEAs will include the offshore petroleum exploration activities, as described in the preceding section, which may occur within the SEA Project Area as a result of future Call for Bids. The SEAs will be reviewed in at least five years to determine validity.

6.3 FACTORS TO BE CONSIDERED

This section outlines the Valued Environmental Components (VECs) to be assessed in the SEAs and includes rationale for the inclusion of each of these components. Appendix A describes those components that will not be considered in the SEA because experience and research has shown that they are unlikely to be significantly adversely affected by petroleum exploration activities. Rationale for the exclusion of these components, and specific mitigation that must be implemented to allow for their exclusion in the SEAs, are also included in Appendix A. These exclusions are considered outside the scope of the SEAs and do not require assessment.

6.3.1 Valued Environmental Components

Each VEC (including components or subsets thereof) will be identified and the rationale for its selection provided. VECs could include “Species of Special Status”, “Special Areas”, “Fisheries”, and “Other Ocean Uses” in the vicinity of the study area since these categories appear to cover environmental components to be potentially adversely affected by offshore hydrocarbon exploration activities.

Species of Special Status

Species of special status includes consideration of the following species and their critical habitat which may be present in the SEA study area and determined to be potentially affected during exploration activities: species designated as at-risk under the *Species at Risk Act* (SARA); species assessed as endangered, threatened, or of special concern by the Committee on the Status of Endangered Wildlife of Canada (COSEWIC) and/or migratory birds protected by the *Migratory Birds Convention Act, 1994*. These are expected to include, but may not be limited to, loggerhead turtle, fin whale, northern bottlenose whale, blue whale, Sowerby’s beaked whale, grey seal, sperm whale, coral/sponges, and migratory birds.

Special Areas

Designated areas of special interest due to their ecological and/or conservation sensitivities (*i.e.*, marine protected areas, existing or future coral conservation zones, fish conservation areas, *etc.*) could be potentially affected by exploration activities in the SEA study area. At a minimum, this discussion will include consideration of the Misaine Bank and Eastern Shoal former Area of Interest candidate, the St. Ann’s Bank Area of Interest (AOI), the Gully Marine Protected Area (MPA), Northern Bottlenose Whale Critical Habitat (Haldimand and Shortland Canyons) and ecologically and biologically significant areas (EBSAs) (*e.g.*, nearby canyons, corals and sponges). The scope of the VEC also includes the inhabitants of the special area which may not be covered under the species of special status VEC.

Fisheries

Commercial, recreational and aboriginal fisheries (including relevant fish species) that could be affected by exploration activities in the SEA study area will be considered. The focus of the assessment of this VEC is on potential disruptions to commercial fishing activities, including aboriginal fisheries interests as applicable, through environmental effects on fisheries resources, displacement from current or traditional fishing areas, or gear loss or damage resulting in a demonstrated financial loss to commercial fishing interests. Key fisheries to consider, but not limited to, in the area include shrimp, snow crab and other crab fisheries, offshore clam (surf clam on Banquereau Bank), large pelagics (*e.g.*, tunas, swordfish, sharks), and halibut and other groundfish.

Other Ocean Uses

Other ocean uses that could be affected by exploration activities in the SEA study area (*i.e.*, marine shipping, military use, research surveys, and other petroleum development activities, *etc.*) will also be considered.

6.3.2 Scope of the Factors to be Considered

Each SEA will include the following:

- Historical overview of offshore petroleum exploration activities in the study area and a discussion of regional offshore oil and gas activities in the Nova Scotia offshore area;

- Overview of typical offshore petroleum exploration activities (well site surveys, vertical seismic profiling, 2D/3D/3D WAZ seismic, geotechnical programs, exploration drilling (including onshore to offshore drilling),well abandonment) and methods to carry out these activities (including a brief description of various types of rigs and vessels);

- Overview of the physical and biological environments in the SEA study area based on existing information and data, with data gaps highlighted;

- Overview of other marine activities in the SEA study area (*e.g.*, commercial and recreational fisheries, aboriginal fisheries, marine transportation);

- Identification and qualitative assessment of potential environmental interactions of the VECs with petroleum exploration activities;

- Identification of mitigation measures and monitoring that might be considered in project-specific EAs for offshore activities to minimize residual effects, highlighting specific or "non-typical" mitigation that may be required to address specific concerns especially those proposed for any species of special status, migratory birds, or special areas identified within or adjacent to the SEA study area. This may include mitigation required in addition to that which is listed in the Statement of Canadian Practice with Respect to the Mitigation of Seismic Sound in the Marine Environment, for example;

- Discussion of potential planning implications/considerations (*i.e.*, need for additional data, special mitigation) which may have to be considered in project-specific EAs within the SEA study area;

- General discussion of effects and mitigation of potential accidental events and malfunctions associated with offshore oil and gas exploration activity; and

- General discussion of potential cumulative environmental effects associated with multiple offshore human use activities in the study area based on past, present and an estimate of potential future human use activity.

The SEAs will consider the environmental factors and issues outlined in Sections 6.3.3-6.3.5, as a minimum, with emphasis upon factors unique to the SEA study areas. Sufficient supporting information will be provided, or referenced and summarized if it already exists in publicly available publications. Substantive uncertainties or information gaps will be identified.

6.3.3 Potential Exploration Activities - Environment Interactions

For each of the identified VECs, a description of the interactions of petroleum exploration activity with the environment will be presented. Proposed activities include:

- Seismic surveying;
- Seabed surveying (*i.e.*, geophysical, geotechnical data collection);
- Vertical seismic profiles (VSPs);
- Exploratory/delineation drilling (*e.g.*, mobile offshore drilling unit (semi- submersible or drill ship)) and ancillary activities;
- Vessel traffic (*e.g.*, supply vessels, seismic vessels, helicopters); and
- Well abandonment operations.

Potential project interactions include, but are not limited to the following:

- Underwater noise (*e.g.*, during seismic surveying, seabed surveying, drilling) issues (*e.g.*, hearing loss, behavioural effects, *etc.*) on species of special status, migratory birds, and commercial fish species;
- Effects (*e.g.*, smothering, toxicity) of operational discharges (*i.e.*, drill wastes) on Species of Special Status, and commercial fish species, particularly bottom-dwelling fish and shellfish species;
- Interference with fisheries and other ocean uses during routine operations (*i.e.*, seismic surveying, seabed surveying, drilling) and/or accidental events (*e.g.*, large oil spill, blow-out);
- Attraction (due to lights and/or flares) of migratory birds or bird species of special status to platform structures or support vessels; and
- Effects of accidental events (*e.g.*, large condensate spill) on all VECs.

6.3.4 Cumulative Exploration Activities - Environment Interactions

Cumulative environmental effects will be examined in consideration of the past, present and potential future petroleum activities in the SEA study area and mitigation measures identified. Planned and reasonably foreseeable exploration activities will be included in the cumulative environmental effects assessment and it will also consider other non-petroleum activities ongoing in the SEA study area (and adjacent Shelf and Slope areas) such as commercial fishing, marine traffic, and fisheries research surveys.

6.3.5 Effects of the Environment on the Project

For exploration activities identified, the SEA will include a discussion of the physical environmental conditions which could potentially affect exploration activities, including earthquakes, tsunamis, turbidity current, and significant storm (severe winds and waves) events within the SEA study area.

7.0 Conclusions and Recommendations

Based on the information presented in the physical and biological environment overview, the description of potential exploration activities-environment interactions and the application of mitigation measures, conclusions will be presented and planning approaches recommended for the CNSOPB to consider in the issuance of exploration licenses in the SEA study areas. Data gaps with potential to affect the validity of these conclusions will be highlighted. It is anticipated that any data gaps identified are unlikely to compromise the ability to identify the likelihood of potentially significant impacts with an adequate level of certainty for this assessment. Should project-specific EAs be conducted in areas where data gaps are identified in this, or other, studies, these data gaps will need to be addressed at the project-specific EA level. Sensitive issues, particularly those of public concern identified during the SEA process, will also be highlighted.

8.0 Consultations

Throughout the development of the SEAs, the CNSOPB and its contractor will consult with federal government departments, the fishing industry and other ocean users, and local non-governmental organizations. Information on the SEA process will be provided and stakeholders will be encouraged to discuss issues and concerns that are relevant to the SEA study areas and SEA objectives. SEA documents will be posted on the CNSOPB Public Registry.

It is anticipated that the final draft SEAs will be published for public/stakeholder review and comment for a 6-week period commencing mid-January 2013. Comments received will be considered by the CNSOPB, and the SEAs revised as appropriate, with final SEA documents published in April 2013.

APPENDIX A

Components and Activities Outside of the Scope

The following components are proposed to be excluded from the scope of the SEA process based on limited interactions and/or standard mitigation.

I) Air Quality

Emission sources from the proposed project are seismic and other survey/support vessels and drilling rigs. It is anticipated that emissions from routine exploration-related operational activities will not cause an exceedence(s) of applicable air quality standards or guidelines. Since there are limited emissions sources and few receptors (if any) in the SEA study area, and given the short duration of exploration projects, assessment of potential effects on air quality can be excluded from the SEA and EAs provided that future licenses holders/operators adhere to:

- MARPOL Annex VI, Regulations for the Prevention of Air Pollution from Ships; and
- Air Emissions provisions of the Offshore Waste Treatment Guidelines, including submissions of greenhouse gas emissions.

However, malfunctions and accidental events (*i.e.*, blow-out) may have an environmental effect on air quality. An environmental assessment of the potential effects of air quality as a result of a blow-out on VECs proposed in Section 6.3 (*i.e.*, Species of Special Status, Special Areas, Fisheries, and Other Ocean Uses) is the appropriate focus for this assessment rather than “Air Quality” per se. Assessment of the environmental effects of malfunctions and/or accidental events is required as is stated in Section 6.3.

II) Water Quality

Assessment of the potential environmental effects of discharges from platforms/vessels on water quality during routine exploration activities can be excluded from the SEA and EAs provided that future leaseholders/operators adhere to:

- Nova Scotia Offshore Area Petroleum Geophysical Regulations;
- Offshore Waste Treatment Guidelines; and
- *Fisheries Act* (Section 36).

Compliance with the above requirements involves implementation of standard mitigation and will prevent adverse environmental effects on water quality for routine operations. However, malfunctions and accidental events (*i.e.*, oil spills) may have an environmental effect on water quality. An environmental assessment of the potential effects on water quality as a result of oil spills on VECs proposed in Section 6.3 (*i.e.*, Species of Special Status, Special Areas, Fisheries) is the appropriate focus for this assessment rather than Water Quality per se. Assessment of the environmental effects of malfunctions and/or accidental events is required as is stated in Section 6.3.

III) Fish

Fish species of special status, important feeding, nursery, and/or spawning grounds for fish, and commercial and Aboriginal fisheries resources are addressed under relevant VECs (Species of Special Status, Special Areas, and Fisheries VECs) and assessed as stated in Section 6.3. Fish species which are not species of special status, don't support fishery resources or other fish species of special status, and are not present in such abundance for a special area to be designated for that species, are excluded from the SEA and EAs provided that future licenses holders/operators adhere to:

- Statement of Canadian Practice with Respect to the Mitigation of Seismic Noise in the Marine Environment (SOCP).

The SOCP was developed as a result of an extensive review by federal and provincial government advisors and scientific experts of the most effective and appropriate mitigation measures used world-wide to minimize adverse environmental effects on marine life. Compliance with the SOCP will result in minimization and/or avoidance of adverse residual environmental effects on marine fish and other marine life.

IV) Marine Benthos

Discharges of drilling mud and rock cuttings during exploration drilling can result in burial or toxic effects on the marine benthos. Based on past environmental effects monitoring results and other research studies, these effects are understood to be limited spatially and temporally. However, in recognition of sensitive and/or commercially important benthic species that may occur within the SEA study area (*e.g.*, sponges, corals scallop, clam, quahog, crab, shrimp, and sea cucumber), these effects will be assessed in the Special Areas and Fisheries VECs, respectively, as stated in Section 6.3. No further assessment of marine benthos is required at this time.

V) Marine Mammals and Sea Turtles

As stated in Section 6.3, the potential for environmental effects on marine mammal and/or sea turtle Species of Special Status that may occur within the SEA study area, as well as those species that may occur in nearby designated environmentally sensitive areas will be assessed under the Species of Special Status VEC and Special Areas VEC respectively. Provided that appropriate mitigation is applied for species of special status, it is not anticipated that exploration activities will have an adverse environmental effect at the population level for secure populations of marine mammals or sea turtles.

No further assessment beyond that stated in Section 6.3 will be required provided that:

- The proponent adheres to mitigation measures outlined in the Statement of Canadian Practice with Respect to the Mitigation of Seismic Noise in the Marine Environment for marine mammals and sea turtles.

As stated in Section 6.3, the proponent should note that additional mitigation may be required following the conduct of a project-specific EA.

VI) Seabirds

It is recognized that the attraction of any avian species to lights on platforms/vessels or to flares during drilling operations/well testing, may cause injury or death from collisions or may disrupt migrations. An environmental assessment of the potential adverse environmental effects on avian species of special status (including migratory birds) will be carried out under the Species of Special Status VEC, as outlined in Section 6.3. Population level effects on seabirds, however, are not anticipated.

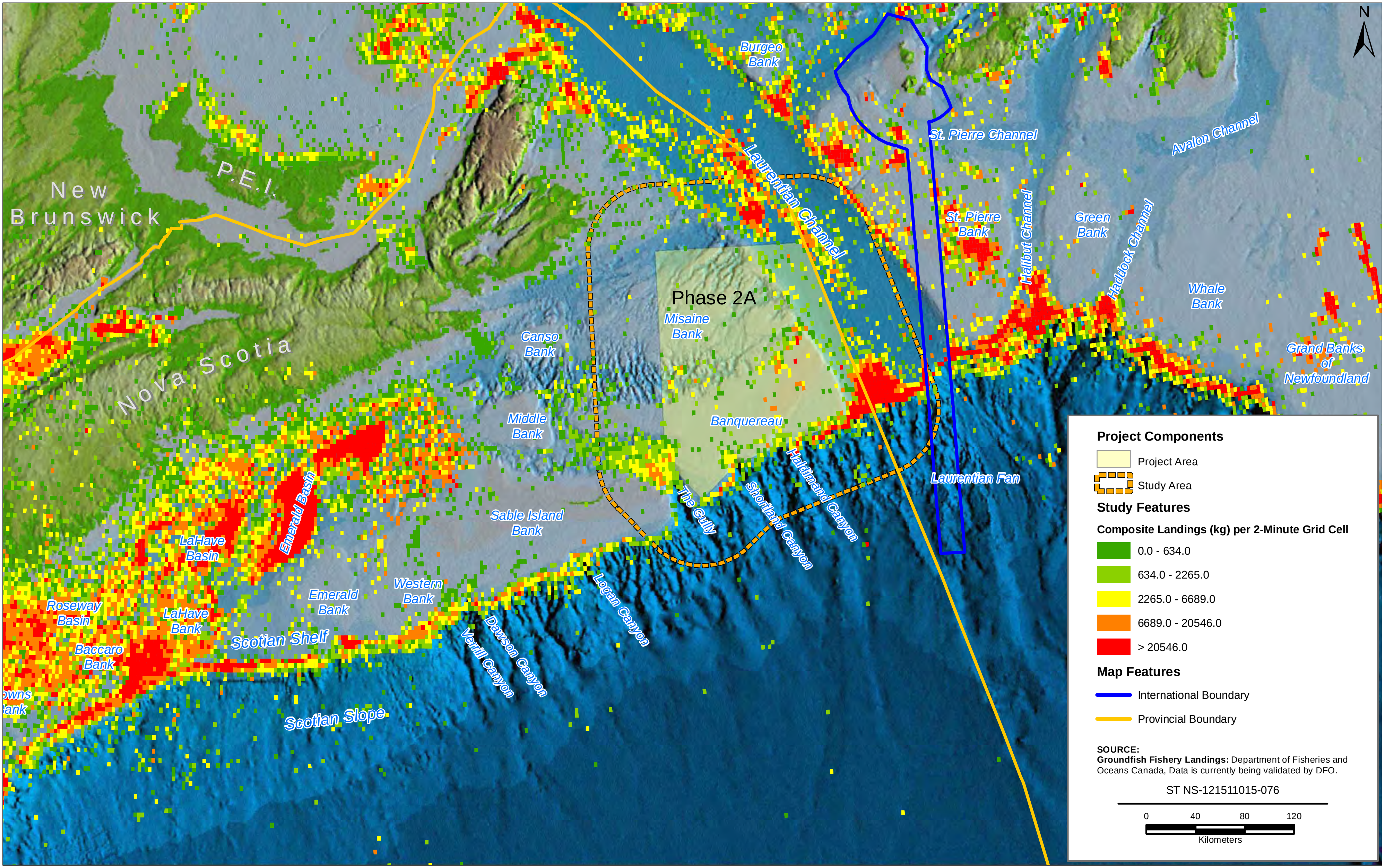
As stated in Section 6.3, the proponent should note that additional mitigation may be required following the conduct of a project-specific EA.

No further assessment of environmental effects on seabirds not assessed in Section 6.3 shall be required, provided that:

- The SEA and EAs consider the potential impacts of vessel lights/flares on avian species of special status (including migratory birds) and identify any necessary mitigation measures (*i.e.*, should birds land on vessels involved with the project, then implementation of the Williams and Chardine handling protocol brochure entitled “The Leach’s Storm Petrel: General Information and Handling Instructions” should be carried out. A permit is required from the Canadian Wildlife Service of Environment Canada to implement this protocol).

APPENDIX B

Composite Fishery Landings Maps



SOURCE:
Groundfish Fishery Landings: Department of Fisheries and Oceans Canada, Data is currently being validated by DFO.

PREPARED BY:
M. Huskins-Shupe

REVIEWED BY:
C. Shupe

CLIENT:
Canada - Nova Scotia Offshore Petroleum Board

Eastern Scotian Shelf - Misaine and Banquereau Bank Strategic Environmental Assessment

Groundfish, All Gear Types, 2006-2010

FIGURE NO.:
1

DATE:
Dec 07, 2012

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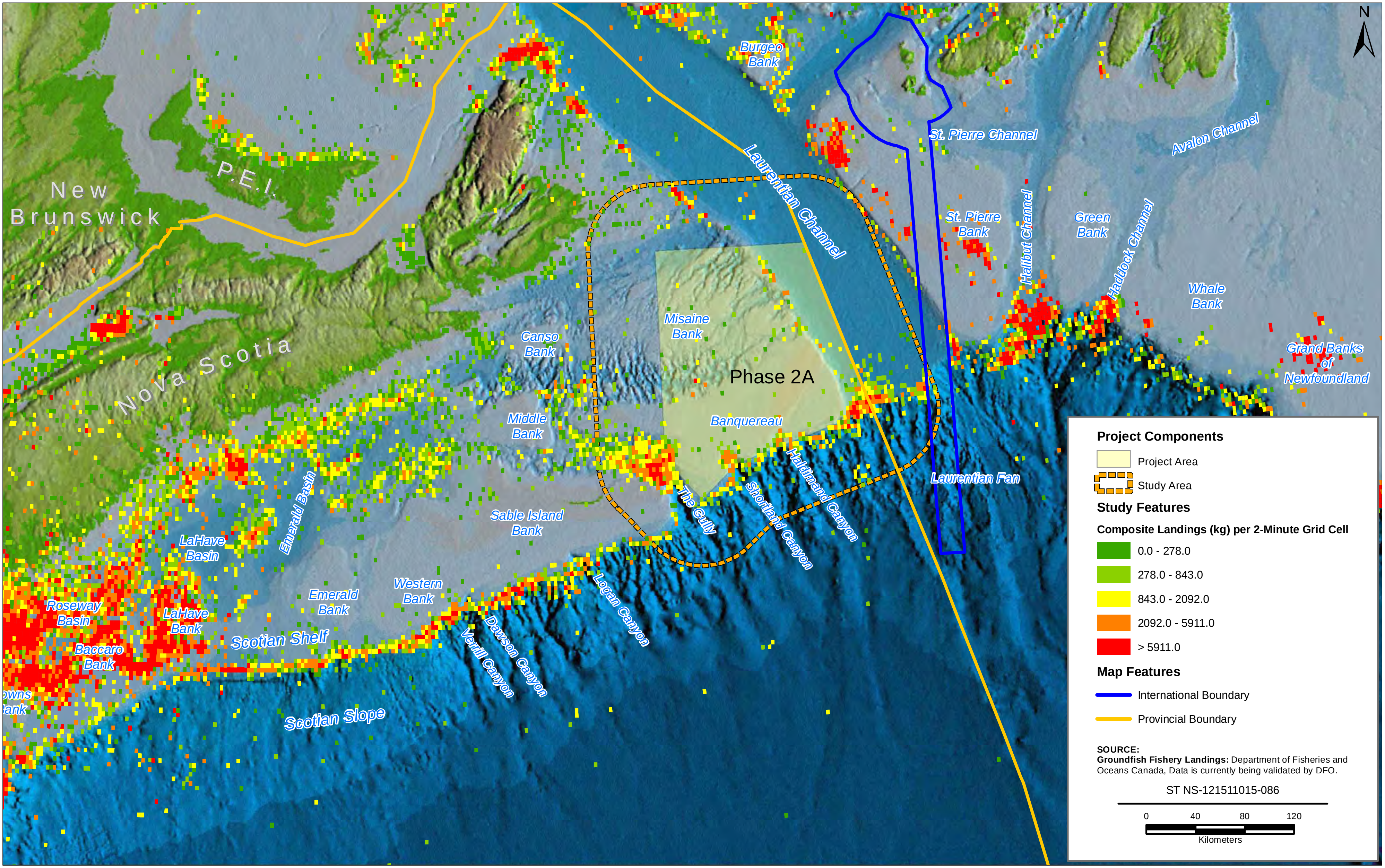

SOURCE:
Groundfish Fishery Landings: Department of Fisheries and Oceans Canada, Data is currently being validated by DFO.

ST NS-121511015-086

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Groundfish, Longline, 2006-2010

FIGURE NO.:
2

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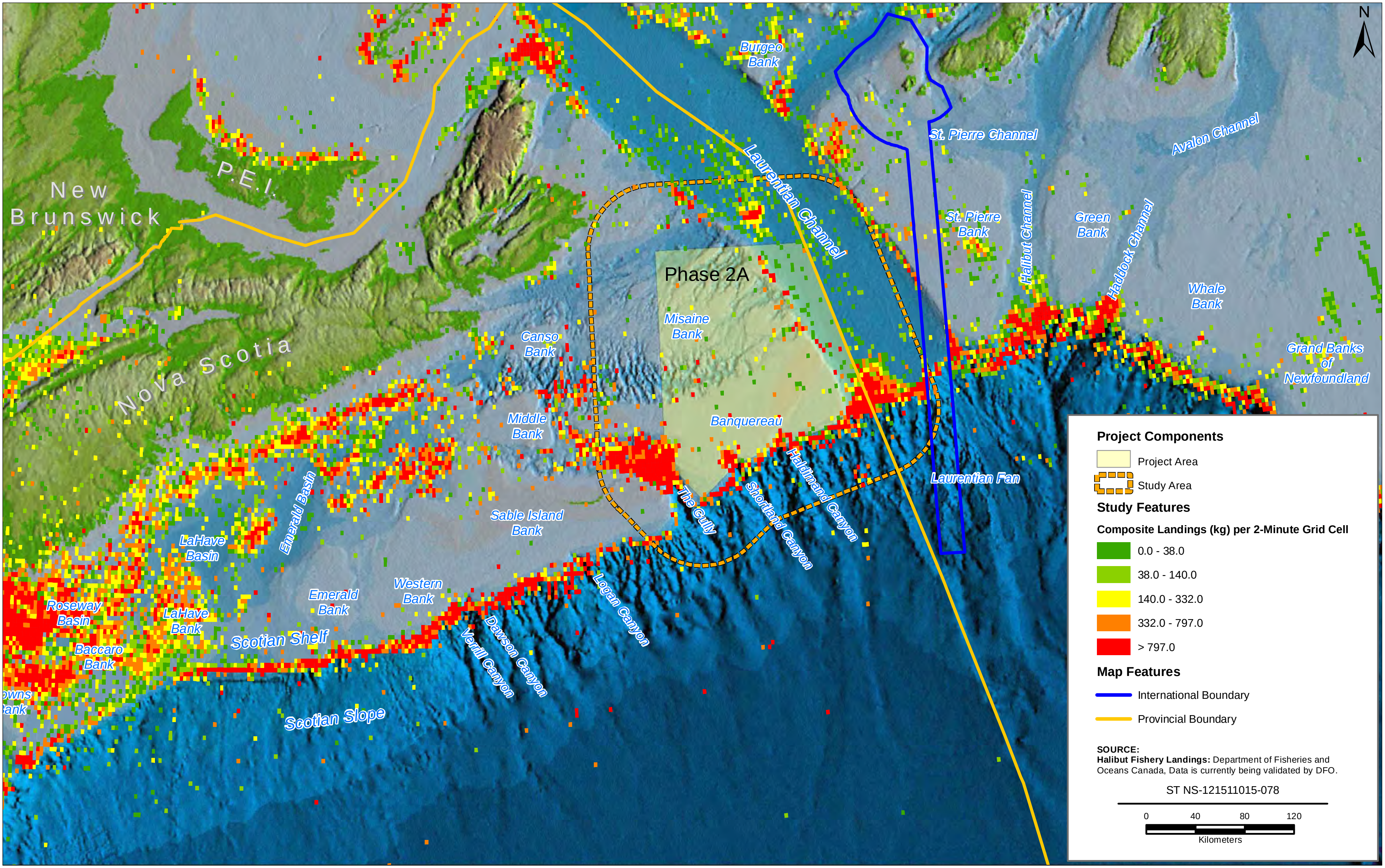

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Halibut Fishery Landings: Department of Fisheries and Oceans Canada, Data is currently being validated by DFO.

ST NS-121511015-078

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Halibut, 2006-2010

FIGURE NO.:
3

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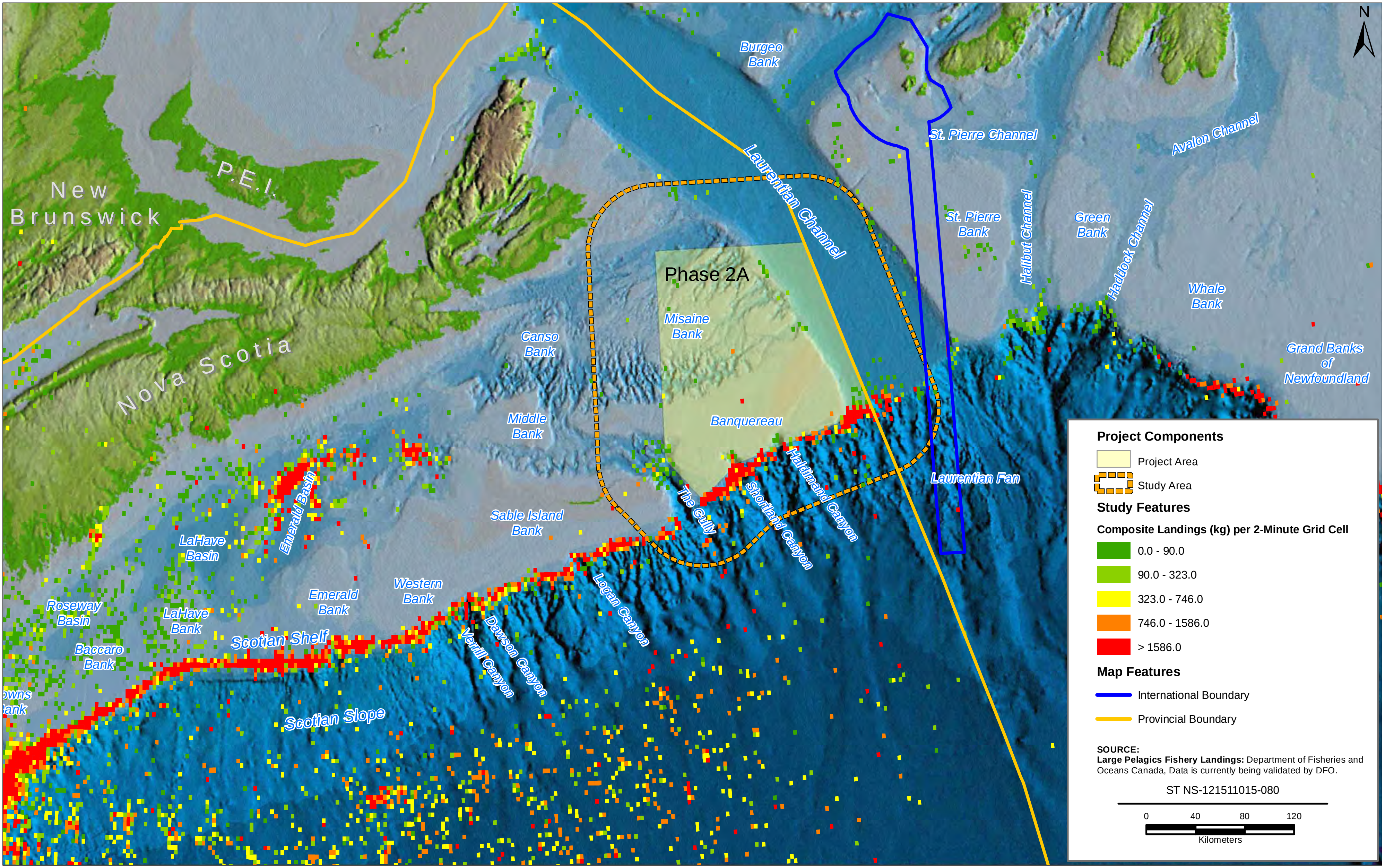

SOURCE:
Large Pelagics Fishery Landings: Department of Fisheries and Oceans Canada, Data is currently being validated by DFO.

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REVIEWED BY:
C. Shupe

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Eastern Scotian Shelf - Misaine and Banquereau Bank Strategic Environmental Assessment

Large Pelagics, 2006-2010

FIGURE NO.:
4

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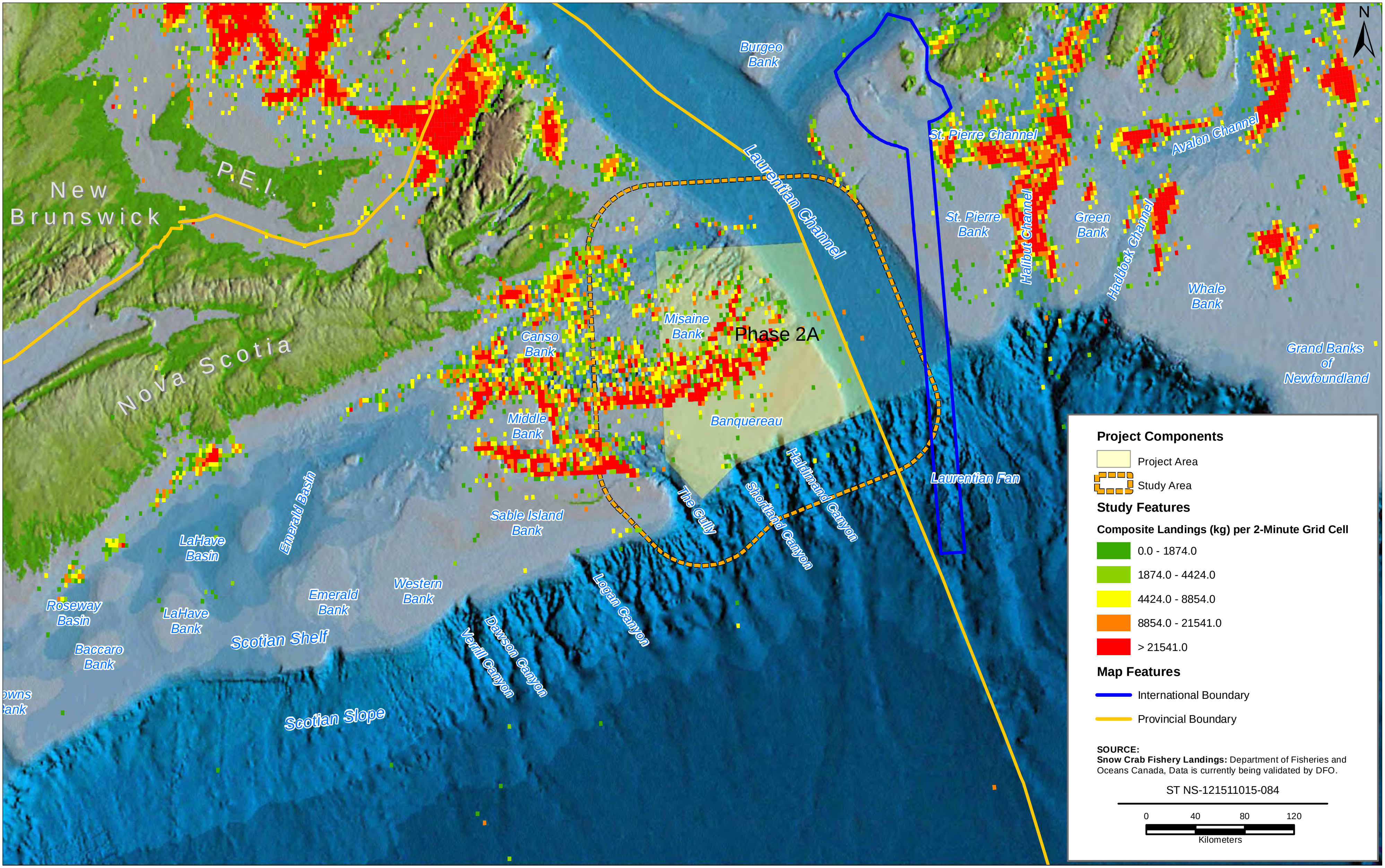

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ST NS-121511015-084

PREPARED BY: M. Huskins-Shupe	Eastern Scotian Shelf - Misaine and Banquereau Bank Strategic Environmental Assessment	FIGURE NO.: 5
REVIEWED BY: C. Shupe		DATE: Dec 07, 2012
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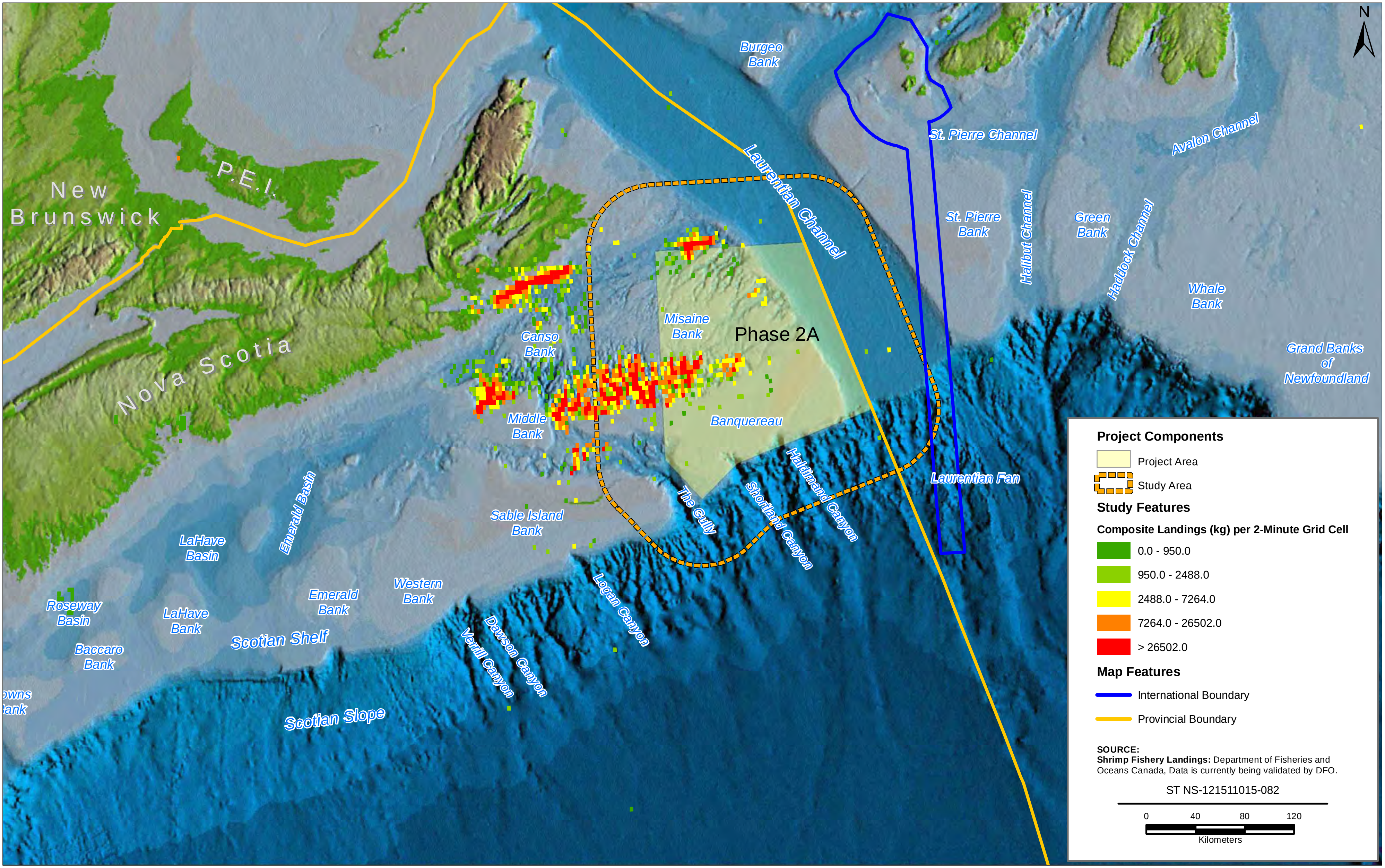

SOURCE:
Shrimp Fishery Landings: Department of Fisheries and Oceans Canada, Data is currently being validated by DFO.

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C. Shupe

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Eastern Scotian Shelf - Misaine and Banquereau Bank Strategic Environmental Assessment

Shrimp, 2006-2010

FIGURE NO.:
6

DATE:
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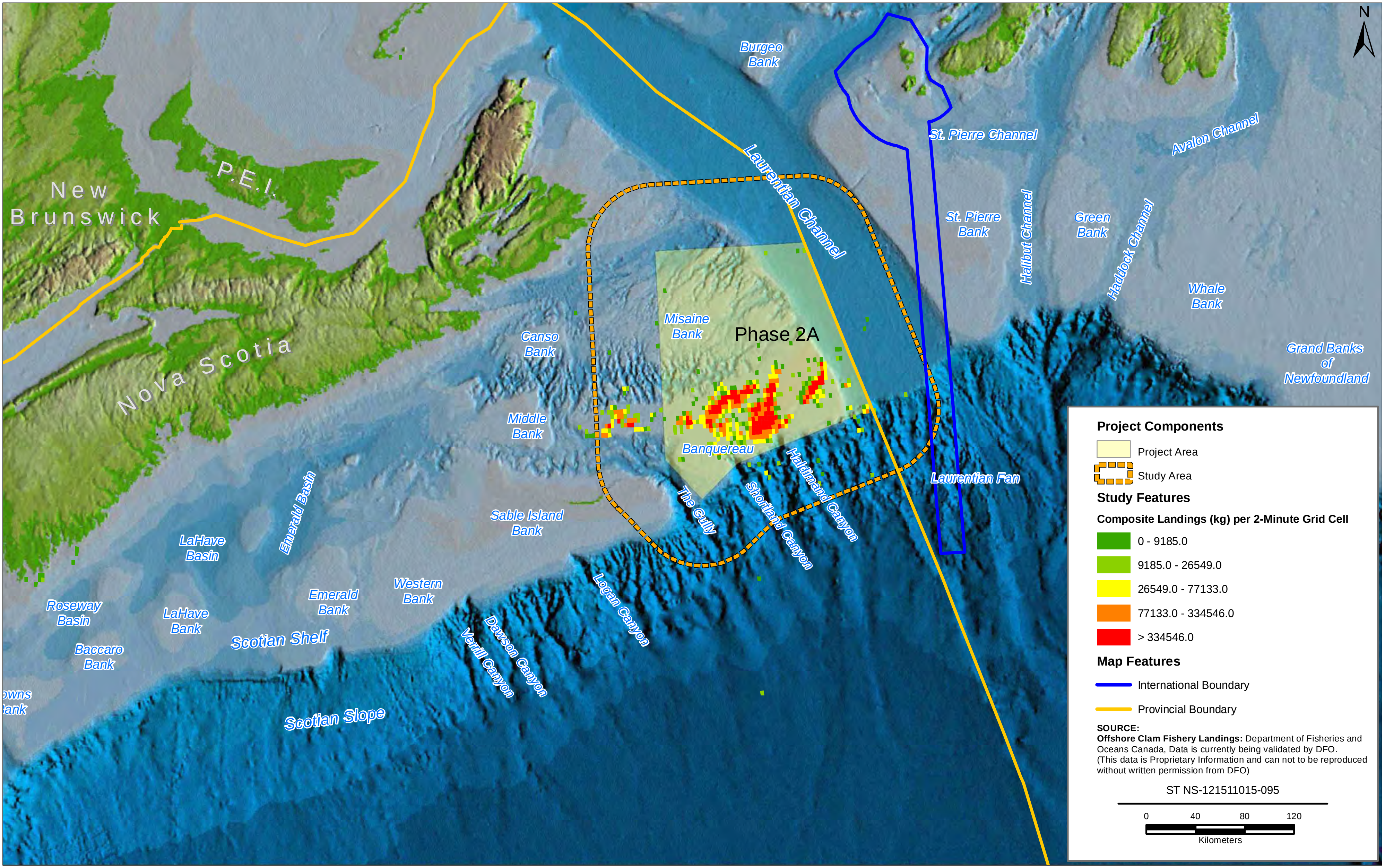

SOURCE:
Offshore Clam Fishery Landings: Department of Fisheries and Oceans Canada, Data is currently being validated by DFO.
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ST NS-121511015-095

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Eastern Scotian Shelf - Misaine and Banquereau Bank Strategic Environmental Assessment

Offshore Clam, 2006-2010

FIGURE NO.:
7

DATE:
Dec 07, 2012

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APPENDIX C

Eastern Canada Seabirds at Sea (ECSAS) Standardized Protocol for Pelagic Seabird Surveys from Moving and Stationary Platforms (Gjerdrum *et al.* 2012)

Environment Canada Environnement Canada

www.ec.gc.ca

Eastern Canada Seabirds at Sea (ECSAS) standardized protocol for pelagic seabird surveys from moving and stationary platforms

Carina Gjerdrum, David A. Fifield, and Sabina I. Wilhelm

Atlantic Region

Canadian Wildlife Service
Technical Report Series Number 515

Canada

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EASTERN CANADA SEABIRDS AT SEA (ECSAS) STANDARDIZED PROTOCOL FOR PELAGIC SEABIRD SURVEYS FROM MOVING AND STATIONARY PLATFORMS

Carina Gjerdrum[1], David A. Fifield[2], Sabina I. Wilhelm[2]

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April 2012
Canadian Wildlife Service
Atlantic Region

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A copy of this report can be obtained by contacting:
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Aussi disponible en français

ABSTRACT

Marine birds play an important role in marine ecosystems and their responses to oceanographic variability can be used to monitor changes in the marine environment. To understand their roles and to identify and minimize human impacts on birds at sea, data on their offshore distributions and abundance are required. Numerous methods are employed throughout the world's oceans to study seabirds at sea from ships, but for studies to be comparable, methods have to be standardized. In Atlantic Canada, data were collected between 1966 and 1992 under PIROP (Programme Intégré de Recherches sur les Oiseaux Pélagiques), but there was no systematic monitoring of birds at sea after the mid-1980s. In 2005, the Canadian Wildlife Service of Environment Canada re-initiated the pelagic seabird monitoring program in eastern Canada (Eastern Canada Seabirds at Sea; ECSAS) and developed a survey protocol based on those used elsewhere in the Atlantic. We record birds observed along a line transect, scanning a 90^o arc to one side of the ship, and follow the recommended snapshot approach for flying birds (Tasker et al. 1984). Distance sampling methods are incorporated to address the variation in bird detectability. This method allows the estimation of seabird densities. In this report we describe the general methods we use to conduct seabird surveys at sea, and then provide detailed instructions on how to fill out each data field. We also provide worked examples for surveys from moving and stationary platforms. It is our hope that this report will serve as a guide for other such studies in the Atlantic and beyond so that comparisons of seabird communities can be made among regions and between research organizations.

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1. INTRODUCTION

1.1 History of pelagic seabird surveys in eastern Canada

Gathering systematic information on the pelagic distribution of seabirds in eastern Canadian waters was pioneered by R.G.B. Brown (Canadian Wildlife Service; CWS) through PIROP (Programme Intégré de Recherches sur les Oiseaux Pélagiques), a joint initiative between the Canadian Wildlife Service and P. Germaine at l'Université de Moncton. Data collection under PIROP occurred from the late 1960s until the early 1990s, with the bulk of the data collected during the 1970s. In addition to doing much of the field work, R.G.B. Brown published extensively on the oceanographic factors that influence seabird distribution (e.g., Brown 1970, 1976, 1979, 1985), and produced a series of atlases summarizing the seasonal distribution and abundance of seabirds in the northwest Atlantic (Brown et al. 1975, Brown 1977, 1986). In the early 1990s, A.R. Lock (CWS) organized the PIROP data into one database and published a Gazetteer, which re-mapped the pelagic distribution of seabirds throughout the northwest Atlantic, with special emphasis on abundance and distribution of seabirds vulnerable to marine oil pollution (Lock et al. 1994). The PIROP database has since been used to examine seabird migration, seasonal moult, and the abiotic factors that influence seabird distribution (Huettmann 2000, Huettmann and Diamond 2000, 2001a,b, 2006).

The PIROP database continued to be relied on heavily well after data collection had ceased, particularly as it related to environmental assessments and impact statements associated with increasing offshore oil and gas activities and the high chronic oiling rates of seabirds reported along the east coast (Wiese and Ryan 2003, Lucas and MacGregor 2006). By the early 2000s, it became evident that current data were required to fill substantial spatial and temporal gaps in the database, and that a revival of a pelagic seabird survey program was necessary. An important step toward this implementation was to develop a standardized survey protocol.

1.2 Development of the standardized protocol

Early PIROP surveys were based on 10 min observation periods during which all birds observed were recorded, regardless of their distance from the moving vessel. These surveys were designed to gather information on the relative abundance and distribution of seabirds, and the short recording periods allowed observations to be related to the variable oceanographic conditions of the area (Brown et al. 1975). Following a review of survey methods by Tasker et al. (1984), PIROP surveys after 1984 recorded birds observed within a 300 m band transect, scanning a 90^o arc to one side of the ship. This change in protocol allowed the estimation of densities (i.e., birds per square kilometer) but the protocol did not adopt the recommended snapshot approach for flying birds, which often move faster than the ship and thus inflate estimates of local density (Tasker et al. 1984, Gaston et al. 1987). During the re-vitalization of the pelagic seabird survey program for the Canadian east coast in the early 2000s, A.R. Lock recommended that CWS seek pan-Atlantic coordination and develop survey protocols based on those used by the European Seabirds At Sea (ESAS) group. This was successfully established with the help of K. Camphuysen, past chair of the ESAS group, who generously provided materials and at-sea training on current seabird survey practices in the North Sea.

Standardised data collection among institutes of various countries bordering the North Sea began in the early 1980s, with the establishment of the ESAS database. Early surveys focused on assessing the vulnerability of certain areas to surface pollutants and were therefore designed to collect data that allowed the mapping of relative abundance and distribution of seabirds at sea (see Camphuysen 1996 for review). More recently, surveys in the North Sea have evolved to include the collection of detailed behavioural data, with considerable interest in foraging behaviour of individuals (Camphuysen and Garthe 2004). The methods require extensive training and practice for an observer to gain proficiency in identifying and recording the 92 codes for behaviour and association, in addition to the flight direction data, and were deemed too detailed for the proposed pelagic seabird survey program in eastern Canada. Therefore, a selection of behavioural and association codes taken from the ESAS protocol have been implemented along with the general methods used by European observers, to develop the standardized protocol presented in this report. This protocol will allow for direct comparison with data collected currently in the northeast Atlantic.

We developed a standardized protocol for surveys conducted from two types of observation platform, moving (e.g., oceanographic research or platform supply vessels) and stationary (e.g., oil production rig or supply vessel on stand-by). The protocol for surveys conducted aboard moving platforms was modelled after Tasker et al. (1984), and the protocol for stationary platforms was adapted from methods described in Tasker et al. (1986) and Baillie et al. (2005). Distance sampling methods were included to address variation in bird detectability and to allow for calculation of correction factors to account for missed birds (Buckland et al. 2001). We also reduced the observation period length from 10 min to 5 min in order to obtain more precise spatial information for each bird sighting. This change does not, however, affect our ability to compare seabird densities to those surveys that use longer observation periods. The Eastern Canada Seabirds at Sea (ECSAS) program has used this survey protocol, with minor modifications, in eastern Canada since 2006 (Gjerdrum et al. 2008, Fifield et al. 2009), during which time almost 80,000 km of transect have been surveyed and 144,000 birds counted. In this report, we describe the general methods we use to conduct surveys, and then describe each data field in detail. A series of appendices provide distance estimation equations, data field coding details, example surveys and blank datasheets.

2. GENERAL REQUIREMENTS FOR SEABIRD OBSERVERS

Seabird observers collecting data on pelagic seabird occurrence and behaviour for the ECSAS program are required to use this standardized protocol. It is also strongly recommended (and may be required) that each observer participate in a training workshop. The workshop includes instruction on boat safety, survey methods, distance sampling, and seabird identification. Instruction takes place in a classroom, although students will also be expected to train with an experienced observer at sea. Students will be evaluated in their understanding of the recording methods and seabird identification. As trips can last anywhere between three days and six weeks and travel in a variety of environmental conditions, observers can expect to stand for long periods of time, often under arduous conditions. Limited space on board the vessels may also require observers to share living areas. To ensure the highest quality of data is collected, observers should have the following:

- Experience working with seabirds and a strong knowledge of their behaviour and ecology
- Ability to rapidly identify Atlantic seabirds in all plumages, in various lighting conditions, reduced visibilities, and in rough ocean conditions

- Ability to follow the ECSAS protocol for surveying seabirds at sea
- Ability to accurately record data on data sheets (or electronically) according to protocol, including information on vessel, weather conditions, and birds
- Ability to work independently
- Experience travelling in boats and an ability to work in rough sea conditions without getting seasick
- Good communication skills and the ability to live and work closely with ship's crew and staff for extended periods of time

3. DISTANCE SAMPLING: THE IMPORTANCE OF RECORDING DISTANCES TO BIRDS

3.1 Introduction to Distance Sampling

A crucial question to address in any survey program is that of detection probability. It is well known that some birds will be missed by even the best observer due to sea and weather conditions, vessel characteristics, observer fatigue, etc. (Buckland et al. 2001). The question is, how many? If we do not account for detectability we are forced to assume that all animals within the survey transect are detected, which will underestimate abundance, perhaps drastically. In that case, all we can produce are (likely biased) indices of relative abundance. Relative abundance indices are difficult to compare between surveys, years, observers, etc. when variation in detectability is not assessed (i.e., failure of the assumption of constant proportionality) (Norvell et al. 2003).

Distance sampling is a powerful technique that allows us to estimate the proportion of birds present that are actually detected (i.e., detection probability) and to automatically factor this into abundance calculations (Buckland et al. 2001). Distance sampling is based on the premise that the likelihood of detecting a bird decreases the further away it is from the observer. Likewise, detectability varies by species and environmental conditions.

The subsequent data analysis involves the use of specialized software called Distance (Thomas et al. 2010). The software works by comparing the number of birds actually observed within each distance class with the number that would have been counted if every bird had been detected. If all birds present were detected, then on average there should be equal numbers of birds in each equal-size distance class[†]. This is the same as saying that birds in all distance classes have equal detection probability (Figure 2a). In reality, this never happens. Bird detectability and thus the number in each distance class decreases with distance from the observer. This can readily be seen by simply plotting the number of birds actually observed in each distance class as a histogram. The histogram in Figure 2b shows a typical data set where detection probability decreases with distance. The smooth dark line is a curve that has been fit to the histogram. A correction factor, called the detection probability, is computed by dividing the area under the curve by the area of the entire dashed rectangle. The distance sampling software does this and thus computes abundance, taking birds that were missed into account. Note that detectability will also be affected by other factors including the identity and behaviour of the species, weather conditions, sea state, and observer, all of which the software factors into the analysis (Thomas et al. 2010).

[†] Distance automatically adjusts for distance classes of unequal width.

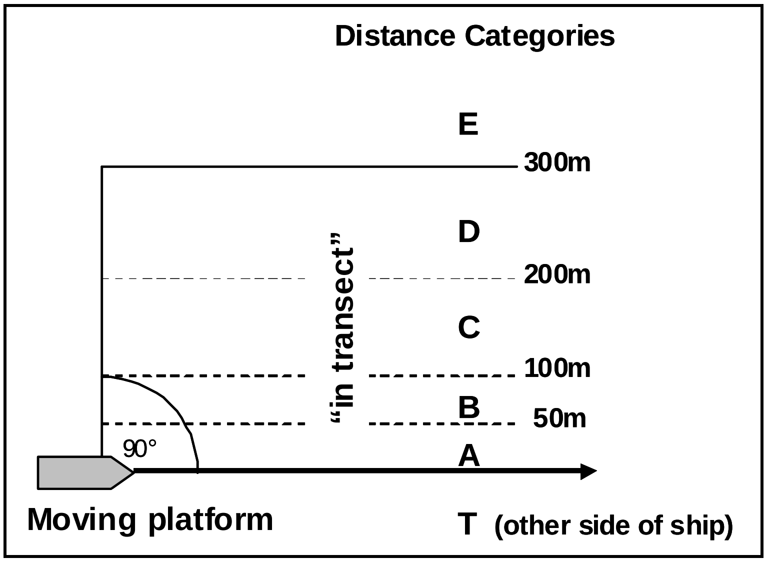


Figure 1. Illustration of a survey using a 90° scan, covering a 300 m transect from a moving platform. All birds observed within this transect, whether flying or on the water, are recorded. The perpendicular distance from the line to birds detected on the water or in flight is estimated. Birds observed outside the transect are normally also recorded if this does not affect observations within the transect. Distance categories "E" and "T" are both considered not in transect. See Section 4 for details of distance measurements.

For distance sampling to work, all the observer has to do is estimate the distance to each flock of birds, which we do in distance classes or "bins" (Figure 1). Note that the mathematical framework requires that the observer records the *perpendicular* distance from the ship's track line to each flock (Figure 1). Imagine extending a 300 m long "yardstick" perpendicular to the ship, counting each flock and estimating its distance as it passes under the stick. In this way, a 300 m wide rectangular swath of ocean is surveyed as the ship proceeds. In reality, it is often necessary to estimate the perpendicular distance before the ship reaches a flock of birds because they are in flight or to ensure that birds on the water are not displaced by the ship (see section 4.1).

3.2 Analysis assumptions

Distance sampling produces unbiased density estimates while depending on only a small set of assumptions (Thomas et al. 2010). These include: 1) all birds on the line (i.e., within the first distance class) are detected, 2) birds are neither attracted to nor displaced by the survey platform before being detected (requires looking well ahead of the vessel for some species) and 3) distances are measured accurately. The first assumption is due to the internal mathematics used by the software to compare the relative numbers of birds in each distance class. If many birds in distance class "A" are missed, then the computed probability of detection will be artificially high, resulting in an underestimate of abundance. It is therefore extremely important to ensure that all birds in the first bin are detected. However, a balance of effort is required so that observers are not concentrating so much on birds that are close to the vessel that they will miss other more distant birds. In order to avoid violating the third assumption, observers are also required to look well ahead of a moving platform to detect birds before they dive or fly away.

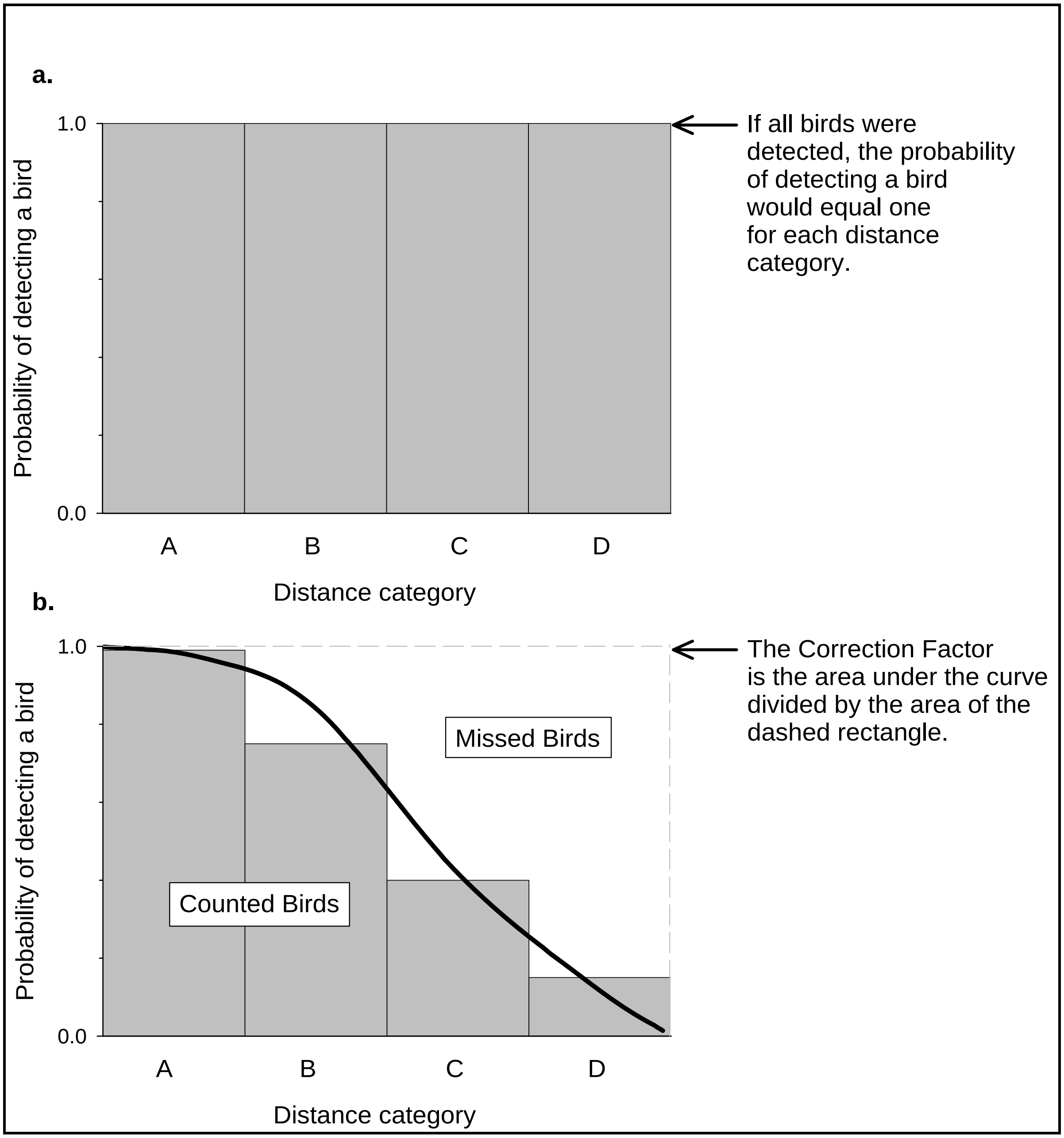


Figure 2. Typical example showing how the histogram would look if (a) all birds were detected, and (b) detectability of birds decreasing with increasing distance. The correction factor is computed as the area under the curve divided by the area of the entire dashed rectangle.

4. GENERAL METHODS FOR SEABIRD SURVEYS

4.1 Surveys from moving platforms

Surveys are conducted while looking forward from the moving survey platform, scanning at a 90^o angle from either the port or starboard side (Figure 1). The transect is continuously surveyed by eye to count and identify birds present in air or on water. Binoculars are used to confirm species identification, and other details, such as age, moult, and behaviour. Observers scan ahead regularly (e.g., every minute) to detect birds that may dive as the ship approaches. If large concentrations of birds in the transect fly off as the ship approaches, binoculars can be used to help count individuals, and these birds are recorded as being on water. Priority is given to birds observed in transect (Figure 1). Birds not in transect are also important and are recorded if these observations do not interfere with observations of birds in transect.

A survey consists of a series of 5 min observation periods, which are exclusively dedicated to detecting birds. As many consecutive 5 min observation periods are conducted as possible, regardless if birds are present or not, and consistent coverage throughout the day is encouraged. The transition between observation periods may take one or two minutes, in order to record the vessel's position and any conditions that may have changed since the last 5 min observation period (see Section 5.1 on recording observation period information). Transits longer than two hours may need to be broken up to avoid observer fatigue.

Surveys are best conducted when the platform is travelling at a minimum speed of 4 knots (7.4 km/h) and a maximum of 19 knots (35.2 km/h). Surveys can be done when the ship is travelling less than 4 knots, but birds are often attracted to slow moving or stationary vessels. If birds are clearly gathering around the vessel and settling on the water when the ship is moving at decreased speeds (i.e., less than 2 knots), cease your observations. If the ship is no longer moving at all, switch to the protocol used for stationary surveys (section 4.2). When visibility is poor due to rain or fog and the entire width of the 300 m transect is not visible, surveys from moving platforms can still be conducted, however, observers must record the width of the transect that is visible during the survey (e.g., 200 m) in the "Notes" section of the record sheet (see Appendix X for blank record sheets). When no birds are detected during a 5 min period, it is important to record "No birds observed" on the datasheet. If vessel speed or direction changes significantly during an observation period, record the time and location of termination and begin a new observation period.

Observers should practice estimating the locations of the various distance bands. This is best accomplished with a distance gauge made from a transparent plastic ruler (see Appendix I). This gauge should be kept close at hand to quickly verify bird distances.

4.1.1. Detecting and recording bird sightings

One of the primary goals of pelagic surveys is to quantify bird distribution and abundance. To do this, we need estimates of density, which is the number of birds occupying a prescribed area of ocean surface at any given instant in time. During a 5 min observation period, a 300 m wide rectangular area of ocean will be covered (see Figure 1, Appendix VII), the length of which is determined by ship speed. For example, for a ship traveling at 10 knots, the rectangle will be 300 m wide and approximately 1500 m long. To compute bird density, it would be ideal to be able to count all birds that occur within this rectangle *at a single instant in time,* before they swim or fly away, giving a measure of birds/km^2. Since we do not have the ability to see the entire area simultaneously, birds must be counted as the ship approaches them.

4.1.2. Recording birds on the water

All birds observed on the sea surface are continuously recorded throughout the 5 min period and their perpendicular distance from the observer is estimated (Figure 1). If a bird appears to have been flushed off the water, it is counted as a bird on water and not subsequently counted as a flying bird during a snapshot – see below. Observers scan ahead regularly (e.g., every minute) to detect birds that may dive as the ship approaches.

4.1.3. Recording birds in flight

During the observation period, more birds will fly through the survey area than were present in that area at a single instant in time (Tasker et al. 1984). The faster the birds fly relative to the ship's speed, the greater the number of birds will pass through the transect area during a 5 min period. If these flying birds are counted continuously as they are encountered, their density will be overestimated by an amount that is proportional to the relative speeds of the bird and observer (Tasker et al. 1984, Spear et al. 1992). Therefore, flying birds are recorded using a series of instantaneous counts, or snapshots, at regular intervals along the transect (see Appendix VII for an example). The time interval between snapshots depends on the speed of the ship and is chosen so that the ship moves roughly 300 m between snapshots (Table 1). For example, if the platform is moving at a speed of 10 knots, snapshots will occur every minute for the duration of the 5 min observation period. At the time of the snapshot, all flying birds within the transect and up to 300 m ahead of the observer are counted (Figure 1, Appendix VII). In this way, the entire survey transect is covered by a series of instantaneous snapshots. During each snapshot, flying birds are recorded as in transect only if they are within 300 m to the side or 300 m ahead of the vessel (Figure 1). All other flying birds that are seen beyond 300 m OR between snapshot intervals are recorded as not in transect. Birds recorded not in transect (or not in semi-circle for stationary surveys) provide important information on distribution, timing of occurrence, and behaviour, and effort should be made to record them if at all possible. Nothing is recorded if no birds are observed during the snapshot. *It is important to remember that all 5 min observation periods begin with a snapshot of flying birds.*

Table 1. Intervals at which instantaneous snapshot counts of flying birds are conducted from a moving platform.

Platform Speed (knots)	Interval between counts (min)
< 4.5	2.5
4.5 - 5.5	2
5.5 - 8.5	1.5
8.5 - 12.5	1
12.5 - 19	0.5

4.1.4. Lines of flying birds

Some species (e.g., murres (*Uria* spp.), Northern Gannets (*Morus bassanus*)) may fly in long lines across the survey area. At the time of the snapshot, the number of birds in the flock is counted and the distance class is assigned according to the location of the centre of the flock. All the birds are recorded as in transect if the centre of the flock is within the 300 m transect. If the centre of the group is beyond 300 m, they are recorded as not in transect, despite some individuals being within 300 m (see Appendix VII).

4.1.5. Large numbers of birds

When very large numbers of birds are encountered that overwhelm the observer's ability to count and measure the distance to individual flocks (this does not include typical ship-followers circling the ship), snapshots (of all birds whether in flight or on water) are conducted rather than continuous counts. Snapshot intervals are the same as those used to count flying birds (Table 1). At the time of the snapshot, all the birds that occur within 300 m of the observer (perpendicular to, as well as ahead of the observer) are counted, but the flying birds are not separated from those on the water. Another count does not occur until the next snapshot interval when the ship has travelled another 300 m. Although it is not practical to estimate distance to each bird, you should indicate whether the birds were observed within 300 m (see Section 5.2). If the majority of the birds are in the air, they can be recorded as flying. However, if they appear to be flushing off the surface of the water as the ship approaches, or continuously moving between the water and air, they are recorded as on the water. When such large flocks are recorded in this way, it is important to indicate the change in protocol in the notes. This scenario is a relatively rare occurrence. Most of the time, distance estimates can be made and flying birds can be separated from those observed on the water.

4.1.6. Birds that follow the ship

After recording a flying bird, it is not subsequently recorded again if it is following the ship. The same bird is not recorded on subsequent snapshots, even if it leaves and then re-enters the survey area. When dozens or more birds are following the vessel, it will be impossible to determine which individuals have already been recorded and which have recently joined the ship. For example, Northern Fulmars (*Fulmarus glacialis*) at times circle the ship in large numbers and as far out as the edge of the transect and beyond. In this case, the number of birds following the ship is estimated at regular intervals (i.e., once an hour) and their association as ship followers (code 18; Appendix VI) is recorded. The ship followers are ignored at intervals between counts. If it can be determined that new individuals are joining the flock, these are recorded and their distance from the observer is estimated.

4.2. Surveys from stationary platforms

Observations from stationary platforms (including ships stopped on station or on standby) are conducted using instantaneous counts, or snapshots, of birds within an area that is scanned at regular intervals throughout the day. These surveys will usually last only a few seconds. The survey is conducted from a position outdoors whenever possible, as close to the edge of the platform as permitted. A position near the edge will increase the detection rates of birds, especially for birds that use the waters at the base of the platform. If surveys are being conducted from a stationary platform such as an oil drilling rig, observers should scan from the same location each time in order to increase the comparability among scans.

Surveys are conducted by scanning a 180^o arc, giving priority to birds within a 300 m semi-circle (Figure 3). Observers should practice estimating the locations of the various distance bands prior to beginning observations. This is best accomplished with a distance gauge made from a transparent plastic ruler (see Appendix I). This gauge should be kept close at hand to quickly verify bird distances. The area is visually swept only once per scan, from one side to the other, and all birds on the water and in flight are systematically recorded at that time. The distance to birds from the observer is estimated and recorded for all birds (Figure 3). Binoculars and spotting scopes can be used to confirm species identification and other details as necessary.

The same area is surveyed once every hour during the day, regardless if birds are present or not. When the entire width of the 300 m semi-circle is not visible, the observer indicates the limit of visibility on the data sheet. When no birds are detected during a scan, it is important to record “No birds observed” on the record sheet.

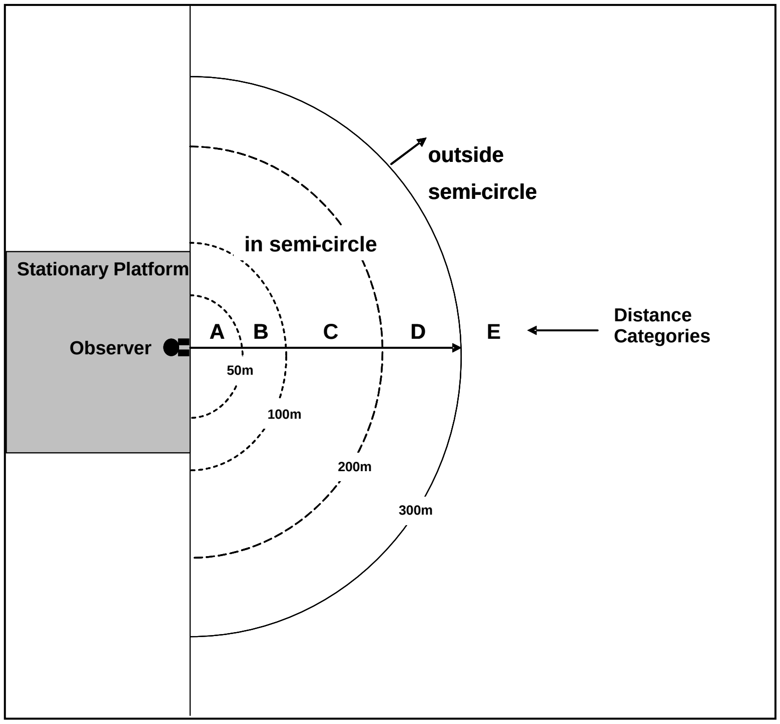


Figure 3. Illustration of survey using a 180^o scan, surveying an area 300 m from a stationary observer. All birds observed within this area, whether flying or on the water, are recorded. Birds visible beyond 300 m are also important and are recorded, if at all possible. The distances to all birds are estimated. Birds observed outside the 300 m semi-circle are recorded as not in semi-circle.

5. DATA RECORDING

This section provides detailed information on recording information during each observation period. See Appendix X for example data sheets. Section 5.1 describes the data fields that must be filled in for each 5-minute observation period. Section 5.2 describes the fields recorded for each bird sighting.

5.1 Observation Period Information

It is important to fill in all the fields under the heading “Observation period information” for moving platform surveys, or “Scan information” for stationary surveys at the beginning of each survey. The information collected here may affect which birds are observed and therefore will be important to incorporate into any subsequent analyses.

Company/agency: Seabird observers may be volunteers or contracted through private industry or government agency. Indicate the company, agency or organisation that has requested the surveys (e.g., Canadian Wildlife Service, ExxonMobil, Memorial University).

Platform name and type: Platform type may include seismic ship, offshore supply vessel, fishing boat, research ship, ferry, etc.

Observer(s): Indicate the first and last name of the primary observer. Also record the name of any additional observers assisting with the survey.

Date: Record the date that the survey took place. Use format DD-MMM-YYYY (e.g. 12-Apr-2008) to avoid ambiguity.

Time at start / Time at end: Record the time (using 24 h notation) at the start and end of the observation period. Use Universal Time (UTC) to standardize across regions. Note that the conversion from local time to UTC will be influenced by daylight savings time.

Latitude and longitude at the start and end of the observation period: Indicate position of platform in either decimal degrees (e.g. 47.5185) or degrees and decimal minutes (e.g. 47˚ 31.11´) depending on which format is available to you.

Platform activity: Platform activity may influence observations and should therefore be noted. Activities could include steaming, seismic array active, drilling, off-loading at drilling rig, etc.

Scan type (for stationary platforms only): Conduct a 180˚ scan for all stationary surveys. If part of the survey area is obstructed, indicate the scan angle used.

Scan direction (for stationary platforms only): Indicate the true (not magnetic) bearing when looking straight ahead, at centre of semi-circle.

Visibility: Measure visibility by determining the greatest distance at which you can distinguish objects, ideally black, against the horizon sky with the unaided eye. Under normal atmospheric conditions, visibility depends only on the height above the sea surface from which it is observed (visibility in kilometres = 3.84 * sqrt(height in meters)). For example, on a clear day on a vessel 12 m above the surface, maximum visibility will be 13 km. Visibility will be considerably less during foggy conditions.

Weather conditions: Record the general weather conditions at the time of the survey according to codes in Appendix II. Record the most prominent conditions within the survey area. For example, if there are distant fog patches that do not directly affect the survey conditions, the weather code will be 0 or 1. Alternatively, if there is < 50% cloud cover but you are travelling through fog patches, the weather code will be 2.

Glare conditions: Light reflecting off the surface of the water can often influence bird detection. Record the glare conditions at the time of the survey according to codes in Appendix II.

Sea state code: Sea state codes give an approximate description of current conditions on the surface of the water. Use codes from Appendix III.

Wave height: Estimate wave height (m) from the highest point of a wave (peak) to the lowest point (trough).

Wind speed or force: Indicate wind speed in knots. If observations are from a moving platform, be sure to record the TRUE wind speed, as this takes into account the ‘apparent’ wind generated from the forward momentum of the vessel. If relative wind speed is the only measurement available, indicate that you are recording relative wind speed so that appropriate adjustments can be made later. If no measurements are available, estimate wind speed using Beaufort codes from Appendix III.

Wind direction: Wind direction is the direction from which a wind originates. If observations are from a moving platform, be sure to record the TRUE wind direction, as this takes into account the ‘apparent’ wind generated from the forward momentum of the vessel. If relative wind direction is the only measurement available, indicate that you are recording relative wind direction so that appropriate adjustments can be made later. Use ***ND*** (No Direction) if the wind direction is variable or too light to indicate a particular direction.

Ice Type and Concentration: If ice is present during the survey, indicate the type and concentration using codes from Appendix IV. Indicate in the notes if the ice is present only beyond the transect limits.

Platform speed and direction (for moving platforms only): Record the platform speed in knots and the true (NOT magnetic) platform direction. If the platform speed or direction changes significantly during an observation period, terminate the observation period and record the time and position of termination. Start a new observation period, recording the new speed and/or direction.

Observation side (for moving platforms only): Circle whether you are surveying from ***Starboard*** or ***Port***.

Height of eye (meters): Indicate height of observer's eye above the water in meters. This measurement is important to calibrate distance categories (Appendix I) and may need to be measured with a measuring tape or rope.

Outdoors or Indoors: Circle ***Out*** when conducting observations from a position outdoors and ***In*** for indoor observations.

With snapshot? (for moving platforms only): Indicate if snapshot method is being used for birds in flight by circling ***Y*** or ***N***. Under normal circumstances, snapshots should always be used for birds in flight.

Notes: Make note of disturbances or relevant activities in the area, especially if there are large vessels or fishing activities nearby, or if your vessel is sounding the fog horn.

5.2 Bird Information

At a minimum, the species (which can be unknown), count, fly or water, and in transect (or in semi-circle, if doing stationary surveys) fields MUST be filled in for each sighting. Note that some fields are only appropriate for certain species. For example, age and sex will only be recorded for species where this can be determined (e.g., ageing gulls or sexing waterfowl). Priority is given to birds that are in transect, since these are the only birds that are used in density estimates. Birds recorded not in transect or not in semi-circle give us important information on distribution, timing of occurrence, and behaviour, and effort should be made to record them if time permits.

Species: Identify each individual bird seen to species. If this is not possible, identify to genus or family. Record all unknowns, even if they are identified only as "unknown gull" or "unknown bird". See Appendix V for a list of commonly used species codes. See Section 5.2.1 for information on recording mixed species/age flocks. When garbage is encountered within the survey area, it should be recorded as GARB. Marine mammals, fish and sharks should also be recorded if possible.

Count: Record the number of birds in each sighting in the count field. Record homogenous flocks on a single line. For example, a group of 10 Common Murres (*Uria aalge*) close together on the water is recorded in a single row as a flock of 10 and not as 10 individual rows. If large numbers are present, estimate the number as accurately as possible.

Fly or Water?: Indicate whether the bird(s) observed is in flight (***F***) or on the water (***W***). Occasionally you will have a songbird that may land on the ship. We record these as on the ship (***S***). When surveying close to land, birds sitting on land may be recorded as ***L***.

In transect or semi-circle?: Indicate if bird observed is in (***Y***) or out (***N***) of the transect (moving) or semi-circle (stationary). See Section 5.2.2 for more details. Give priority to birds that are in the transect or semi-circle. Record birds seen outside the transect if activity levels permit.

Association and Behaviour: Record one or more association and/or behaviour codes with each bird when appropriate (see Appendix VI for association and behaviour codes, and refer to Camphuysen and Garthe (2004) for further information).

Distance: Record the distance to each bird or flock. This information is used to assess detectability and account for missed birds (see Section 3). For all birds, estimate the perpendicular distance between the bird(s) and the observer (Figure 1). Distance categories are as follows: ***A*** = 0-50 m, ***B*** = 51-100 m, ***C*** = 101-200 m, ***D*** = 201-300 m, and ***E*** = > 300 m. Record flocks of birds as a single unit by recording the distance to the ***centre*** of the flock. For example, if a group is straddling the 300 m boundary with the flock centre located in ***D*** (with some individuals inside and some individuals outside the transect) record **the entire flock** as being in ***D*.** If the flock centre is outside the transect, record the entire flock as distance class ***E***. It is very important to record distance to birds within the 300 m strip, but if this is not possible (i.e., too busy), you may use ***3*** = within 300 m but no distance recorded. Distance ***T*** is used to indicate that the bird or flock was observed on the opposite side of the vessel.

Flight direction: Indicate true heading direction (***N***, ***NE***, ***E***, ***SE***, ***S***, ***SW***, ***W***, ***or NW****)* for birds in flight if they are not associated with the platform. If birds are flying erratically such that no one direction is appropriate, record them as ***ND*** **(no direction)**. Note that *ND* is not the same as not recording flight direction. For example, if the data field is left blank, flight direction information was not collected for that sighting. However, if *ND* was recorded for the sighting, that particular bird(s) was flying erratically, in circles, etc.

Age: Record age based on plumage, where ***J***(uvenile) = first coat of true feathers acquired before leaving the nest; ***I***(mmature) = the first fall or winter plumage that replaces the juvenile plumage and may be worn for several years (across multiple moults) until reaching adulthood; and ***A***(dult) = all subsequent plumages.

Plumage: Adult plumage can be further categorized as ***B***(reeding) = spring and summer plumage, or ***NB*** (non-breeding) = fall and winter plumage. ***M*** is used to indicate a bird with flight feathers moulting.

Notes: Record other pertinent information such as color phase, unusual behaviours, etc.

5.2.1 Recording mixed groups of birds

Sometimes flocks of birds will contain multiple species or age classes and will require multiple rows on the datasheet (e.g., a flock containing both Great and Sooty Shearwaters (*Puffinus gravis* and *P. griseus*), or a flock of Black-legged Kittiwakes (*Rissa tridactyla*) containing both adult and immature birds). Subsets of the group that share the same morphological and behavioural characteristics are recorded in the same row (e.g., all adult kittiwakes in breeding plumage flying in the same direction). Other individuals from the group that have different characteristics (e.g., juveniles) are recorded in subsequent rows. Draw an arc linking all rows from the group to indicate that they were together (see example in Appendix VII).

5.2.2 For moving platforms, when are birds recorded as in transect?

Whether birds are in transect or not depends on whether they are on the water or in flight. Birds on the surface of the water within 300 m perpendicular distance from the observer are always considered in transect (Figure 1). When visibility is good, birds on the water may be seen up ahead of the platform, perhaps as far as 400 m or 500 m ahead, but still within the 300 m transect. Because these individuals may dive or fly away as a result of the approaching vessel, they should be counted as in transect and their perpendicular distance recorded when they are first detected (unless the observation period will end before the ship reaches them, in which case they are recorded in the next period). Flying birds are only considered in transect if they are observed during a snapshot AND they are physically within the snapshot block (within 300 m to the side and 300 m ahead of the vessel) (Figure 1, Appendix VII).

6. CONCLUSION

The Eastern Canada Seabirds at Sea (ECSAS) monitoring program uses this protocol to collect distribution and abundance information for birds at sea in Atlantic Canada. The protocol follows recommendations for standardized recording techniques (Tasker et al. 1984) that are used in the North Sea and northeastern Atlantic with modifications to allow for the estimation of bird detectability (Buckland et al. 2001). Although we are far from achieving a global standardization of methods, it is our hope that this report will serve as a guide for others conducting pelagic bird surveys in our region and elsewhere so that comparisons among seabird communities can be made. It is our recommendation that before any surveys are conducted, observers have the skills necessary to identify the seabirds in their survey area, and participate in a training program that includes specific instruction on implementing the protocol. Future modifications of the protocol will be necessary as methods are tested and techniques developed, and we encourage any feedback that will improve upon our current survey approach.

7. ACKNOWLEDGEMENTS

We wish to thank Tony Lock for initializing the development of a standardized protocol for the northwest Atlantic, and Kees Camphuysen for training on European methods for surveying seabirds at sea. We would also like to thank Sue Abbott, François Bolduc, Andrew Boyne, Kees Camphuysen, John Chardine, Nicolle Davis, Richard Elliot, Stefan Garthe, Kathy Kuletz, Bill Montevecchi, Ken Morgan, Greg Robertson, Robert Ronconi, Pierre Ryan, Richard Veit, and Sarah Wong for discussion and providing suggestions on earlier drafts of the protocol. Thanks also to Pierre Ryan and François Bolduc for extensive testing of the protocol, and Kathy Kuletz and Ken Morgan for sharing the seabird survey protocols used within their respective programs.

8. LITERATURE CITED

Baillie, S.M., Robertson, G.J., Wiese, F.K., and Williams, U.P. 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. v + 47 pp.

Brown, R.G.B. 1970. Fulmar Distribution: a Canadian perspective. Ibis 112: 44-51.

Brown, R.G.B. 1976. The foraging range of breeding Dovekies *Alle alle*. Canadian Field-Naturalist 90: 166-168.

Brown, R.G.B. 1977. Atlas of eastern Canadian seabirds Supplement 1, Halifax-Bermuda transects. Canadian Wildlife Service, Ottawa, ON.

Brown, R.G.B. 1979. Seabirds of the Senegal upwelling and adjacent waters. Ibis 121: 283-292.

Brown, R.G.B. 1985. The Atlantic Alcidae at Sea. *In* The Atlantic Alcidae, D.N. Nettleship and T.R. Birkhead, Eds. Academic Press, London.

Brown, R.G.B. 1986. Revised atlas of eastern Canadian seabirds. Bedford Institute of Oceanography, Dartmouth, NS, and Canadian Wildlife Service, Ottawa, ON.

Brown, R.G.B., Nettleship, D.N., Germain, P., Tull, C.E., and Davis, T. 1975. Atlas of eastern Canadian seabirds. Canadian Wildlife Service, Ottawa, ON.

Buckland, S.T., Anderson, D.R., Burnham, K.P., Laake, J.L., Borchers, D.L. and Thomas, L. 2001. Introduction to distance sampling: estimating abundance of biological populations. Oxford University Press. Oxford, UK.

Camphuysen, C.J. 1996. The spatial distribution of seabirds in the North Sea: Towards understanding patterns. Sula 10 (special issue 2): 41-88.

Camphuysen, C.J. and Garthe, S. 2004. Recording foraging seabirds at sea: Standardised recording and coding of foraging behaviour and multi-species foraging associations. Atlantic Seabirds 6: 1-32.

Fifield, D. A., Lewis, K.P., Gjerdrum, C, Robertson, G.J., Wells, R. 2009. Offshore Seabird Monitoring Program. Environment Studies Research Funds Report No. 183. St. John’s. 68 p.

Gaston, A.J., Collins, B.T., and Diamond, A.W. 1987. Estimating densities of birds at sea and the proportion in flight from counts made on transects of indefinite width. Canadian Wildlife Service Occasional Paper 59, p. 1-16.

Gjerdrum, C., Head, E.J.H., and Fifield, D.A. 2008. Monitoring Seabirds at Sea in Eastern Canada. AZMP Bulletin PMZA 7: 52-58.

Heinemann, D. 1981. A range finder for pelagic bird censusing. Journal of Wildlife Management 45: 489-493.

Huettman, F. 2000. Environmental Determination of Seabird Distribution in the Northwest Atlantic, Ph.D. Thesis, University of New Brunswick, Fredericton, NB.

Huettmann, F., & Diamond, A. W. 2000. Seabird migration in the Canadian northwest Atlantic Ocean: moulting locations and movement patterns of immature birds. Canadian Journal of Zoology 78:624-647.

Huettmann, F., & Diamond, A. W. 2001a. Using PCA scores to classify species communities: an example for pelagic seabird distribution. Journal of Applied Statistics 28:843-853.

Huettmann, F., & Diamond, A. W. 2001b. Seabird colony locations and environmental determination of seabird distribution: a spatially explicit breeding seabird model for the northwest Atlantic. Ecological Modelling, 141:261-298.

Huettmann, F., & Diamond, A. W. 2006. Large-scale effects on the spatial distribution of seabirds in the northwest Atlantic. Landscape Ecology 21:1089-1108.

Lock, A.R., Brown, R.G.B., Gerriets, S.H. 1994. Gazetteer of marine birds in Atlantic Canada. Canadian Wildlife Service, Atlantic Region.

Lucas, Z. and MacGregor, C. 2006. Characterization and source of oil contamination on the beaches and seabird corpses, Sable Island, Nova Scotia, 1996-2005. Marine Pollution Bulletin 52: 778-789.

Norvell, R.E., Howe, F.P., Parrish, J.R. 2003. A seven-year comparison of relative-abundance and distance-sampling methods. Auk 120:1013-1028.

Spear, L., Nur, N., and Ainley, D.G. 1992. Estimating absolute densities of flying seabirds using analyses of relative movement. Auk, 109:385-389.

Tasker, M.L., Hope Jones, P., Dixon, T., and Blake, B.F. 1984. Counting seabirds at sea from ships: A review of methods employed and a suggestion for a standardized approach. Auk 101: 567-577.

Tasker, M.L., Hope Jones, P., Blake, B.F., Dixon, T.J., and Wallis, A.W. 1986. Seabirds associated with oil production platforms in the North Sea. Ringing and Migration 7: 7-14.

Thomas, L., Buckland, S.T., Rexstad, E. A., Laake, J.L., Strindberg, S., Hedley, S.L., Marques, T.A., Bishop, J.R.B., and Burnham, K.P. 2010. Distance software: design and analysis of distance sampling surveys for estimating population size. Journal of Applied Ecology 47:5-14.

Wiese, F.K. and Ryan, P.C. 2003. The extent of chronic marine oil pollution in southeastern Newfoundland waters assessed through beached bird surveys 1984-1999. Marine Pollution Bulletin 46: 1090-1101.

APPENDIX I. Estimating distance categories

The various distance categories can be estimated using the following equation[1]:

$$d_h = 1000 \frac{(ah3838\sqrt{h}) - ahd}{h^2 + 3838d\sqrt{h}}$$

e.g. if a = 0.730 m, h = 12.5 m, and d = 300 m

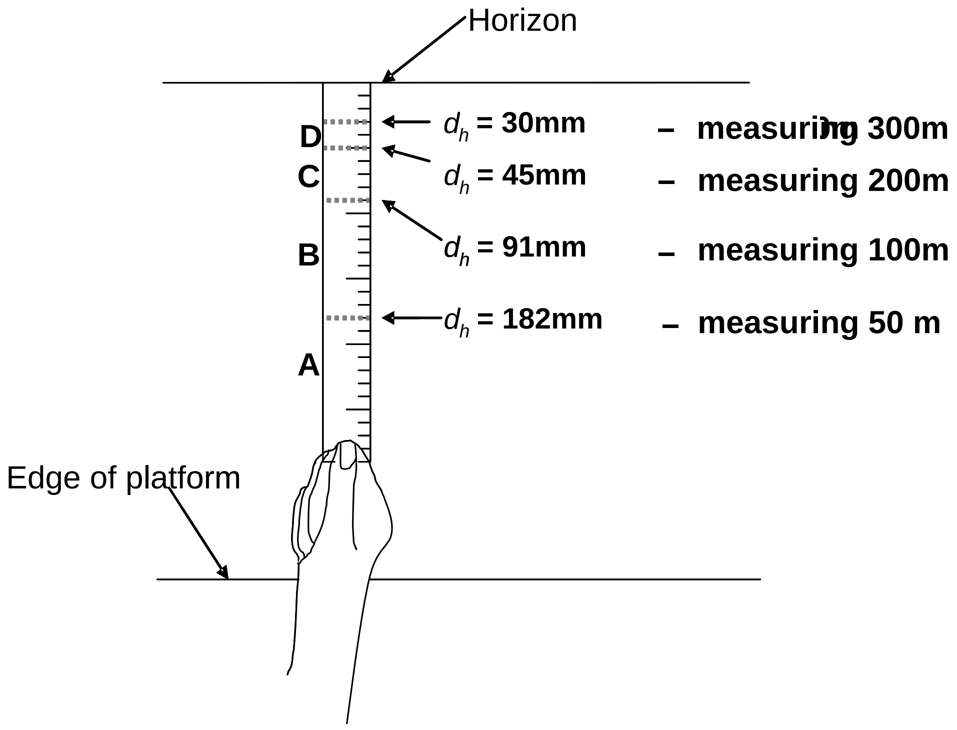
then d_h = 30.0 mm

where:

d_h = distance below horizon (mm)
a = distance between the observer's eye and the ruler when observer's arm is fully out-stretched (m)
h = height of the observer's eye above the water at the observation point (m)
d = distance to be estimated (m; a separate calculation is required for each of 50, 100, 200, 300)

Distances are easily estimated using a gauge made from a transparent plastic ruler. A different ruler will be required for each combination of observer arm length (a) and platform height (h). Calculate d_h for the boundary of each distance class (A, B, C, D) and mark them on the ruler (dashed lines in figure). To use the gauge, extend the arm fully and keep the top end of the ruler aligned with the horizon. The dashed lines now demark the distance class boundaries on the ocean surface. Keep the gauge nearby during surveys to quickly verify bird distances.

Measurements for an observer with a = 73 cm and h = 12.5 m:



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[1] Formula derived by J. Chardine, based on Heinemann 1981. A spreadsheet is available from the corresponding author to perform this calculation.

APPENDIX II. Codes for general weather conditions and glare

Code	Description	Explanation
Weather conditions		
0		< 50% cloud cover (with no fog, rain, or snow)
1		> 50% cloud cover (with no fog, rain, or snow)
2		patchy fog
3		solid fog
4		mist/light rain
5		medium to heavy rain
6		fog and rain
7		snow
Glare conditions		
0		none
1		slight/grey
2		bright on the observer's side of vessel
3		bright and forward of vessel

APPENDIX III. Codes for sea state and Beaufort wind force

Wind Speed (knots)	Sea state code and description	Beaufort wind force and description
0	**0** Calm, mirror-like	**0** calm
01 – 03	**0** Ripples with appearance of scales but crests do not foam	**1** light air
04 – 06	**1** Small wavelets, short but pronounced; crests do not break	**2** light breeze
07 – 10	**2** Large wavelets, crests begin to break; foam of glassy appearance; perhaps scattered white caps	**3** gentle breeze
11 – 16	**3** Small waves, becoming longer; fairly frequent white caps	**4** moderate breeze
17 – 21	**4** Moderate waves with more pronounced form; many white caps; chance of some spray	**5** fresh breeze
22 – 27	**5** Large waves formed; white foam crests more extensive; probably some spray	**6** strong breeze
28 – 33	**6** Sea heaps up; white foam from breaking waves blows in streaks in direction of wind	**7** near gale
34 – 40	**6** Moderately high long waves; edge crests break into spindrift; foam blown in well-marked streaks in direction of wind	**8** gale
41 – 47	**6** High waves; dense streaks of foam in direction of wind; crests of waves topple and roll over; spray may affect visibility	**9** strong gale
48 – 55	**7** Very high waves with long overhanging crests; dense foam streaks blown in direction of wind; surface of sea has a white appearance; tumbling of sea is heavy; visibility affected	**10** storm
56 - 63	**8** Exceptionally high waves; sea is completely covered with white patches of foam blown in direction of wind; edges blown into froth; visibility affected	**11** violent storm
64 +	**9** Air filled with foam and spray; sea completely white with driving spray; visibility seriously affected	**12** hurricane

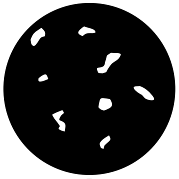
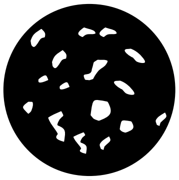
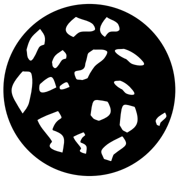
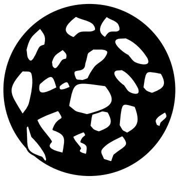
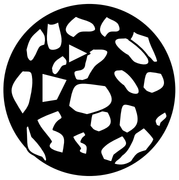
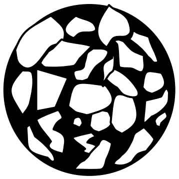
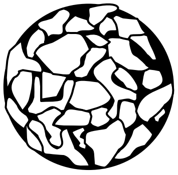
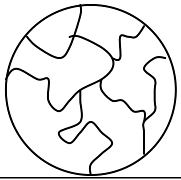
APPENDIX IV. Codes for ice conditions

Adapted from NOAA: Observers Guide to Sea Ice

Sea Ice Forms

Code	Name	Description
0	New	small, thin, newly formed, dinner plate-sized pieces
1	Pancake	rounded floes 30 cm - 3 m across with ridged rims
2	Brash	broken pieces < 2 m across
3	Ice Cake	level piece 2 - 20 m across
4	Small Floe	level piece 20 - 100 m across
5	Medium Floe	level piece 100 -500 m across
6	Big Floe	level, continuous piece 500 m - 2 km across
7	Vast Floe	level, continuous piece 2 - 10 km across
8	Giant Floe	level, continuous piece > 10 km across
9	Strip	a linear accumulation of sea ice < 1 km wide
10	Belt	a linear accumulation of sea ice from 1 km to over 100 km wide
11	Beach Ice or Stamakhas	irregular, sediment-laden blocks that are grounded on tidelands, repeatedly submerged, and floated free by spring tides
12	Fast Ice	ice formed and remaining attached to shore

Sea Ice Concentration

Code	Concentration	Description	
0	< one tenth	"open water"	
1	two-three tenths	"very open drift"	
2	four tenths	"open drift"	
3	five tenths	"open drift"	
4	six tenths	"open drift"	
5	seven to eight tenths	"close pack"	
6	nine tenths	"very close pack"	
7	ten tenths	"compact"	

APPENDIX V. Species codes for birds seen in Eastern Canada

Common name	Species code	Latin name
COMMON, REGULAR OR FREQUENTLY SEEN SPECIES		
Northern Fulmar	NOFU	*Fulmarus glacialis*
Great Shearwater	GRSH	*Puffinus gravis*
Manx Shearwater	MASH	*Puffinus puffinus*
Sooty Shearwater	SOSH	*Puffinus griseus*
Wilson’s Storm-Petrel	WISP	*Oceanites oceanicus*
Leach‘s Storm-Petrel	LESP	*Oceanodroma leucorhoa*
Northern Gannet	NOGA	*Morus bassanus*
Red Phalarope	REPH	*Phalaropus fulicaria*
Red-necked Phalarope	RNPH	*Phalaropus lobatus*
Long-tailed Jaeger	LTJA	*Stercorarius longicaudus*
Parasitic Jaeger	PAJA	*Stercorarius parasiticus*
Pomarine Jaeger	POJA	*Stercorarius pomarinus*
Great Skua	GRSK	*Stercorarius skua*
Herring Gull	HERG	*Larus argentatus*
Iceland Gull	ICGU	*Larus glaucoides*
Glaucous Gull	GLGU	*Larus hyperboreus*
Great Black-backed Gull	GBBG	*Larus marinus*
Black-legged Kittiwake	BLKI	*Rissa tridactyla*
Common Murre	COMU	*Uria aalge*
Thick-billed Murre	TBMU	*Uria lomvia*
Razorbill	RAZO	*Alca torda*
Dovekie	DOVE	*Alle alle*
Atlantic Puffin	ATPU	*Fratercula arctica*
SPECIES MORE COMMONLY SEEN INSHORE		
Common Loon	COLO	*Gavia immer*
Red-throated Loon	RTLO	*Gavia stellata*
Red-necked Grebe	RNGR	*Podiceps grisegena*
Horned Grebe	HOGR	*Podiceps auritus*
Great Cormorant	GRCO	*Phalacrocorax carbo*
Double-crested Cormorant	DCCO	*Phalacrocorax auritus*
Greater Scaup	GRSC	*Aytha marila*
Common Eider	COEI	*Somateria mollissima*
Harlequin Duck	HARD	*Histrionicus histrionicus*
Long-tailed Duck	LTDU	*Clangula hyemalis*
Surf Scoter	SUSC	*Melanitta perspicillata*
Black Scoter	BLSC	*Melanitta nigra*
White-winged Scoter	WWSC	*Melanitta fusca*
Red-breasted Merganser	RBME	*Mergus serrator*
Black Guillemot	BLGU	*Cepphus grylle*

Common name	Species code	Latin name
INFREQUENTLY OR RARELY SEEN SPECIES		
Cory’s Shearwater	COSH	*Calonectris diomedea*
Audubon’s Shearwater	AUSH	*Puffinus lherminieri*
Lesser Scaup	LESC	*Aythya affinis*
King Eider	KIEI	*Somateria spectabilis*
South Polar Skua	SPSK	*Stercorarius maccormicki*
Bonaparte's Gull	BOGU	*Larus philadelphia*
Ivory Gull	IVGU	*Pagophila eburnea*
Black-headed Gull	BHGU	*Larus ridibundus*
Laughing Gull	LAGU	*Larus articilla*
Ring-billed Gull	RBGU	*Larus delawarensis*
Lesser Black-backed Gull	LBBG	*Larus fuscus*
Sabine’s Gull	SAGU	*Xema sabini*
Common Tern	COTE	*Sterna hirundo*
Arctic Tern	ARTE	*Sterna paradisaea*
Roseate Tern	ROTE	*Sterna dougallii*
CODES FOR BIRDS IDENTIFIED TO FAMILY OR GENUS		
Unknown Bird	UNKN	
Unknown Shearwater	UNSH	*Puffinus* or *Calonectris*
Unknown Storm-Petrel	UNSP	Hydrobatidae
Unknown Duck	UNDU	Anatidae
Unknown Eider	UNEI	*Somateria*
Unknown Phalarope	UNPH	*Phalaropus*
Unknown Jaeger	UNJA	*Stercorarius*
Unknown Skua	UNSK	*Stercorarius*
Unknown Gull	UNGU	Laridae
Unknown Tern	UNTE	*Sternidae*
Unknown Alcid	ALCI	Alcidae
Unknown Murre or Razorbill	MURA	*Uria* or *Alca*
Unknown Murre	UNMU	*Uria*

APPENDIX VI. Codes for associations and behaviours

From Camphuysen and Garthe (2004). Choose one or more as applicable.

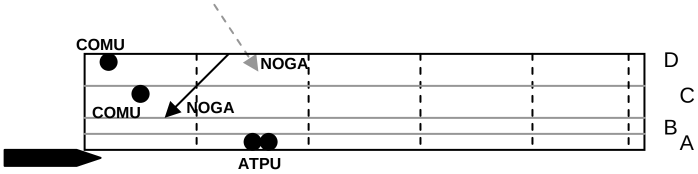
Code	Description
Association	
10	Associated with fish shoal
11	Associated with cetaceans
13	Associated with front (often indicated by distinct lines separating two water masses or concentrations of flotsam)
14	Sitting on or near floating wood
15	Associated with floating litter (includes plastic bags, balloons, or any garbage from human source)
16	Associated with oil slick
17	Associated with sea weed
18	Associated with observation platform
19	Sitting on observation platform
20	Approaching observation platform
21	Associated with other vessel (excluding fishing vessel; see code 26)
22	Associated with or on a buoy
23	Associated with offshore platform
24	Sitting on offshore platform
26	Associated with fishing vessel
27	Associated with or on sea ice
28	Associated with land (e.g., colony)
50	Associated with other species feeding in same location

Code	Description	Explanation
Foraging behaviour		
30	Holding or carrying fish	carrying fish towards colony
32	Feeding young at sea	adult presenting prey to attended chicks (e.g., auks) or juveniles (e.g., terns)
33	Feeding	method unspecified (see behaviour codes 39,40,41,45)
36	Aerial pursuit	kleptoparisitizing in the air
39	Pattering	low flight over the water, tapping the surface with feet while still airborne (e.g., storm-petrels)
40	Scavenging	swimming at the surface, handling carrion
41	Scavenging at fishing vessel	foraging at fishing vessel, deploying any method to obtain discarded fish and offal; storm-petrels in the wake of trawlers picking up small morsels should be excluded
44	Surface pecking	swimming birds pecking at small prey (e.g., fulmar, phalaropes, skuas, gulls)
45	Deep plunging	aerial seabirds diving under water (e.g., gannets, terns, shearwaters)
49	Actively searching	persistently circling aerial seairds (usually peering down), or swimming birds frequently peering (and undisturbed by observation platform) underwater for prey
General behaviour		
60	Resting or apparently sleeping	reserved for sleeping seabirds at sea
64	Carrying nest material	flying with seaweed or other material; not to be confused with entangled birds
65	Guarding chick	reserved for auks attending recently fledged chicks at sea
66	Preening or bathing	birds actively preening feathers or bathing
Distress or mortality		
71	Escape from ship (by flying)	escaping from approaching observation platform
90	Under attack by kleptoparasite	bird under attack by kleptoparasite in an aerial pursuit, or when handling prey at the surface
93	Escape from ship (by diving)	escaping from approaching observation platform
95	Injured	birds with clear injuries such as broken wings or bleeding wounds
96	Entangled in fishing gear or rope	birds entangled with rope, line, netting or other material (even if still able to fly or swim)
97	Oiled	birds contaminated with oil
98	Sick/unwell	weakened individuals not behaving as normal, healthy birds, but without obvious injuries
99	Dead	bird is dead

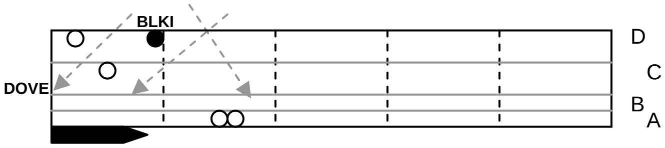
APPENDIX VII. Example 5 min survey from a moving platform[†]

See associated datasheet on pg. 30: We are on a ship travelling east at 10 knots, so in 5 minutes we will travel a distance of approximately 1.5 km. Based on the speed of the vessel, we will conduct a snapshot for flying birds every minute (see Table 1), or 5 times during the survey, and record flying birds detected between snapshots as NOT in transect. In the diagrams that follow, birds on water are represented by dots and flying birds by arrows (birds are at the position of the arrowhead). The vertical dashed lines in the diagrams indicate the boundaries of the 300 m snapshot blocks. Remember, we record the perpendicular distance to all birds.

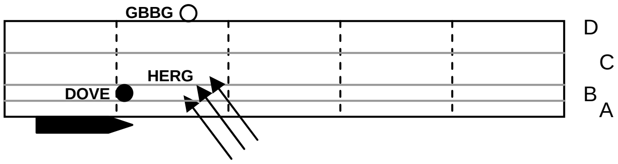
a) We begin the observation period at 11:00 with a snapshot of the flying birds and a count of the birds we see on the water. We see 2 separate adult Northern Gannets flying, although we only count one as in transect, at distance C, as the other is more than 300 m in front of the vessel (at distance D). We also see 2 Common Murres on the water to the port side of the vessel, at distances C and D. These are recorded as in transect. We can also see 2 puffins together on the water, more than 300 m in front of the vessel. We will also count these as in transect, although we will be careful not to count them again as we get closer.



b) Now we are about 30 seconds into the 5 min observation period, **in between snapshot counts**. We have already counted the 2 murres and 2 puffins on the water (shown in the figure as open circles), but an adult Black-legged Kittiwake has appeared on the water at distance D, and we add this to our list as in transect. Despite the appearance of a flying Dovekie within 300 m of the vessel at distance C, we do not count it as in transect because we are between snapshots. We add the Dovekie to our list but indicate that it is NOT in transect.

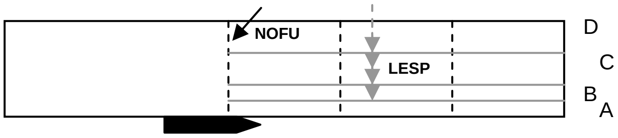


c) At minute 1, we take another snapshot count of flying birds. A flock of 3 Herring Gulls is seen traveling NW. The centre of the flock is at distance B. We also see one Dovekie on the water at distance B, and one Great Black-backed Gull outside 300 m (distance category E). These are all in transect except for the gull at distance E.

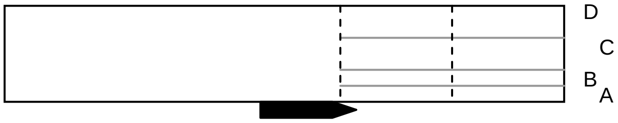


[†] Adapted from Tasker et al. 1984.

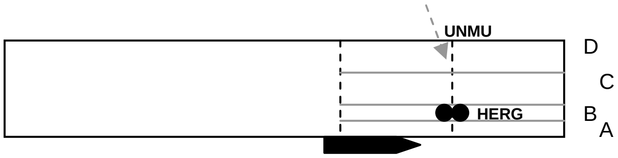
d) At minute 2, we perform another snapshot and count one flying Northern Fulmar in transect at distance D travelling SW. We record the flock of 4 Leach's Storm-Petrels flying south ahead of the vessel (at distance C) but do NOT count them as in transect as they are beyond 300 m.



e) At minute 3 we conduct another snapshot. No new birds are observed, so nothing new is written on our data sheet.

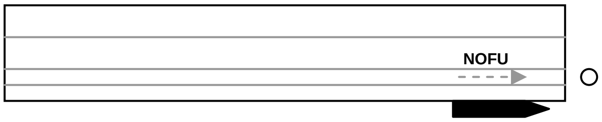


f) At 3:42, a murre of unknown species is observed flying but we DO NOT count it as in-transect because we are **between snapshots**. We will record it as NOT in transect. We record the 2 Herring Gulls feeding (behaviour code 44) up ahead on the water, both in transect at distance B. Because one is a juvenile and one is an adult, we enter them on separate datasheet rows, linking the two with an arc in the left margin.



g) At minute 4, our next snapshot takes place and we note that the unknown murre that we saw flying earlier (see frame f) can now be recorded as in transect at distance B, as it is within 300 m of the vessel AND observed during the snapshot. If we know for certain that this is the same individual we previously recorded as NOT in transect (frame f), we can cross the previous observation out. If we are not certain that this is the same individual we do not cross anything out. There is also a large flock of 200 Great Shearwaters on the water near the edge of the 300 m transect. Since the centre of the group is within the transect, at distance D, we count ALL the shearwaters as being at distance D. If the centre of the group had been beyond 300 m, we would have recorded them as outside the transect at distance E, despite some individuals being in the transect.

h) As we approach the end of the 5 min observation period, we record a Northern Fulmar that is following us (at distance B), but has not been previously recorded. We record it as NOT in transect since we are not at a snapshot point. Remember, you must record ship-followers as “associated with platform” (code 18). We do not include the kittiwake we can see ahead of the vessel, because by the time we reach it, the 5 min observation period will be over. This bird will be counted in the next period.



Example datasheet of a 5 min survey from a moving platform

Observation Period Information:

Company/agency	**CWS**		Sea state code	**3**
Platform name and type	**Hudson, DFO Research**		Wave height (m)	**1**
Observer (s)	**Carina Gjerdrum**		True wind speed [✓ (knots)] **OR** Beaufort code	**12**
Date (DD/MMM/YYYY	**24 May 2007**		True wind direction (deg)	**93˚**
Time at start (UTC)	**11:00**		Ice type code	**0**
Time at end (UTC)	**11:05**		Ice concentration code	**0**
Latitude at start / end	**42˚46.307**	**42˚45.803**	True platform speed (knots)	**10.0**
Longitude at start / end	**-61˚59.156**	**-61˚58.233**	True platform direction (deg)	**191˚**
Platform activity	**Steaming**		Observation side	Starboard [✓ Port]
Visibility (km)	**13.5**		Height of eye (m)	**12.3**
Weather code	**0**		Outdoors or Indoors	Out or [✓ In]
Glare conditions code	**1**		Snapshot used?	[✓ Yes] or No

Notes:

Bird Information: *this field <u>must</u> be completed for each record

	* Species	* Count	* Fly or Water?	* In transect?	* Distance[1]	Assoc.	Behav.	Flight Direc.[2]	Age[3]	Plum.[4]	Sex	Comments
a)	NOGA	1	F	Y	C			SW	A			
	NOGA	1	F	N	D			SE	A			
	COMU	1	W	Y	C							
	COMU	1	W	Y	D							
	ATPU	2	W	Y	A							
b)	BLKI	1	W	Y	D				A			
	DOVE	1	F	N	C			SW				
c)	HERG	3	F	Y	B			NW				
	DOVE	1	W	Y	B							
	GBBG	1	W	N	E							
d)	NOFU	1	F	Y	D			SW				
	LESP	4	F	N	C			S				
f)	UNMU	1	F	N	D			SE				
	HERG	1	W	Y	B		44		A			
	HERG	1	W	Y	B		44		J			
g)	UNMU	1	F	Y	B			SE				
	GRSH	200	W	Y	D							
h)	NOFU	1	F	N	B	18						

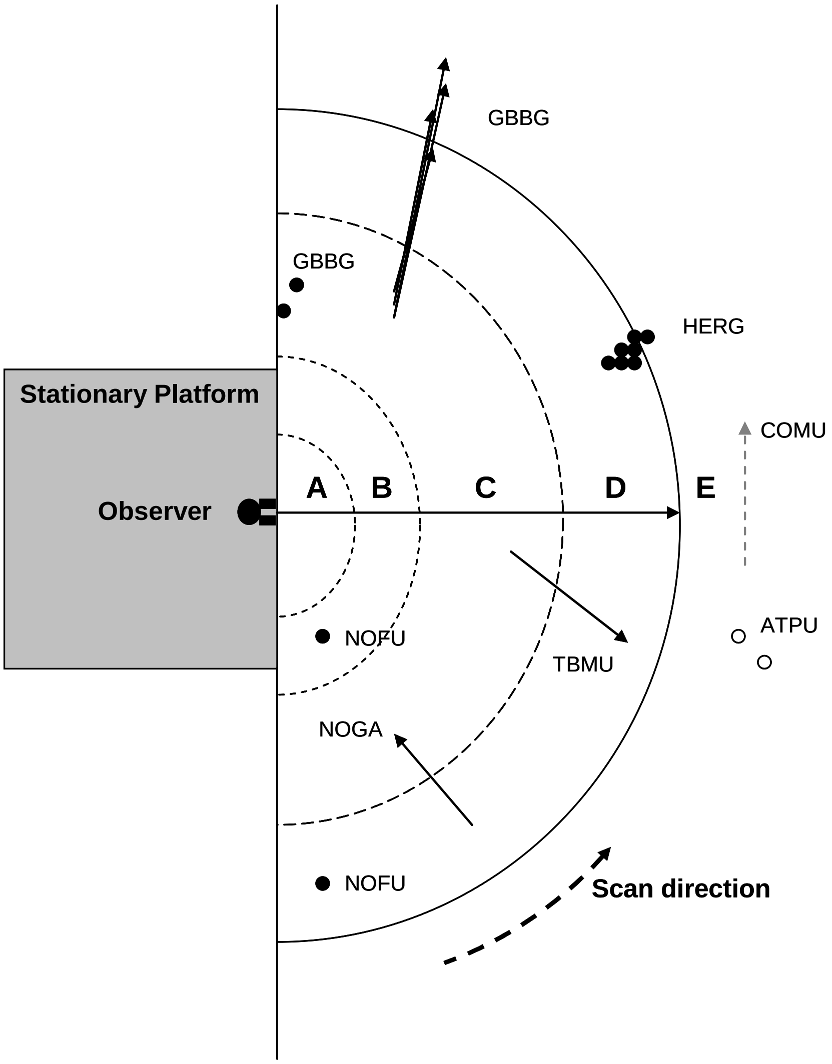
[1] ***A*** = 0-50m, ***B*** = 51-100m, ***C*** = 101-200m, ***D*** = 201-300m, ***E*** = > 300m, ***3*** = within 300m but no distance recorded.

[2] Indicate flight direction (***N***, ***NE***, ***E***, ***SE***, ***S***, ***SW***, ***W***, or ***NW***); ***ND*** = no apparent direction

[3] ***J***(uvenile), ***I***(mmature), or ***A***(dult); [4] ***B***(reeding), ***NB***(non-breeding), ***M***(oult)

APPENDIX VIII. Example survey from a stationary platform

See associated datasheet on pg. 33: We are facing east and about to conduct our first survey of the day from an offshore oil platform. We have estimated the distance from where we are standing out to 50 m, 100 m, 200 m, and 300 m using our ruler gauge created with the formula outlined in Appendix I. We will now visually scan a 180^o arc, counting all birds observed and estimating their distance from the platform. Before we begin the scan, we record the required Observation Period Information at the top of the datasheet. The survey begins on the right hand side of the semi-circle. In the diagram that follows, birds on water are represented by dots and flying birds by arrows (birds are at the position of the arrowhead).



a) A Northern Fulmar sits on the water approximately 250 m away from us. Another sits within 100 m of us. We add both of these as separate entries on the datasheet.

b) An adult Northern Gannet is flying towards us at distance C and we record it as in semi-circle.

c) We observe a flying Thick-billed Murre travelling southeast, and we record it as in semi-circle at distance D.

d) We can see 2 Atlantic Puffins beyond 300 m sitting on the water. We record them on the datasheet in distance E but note that they are NOT in the semi-circle.

e) We also see a Common Murre flying north beyond 300 m and record it as NOT in semi-circle at distance E.

f) A flock of 7 Herring Gulls is observed at the edge of the 300 m semi-circle. Because the centre of the group is within the semi-circle, at distance D, we count ALL the gulls as being at distance D. If the centre of the group had been beyond 300 m, we would have recorded them as outside the semi-circle at distance E, despite some individuals being in the semi-circle.

g) Four Great Black-backed Gulls are flying north, away from the platform. Since the centre of the flock is outside the semi-circle, these individuals are recorded as outside the semi-circle at distance E (see Section 4.1.4, ***Lines of Flying Birds***)

h) Two additional Great Black-backed Gulls are sitting in the water feeding at distance C. The code for feeding behaviour is ‘33’ (see Appendix VI). Because one is an immature and one is an adult, we enter them in two datasheet rows, linking the two with an arc in the left margin.

Example datasheet for a survey from a stationary platform

Scan Information:

Company/agency	**CWS**	Weather code	**1**
Platform name and type	**Terra Nova FPSO**	Glare conditions code	**0**
Observer (s)	**Carina Gjerdrum**	Sea state code	**3**
Date (DD/MMM/YYYY)	**13 April 2007**	Wave height (m)	**1**
Time at start (UTC)	**0800**	True wind speed (knots) **OR** Beaufort code	**12**
Latitude	**46˚45.000**	True wind direction (deg)	**93˚**
Longitude	**-48˚46.799**	Ice type code	**0**
Platform activity	**Anchored offshore**	Ice concentration code	**0**
Scan type	**[✓ 180º] or other (specify:)**	Height of eye (m)	**33 m**
Scan direction	**East**	Outdoors or Indoors	Out or [✓ In]
Visibility (km)	**10 km**		

Notes:

Bird Information: *this field must be completed for each record

	* Species	* Count	* Fly or Water?	* In semi-circle?	* Distance[1]	Assoc.	Behav.	Flight Direc.[2]	Age[3]	Plum.[4]	Sex	Comments
a)	NOFU	1	W	Y	D							
	NOFU	1	W	Y	B							
b)	NOGA	1	F	Y	C			NW	A			
c)	TBMU	1	F	Y	D			SE				
d)	ATPU	2	W	N	E							
e)	COMU	1	F	N	E			N				
f)	HERG	7	W	Y	D							
g)	GBBG	4	F	N	E			N				
h)	GBBG	1	W	Y	C		33		I			
	GBBG	1	W	Y	C		33		A			

[1] ***A*** = 0-50m, ***B*** = 51-100m, ***C*** = 101-200m, ***D*** = 201-300m, ***E*** = > 300m, ***3*** = within 300m but no distance recorded.

[2] Indicate flight direction (***N***, ***NE***, ***E***, ***SE***, ***S***, ***SW***, ***W***, or ***NW***); ***ND*** = no apparent direction

[3] ***J***(uvenile), ***I***(mmature), or ***A***(dult); [4] ***B***(reeding), ***NB***(non-breeding), ***M***(oult)

APPENDIX IX. Check-list of materials required while conducting seabird surveys

☐ Multiple pens or sharp pencils **(required)**

☐ Multiple copies of blank recording sheets and clipboard **(required)**

☐ Binoculars **(required)**

☐ Watch or clock **(required)** - with countdown timer that can beep on snapshot intervals

☐ Global Positioning System (GPS) to determine vessel position, speed and direction plus extra batteries **(required)**

☐ Compass or GPS to determine flight direction of birds **(required)**

☐ Copy of protocol (**required**)

☐ Seabird identification guide (**required**)

☐ Transparent ruler to determine distances (**required**)

☐ Steel toed boots (**required** for most vessels)

☐ Security and medical certificates (**required** for most vessels)

☐ Notebook (recommended)

☐ Warm and waterproof clothing (recommended)

☐ Calculator or Excel spreadsheet[†] for equation in Appendix I to determine observation distances (recommended)

☐ Laptop for data entry (recommended). Software is available for data entry from corresponding author.

[†] An Excel spreadsheet that automatically performs these calculations is available from the corresponding author.

APPENDIX X. Blank record sheets for moving and stationary platforms

Record sheet for a moving platform survey

Observation Period Information:

Company/agency		Sea state code	
Platform name and type		Wave height (m)	
Observer (s)		True wind speed (knots) **OR** Beaufort code	
Date (DD/MMM/YYYY)		True wind direction (deg)	
Time at start (UTC)		Ice type code	
Time at end (UTC)		Ice concentration code	
Latitude at start / end		True platform speed (knots)	
Longitude at start / end		True platform direction (deg)	
Platform activity		Observation side	Starboard Port
Visibility (km)		Height of eye (m)	
Weather code		Outdoors or Indoors	Out or In
Glare conditions code		Snapshot used?	Yes or No

Notes:

Bird Information: *this field must be completed for each record

* Species	* Count	* Fly or Water?	* In transect?	* Distance[1]	Assoc.	Behav.	Flight Direc.[2]	Age[3]	Plum.[4]	Sex	Comments

[1] ***A*** = 0-50m, ***B*** = 51-100m, ***C*** = 101-200m, ***D*** = 201-300m, ***E*** = > 300m, ***3*** = within 300m but no distance recorded.

[2] Indicate flight direction (***N***, ***NE***, ***E***, ***SE***, ***S***, ***SW***, ***W***, or ***NW***); ***ND*** = no apparent direction

[3] ***J***(uvenile), ***I***(mmature), or ***A***(dult); [4] ***B***(reeding), ***NB***(non-breeding), ***M***(oult)

Record sheet for a stationary platform survey

Scan Information:

Company/agency		Weather code	
Platform name and type		Glare conditions code	
Observer (s)		Sea state code	
Date (DD/MMM/YYYY)		Wave height (m)	
Time at start (UTC)		True wind speed (knots) **OR** Beaufort code	
Latitude		True wind direction (deg)	
Longitude		Ice type code	
Platform activity		Ice concentration code	
Scan type	180º or other (specify:)	Height of eye (m)	
Scan direction		Outdoors or Indoors	Out or In
Visibility (km)			

Notes:

Bird Information:

*this field <u>must</u> be completed for each record

* Species	* Count	* Fly or Water?	* In semi-circle?	* Distance[1]	Assoc.	Behav.	Flight Direc.[2]	Age[3]	Plum.[4]	Sex	Comments

[1] ***A*** = 0-50m, ***B*** = 51-100m, ***C*** = 101-200m, ***D*** = 201-300m, ***E*** = > 300m, ***3*** = within 300m but no distance recorded.
[2] Indicate flight direction (***N***, ***NE***, ***E***, ***SE***, ***S***, ***SW***, ***W***, or ***NW***); ***ND*** = no apparent direction
[3] ***J***(uvenile), ***I***(mmature), or ***A***(dult); [4] ***B***(reeding), ***NB***(non-breeding), ***M***(oult)