March 25, 2014

Canada-Nova Scotia Offshore Petroleum Board
1791 Barrington Street
Halifax, Nova Scotia B3J 3K9

Attention: Elizabeth MacDonald

Re: Review Of the Draft Environmental Assessment Of BP Exploration (Canada) Limited’s Tangier 3-D Seismic Survey In Exploration Licenses 2431, 2432, 2433 And 2434.

Dear Ms. MacDonald,

This annotated letter provides BP Exploration (Canada) Limited’s response to the CNSOPB comments and questions provided in the review of the Draft Environmental Assessment of the Tangier 3-D seismic Survey In Exploration Licenses 2431, 2432, 2433 And 2434 in your letter dated March 5, 2014. The CNSOPB comments and questions are included for reference, with the BP responses below.

Environmental Assessments Clarifications

CNSOPB - Section 11.1.1, Visual and Acoustic (PAM) monitoring: further information is sought from the CNSOPB and DFO about the PAM system to be utilized and specific MMO qualifications, training and experience. This information is required in order for DFO to provide a determination with respect to Section 32, 33 and 58 of the Species at Risk Act. See attached letter, Section 11.1.1 and Marine Mammal Specific Comments for specific questions from DEC. Please submit this information as soon as possible to the CNSOPB and it will be forwarded to DFO.

BP – The development of the project specific Marine Mammal Observer Monitoring Management Plan is a planning requirement for BP on the Tangier Project. This service provider was recently selected and the plan production will be expedited to meet this requirement. Submission of the plan will be under separate cover and included with submission of the final EA report.

CNSOPB - Section 6.7, Table 6.5: Table 6.5 lists Kemp’s Ridley sea turtle as likely to occur during “summer, other times?” Please confirm likely time of occurrence in the study area, if possible.

BP – EA text has been modified. Kemp’s Ridley sea turtle is likely to occur in summer. This species prefers warm water, and is expected to have poor survivability in the colder offshore Nova Scotia waters. It is most likely to occur in shallow coastal waters where its primary prey of crabs resides, as opposed to offshore on the Scotian Slope.

CNSOPB - Summary of Key Monitoring and Mitigation Measures, page xvii and Section 7.2.1.3 Haddock Box: with respect to shutdown of airguns during line changes, footnote a states “Except during some periods when the airguns require testing for maintenance or other operational purposes.” This footnote is repeated as text in Section 7.2.1.3
Haddock Box (second bullet, page 90). While the report states several times that airguns will not be activated in the Haddock Box, this statement suggests it is a possibility during testing during line changes. Airguns shall not be activated in the Haddock Box, and as such, testing of airguns shall not occur in the Haddock Box.

BP - EA text has been modified. BP commits that no airguns will be activated in the Haddock Box for testing purposes or otherwise.

CNSOPB - Section 7.3.1.2, Aboriginal Fisheries: add text to the effect of “In terms of the potential effects of this seismic program...” to the first sentence on page 121.

BP – Text has been changed as requested.

CNSOPB - Section 10.3, Military operations and other Oil and Gas Projects: this section notes the proximity to Alma. BP should also include mention of the safety zone around SOEP and a commitment to stay outside of the safety zone and communication with ExxonMobil where necessary.

BP – EA text has been modified. BP commits to acknowledge and respect the 500 m safety exclusion zone around the SOEP facilities and to notify ExxonMobil of project vessel traffic where a direct impact on SOEP facilities is likely to occur.

Section 12.4, Fisheries Interactions: the report states that one or more Fisheries Liaison Officers (FLOs) will be supporting the seismic fleet. Please clarify how many FLOs will be present for the program and which vessels/support craft the officer(s) will be stationed on.

BP – There will be two Fisheries Liaison Officers (FLO) offshore at all times; one will be onboard the lead streamer vessel (RN Western Neptune) and the other will be onboard one of the other streamer vessels (RN Western Regent).

Section 12.1.5, Shut Downs: shut down criteria excludes “Species of Special Status”. Provide the rationale for this exclusion.

BP – The proposed shut down protocol is consistent the requirements of the Statement of Canadian Practice with respect to Mitigation of Seismic Sound in the Marine Environment. Specific actions associated with Species of Special Status include:

The air source array(s) must be shut down immediately if any of the following is observed by the Marine Mammal Observer in the safety zone:

a. a marine mammal or sea turtle listed as endangered or threatened on Schedule 1 of the Species at Risk Act; or

b. based on the considerations set out in sub-section 4(b), any other marine mammal or sea turtle that has been identified in an environmental assessment process as a species for which there could be significant adverse effects”

Additional Commitments

BP agrees to the additional commitments related to mitigating potential impacts to marine mammals.

• During the program, notification shall be provided to the CNSOPB within 24 hours of any shut down that occurs as a result of marine mammal or sea turtle presence.

• Immediate written notification shall be provided to the CNSOPB via the incident reporting email address in the event of a marine mammal strike or turtle entanglement/strike, and immediate verbal notification shall be provided to the Marine Animal Response Society at 1-866-567-6277 or via Coast Guard Emergency VHF channel 16.
• Appropriate Cumulative Effects assessment shall be discussed with CNSOPB prior to activity in 2015 should other Operator exploration activity be planned in the Nova Scotia offshore.

• By way of an amendment report, sections of the ES Report pertaining to species at risk shall be updated prior to activity in 2015 should changes to species’ status under SARA occur prior to the start of the 2015 program.

• By way of an amendment report, appropriate sections of the EA may need to be updated prior to the 2015 program as a result of the Canadian Science Advisory Secretariat (CSAS) outcomes that focus on consideration for enhanced mitigation related to seismic surveys and potential effects on cetaceans.

• 10 days prior to program start notification of the program start shall be provided to DFO via Notice to Mariners.

• Weekly Notice to Mariners updates will be provided to the CNSOPB for posting on the CNSOPB website.

With respect to Passive Acoustic Monitoring data recording, BP is not archiving this information as the PAM system is not equipped to store such large files. The data summary reports on distribution of marine mammals will be provided to CNSOPB and DFO at the conclusion of the survey program each year. This information will provide DFO Science with supplementary knowledge of marine mammals that may be present in that region.

The Final Environmental Assessment Report with effected modifications is attached.

Kind regards,

[Signature]

John Drinkwater
Director, Regulatory Compliance & Environment

cc. William Slopey, BP Exploration (Canada) Limited
Environmental Assessment of
BP Exploration (Canada) Limited’s
Tangier 3-D Seismic Survey

25 March 2014
BP Document No. NS-HS-REP-BP-B01-0001
Environmental Assessment of
BP Exploration (Canada) Limited’s
Tangier 3-D Seismic Survey

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Executive Summary

This document provides an Environmental Assessment (EA) of BP Exploration (Canada) Limited’s three dimensional (3D) seismic program in and near Exploration Licences 2431, 2432, 2433 and 2434 (see Figure below). The seismic program will be conducted during the April to November period in 2014 and 2015. In 2014, a multi-vessel Wide Azimuth Towed Streamer (WATS) 3D survey will be conducted. There will also be a program of conventional or single vessel Narrow Azimuth Towed Streamer (NATS) 3D survey in 2015. Combined, the two 3D acquisition areas total approximately 12,000 km$^2$.

![Locations of the WATS 3D Acquisition, NATS 3D Acquisition, Project, and Study Areas, and BP Exploration Licences](image)

Project Overview

The Project is designated the Tangier 3D Seismic Survey and it will occur in two phases—a WATS survey in 2014 and a NATS survey in 2015. Water depth in the Project Area (i.e., area where data acquisition and vessel turning will occur) ranges from ~100 m to 4,000 m.
**WATS Survey**

The WATS survey will involve five seismic vessels actively involved in surveying, all five seismic vessels will tow airgun source arrays (24 airguns, 5085 in$^3$ array) with the two outer vessels also towing streamers (10 to 12 streamers in total, each 8.1 km long). Seismic vessels will be separated by 1,200 m during surveying. The airgun arrays are not activated simultaneously but instead are activated sequentially (i.e., only one airgun array is activated at a time across all vessels).

The WATS survey fleet will survey lines running parallel to the shelf break and spaced 600 m apart. Average survey line length is 138 km and line changes will take about 5.5 hours to complete. The WATS survey will be about 140 days in duration with data acquisition requiring about 125 days. Seismic data will be acquired in a 7,752 km$^2$ area.

The WATS survey will be supported by two picket vessels and two support vessels. JRCC helicopters will only be used in the event of a life threatening emergency situation.

**NATS Survey**

The NATS survey will involve one seismic vessel that tows airgun arrays (likely 24 airguns, 5085 in$^3$ array) and multiple streamers (10 to 12 streamers in total, each 6.6 km long).

The NATS survey will likely have survey lines running along a North–South azimuth and spaced 600 m apart. Line changes are expected to take 2 to 3 hours. The NATS survey will be about 113 days in duration with data acquisition requiring about 85 days. Seismic data will be acquired in a 4,114 km$^2$ area that is divided into two subareas—NATS West and NATS East (see Figure above).

The NATS survey will be supported by one picket vessel and one support vessel. JRCC helicopters will only be used in the event of a life threatening emergency situation.

**Environmental Assessment Scoping**

The Canada Nova Scotia Offshore Petroleum Board (CNSOPB) provided a Scoping Document for the Project, which outlined factors to be considered in this EA. Stakeholder engagement was undertaken with relevant government agencies, representatives of the fishing industry and other interested groups. These engagements were done primarily to identify issues and concerns and acquire information relevant to the EA. Three Strategic EAs (SEAs) were reviewed to assist with background information and identification of issues relevant to this EA.
Approach and Methodology

The Valued Environment Components (VECs) examined in this EA include those identified in the Scoping Document and during stakeholder consultation and engagement: Species of Special Status; Special Areas; Other Ocean Users; Malfunctions and Accidental Events; and Cumulative Effects.

Impact definitions used in this EA were based upon those presented in the generic EA of seismic exploration on the Scotian Shelf (Davis et al 1998) and used in site-specific seismic EAs offshore Nova Scotia. More specifically, the terminology of magnitude, geographic extent, and duration were used in considering the significance of BP’s proposed seismic program on VECs. An assessment of the level of confidence associated with predictions is also included. A significant effect is defined as having a major magnitude; or a moderate magnitude for a duration of greater than one year and over a geographic extent greater than 100 km$^2$.

Impact zones for VECs, particularly marine mammals, are commonly defined by the areas within which specific sound level thresholds are exceeded. For cetaceans, recommendations provided by a scientific panel of bioacoustics experts as presented in Southall et al. (2007) were used to assess potential hearing impairment effects:

- Received sound energy level (SEL) $\geq$198 dB re 1 $\mu$Pa$^2$ · s (M-weighted) for Permanent Threshold Shift (PTS) in hearing;
- Received sound energy level (SEL) $\geq$183 dB re 1 $\mu$Pa$^2$ · s (M-weighted) for Temporary Threshold Shift (TTS) in hearing.

The 160 dB re 1 $\mu$Pa (rms or root-mean-square) criterion was used in assessing disturbance effects on cetaceans. Sound levels $\geq$160 dB re 1 $\mu$Pa (rms) have commonly been used in EAs of seismic programs in Atlantic Canada for assessing behavioural effects on marine mammals.

These sound criteria and the corresponding distance zones predicted by acoustic modelling were used when assessing effects of BP’s proposed seismic program on cetaceans included in the Species of Special Status VEC. Similarly, sound levels reported in the scientific literature were used to guide the effects predictions for sea turtles and fish included in the Species of Special Status VEC. Effects predictions conservatively consider estimated sound levels representing worst-case scenarios as well as more representative scenarios. Predictions consider available literature on known effects of airgun array sound on marine species. Cumulative effects from increased vessel presence and other significant sources of sound have also been assessed with emphasis on other offshore oil and gas activities, military operations, shipping traffic, and commercial fishing.
Acoustic Modelling

Acoustic modelling of the airgun array (5,085 in³) was undertaken to allow for a description of potential sound exposure levels in and near the Study Area and to provide estimates of the distances and areas where the sound level criteria used in this assessment would be exceeded.

Six modelling sites were selected to represent the range of environmental parameters such as water depth in the Project Area. For each modelling site, two sound speed profiles were used (April and August) to represent the extreme in the profiles during the temporal period of the Project.

Two complementary acoustic models were used to predict the underwater acoustic field of the 5085 in³ airgun array: (1) an Airgun Array Source Model (AASM) was used to predict airgun array pressure signatures and directional source levels (SL), and (2) a Marine Operations Noise Model (MONM) was used to estimate propagated acoustic fields. Combined with the SL prediction, MONM computed the received per-pulse SEL for the airgun array at frequencies of 10 Hz to 2 kHz. The conversion of SEL to rms sound pressure level (SPL) was performed using range-dependent site-specific conversion functions estimated from additional full waveform modelling.

The distances from the airgun array to specific sound levels were estimated for unweighted SELs, M-weighted SELs for each marine mammal functional hearing group (in water), and rms SPLs.

Monitoring and Mitigation

BP is committed to the mitigation measures and monitoring requirements as outlined in the Statement of Canadian Practice with Respect to the Mitigation of Seismic Sound in the Marine Environment (i.e., Statement of Canadian Practice), as well as the additional requirements noted in the Scoping Document and those developed during stakeholder engagement and BP’s planning procedures. Key monitoring and mitigation measures are summarized below.

<table>
<thead>
<tr>
<th>Summary of Key Monitoring and Mitigation Measures</th>
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<tbody>
<tr>
<td><strong>Program Planning</strong></td>
</tr>
<tr>
<td>During WATS survey, start seismic surveying in</td>
</tr>
<tr>
<td>the north and proceed southwards to accommodate</td>
</tr>
<tr>
<td>halibut and swordfishers that fish on the shelf</td>
</tr>
<tr>
<td>break in summer</td>
</tr>
<tr>
<td>Avoid Designated Protected Areas and critical</td>
</tr>
<tr>
<td>habitat. Note that the Scotian Slope/Shelf Break</td>
</tr>
<tr>
<td>EBSA (see below) is not a Designated Protected</td>
</tr>
<tr>
<td>Area.</td>
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<tr>
<td><strong>Marine Mammals and Sea Turtles</strong></td>
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<tr>
<td>Use of three Marine Mammal Observers (MMOs) on</td>
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<tr>
<td>each seismic vessel. All MMOs will be trained in</td>
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<tr>
<td>Passive Acoustic Monitoring (PAM) operation.</td>
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<tr>
<td>Use of a PAM system to detect cetacean calls in</td>
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<tr>
<td>low visibility conditions and during pre-ramp up</td>
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<tr>
<td>watch</td>
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<tr>
<td>Ramp up of the array over a 30-minute period</td>
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<tr>
<td>Establishment of a safety zone based on</td>
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<tr>
<td>consideration of TTS criterion of ≥183 dB re 1</td>
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<tr>
<td>μPa² s SEL, Statement of Canadian Practice, and</td>
</tr>
<tr>
<td>survey design. [WATS survey: safety zone of 600</td>
</tr>
<tr>
<td>m; NATS survey: safety zone of 1200 m]</td>
</tr>
</tbody>
</table>
Delay of ramp up for marine mammals and sea turtles detected inside safety zone. Unless marine mammal or sea turtle observed to leave safety zone, ramp up will be delayed minimum 30 minutes for all sightings with exception of beaked whales. If beaked whales are detected, ramp up will be delayed 60 minutes.

Shutdown of airguns for marine mammals and sea turtles listed as Endangered or Threatened on Schedule 1 of the Species at Risk Act (SARA) detected inside of safety zone. Unless marine mammal or sea turtle observed to leave safety zone, ramp up will be delayed minimum 30 minutes for all sightings with exception of beaked whales. If beaked whales are detected, ramp up will be delayed 60 minutes.

Notification shall be provided to the CNSOPB within 24 hours of any shut down that occurs as a result of marine mammal or sea turtle presence

Shutdown of airguns during line changes

Use of turtle guards on streamer tail buoys

**Birds**

Reduce vessel lighting whenever it is safe and possible to do so to reduce chances of attracting birds

Daily searches of vessels for stranded birds

Rescue and release any stranded birds as per established protocol

Standardized seabird counts (following Canadian Wildlife Service protocol) by trained/experienced biologists

**General Ship Operations**

Vessels will steer a straight course and maintain a constant speed whenever possible

Weekly Notice to Mariners updates will be provided to the CNSOPB for posting on the CNSOPB website

10 days prior to program start notification of the program start shall be provided to DFO via Notice to Mariners.

**Vessel Wastes, Discharges and Emissions**

Vessels will meet or exceed regulations for vessel discharges (MARPOL, Offshore Waste Treatment Guidelines, WesternGeco’s waste management plan) and emissions (MARPOL)

Licenced waste contractor will be used for any waste returned to shore

**Malfunctions and Accidental Events**

Spill prevention plans, Shipboard Oil Pollution Emergency Plan (SOPEP), crew training, proper handling and storage requirements, vessel inspections, fuel transfer plan (including use of TODO® fuel hoses), secondary containment, adherence to the safety management procedures, spill kits onboard vessels, and Emergency Response Plan.

Project vessels will be equipped with spill kits as appropriate

Use of solid streamers

Use of radar and Vessel Monitoring System (VMS) tracking to reduce risk of vessel collision

**Interactions with Other Ocean Users**

On-going engagement with fishing groups, Fisheries and Oceans Canada (DFO), and Department of National Defence (DND)

Provision of weekly updates on seismic survey activity

Notice to Mariners, Notice to Shipping

Use of picket vessels

Use of Fisheries Liaison Officer(s)

Fishing gear compensation guidelines

Use of radar and VMS on all project vessels

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700 m.

1 Except during some periods when the airguns require testing for maintenance or other operational purposes, with exception in the Haddock Box where no airguns will be activated.
Effects on Valued Environment Components

Key interactions between Project activities and VECs that required assessment included: underwater sound from the airgun arrays, collisions between vessels or equipment and marine mammals and sea turtles, vessel lighting and seabirds, and Project interactions with other users of the Project Area.

Species of Special Status

The Scoping Document required assessment of species listed on Schedule 1 of SARA and migratory birds.

SARA-listed Species.—Five species of marine mammals, one sea turtle species, four fish species, and three bird species were assessed given their listing on Schedule 1 of SARA.

It is possible that small numbers of North Atlantic right whales (Endangered), blue whales (Endangered), northern bottlenose whales (Endangered), and Sowerby’s beaked whale (Special Concern) may occur in the Study Area. Fin whales (Special Concern) are expected to be relatively more abundant in the Study Area. The Study Area does not overlap with any identified critical habitat for marine mammals (minimum distances between the closest seismic survey area and Roseway Basin, Grand Manan Basin, and the Gully critical habitat are ~260 km, 400 km, and 81 km, respectively). The Study Area is not known to contain important feeding, breeding, or socializing areas for SARA-listed marine mammals and sea turtles (although for some species this has not been specifically investigated). Based on precautionary acoustic modelling results, it was estimated that cetaceans would have to occur <50 m from the airgun array to be exposed to sound levels from a single airgun pulse exceeding the 198 dB SEL criterion for PTS (i.e., permanent hearing damage). The area where right, blue and fin whales (all low-frequency cetaceans) may experience a temporary change in hearing (TTS) from airgun array sound was estimated as ~300–600 m. For northern bottlenose and Sowerby’s beaked whales (mid-frequency cetaceans), the range where airgun array sound may elicit a temporary change in hearing was estimated as <50–100 m. Using the 160 dB rms SPL as a guide for disturbance response, the area where disturbance by cetaceans would most likely occur would have a radius of ~7–22.1 km from the airgun array. With monitoring and mitigation in place (see Table above), residual effects (hearing impairment, disturbance) of airgun array sound on SARA-listed cetaceans were judged as not significant.

Leatherback sea turtles are listed as Endangered on Schedule 1 of SARA and are expected to occur in small numbers in the Study Area. Critical habitat has not been designated for this species. It is uncertain at what distance a sea turtle may experience hearing impairment from airgun array sound. Based on observations of other sea turtle species and modelling results of the 5085 in³ airgun array, it was estimated that the area where disturbance would most likely occur would have a radius of ~3–18 km. With monitoring and mitigation in place (see Table above),
residual effects (hearing impairment, disturbance) of airgun array sound on leatherback sea turtles were judged as *not significant*.

Given the slow and steady survey speed (~4.5 knots or 8.3 km/h) of seismic vessels, the avoidance of critical habitat, and the tendency for marine mammals and sea turtles to avoid close approach by vessels, residual effects related to the presence of vessels (i.e., collisions with marine mammals and sea turtles), were judged to be *not significant*.

Roseate Tern (Endangered), Red Knot (*rufa* subspecies; Endangered), and Savannah Sparrow (*princeps* subspecies; Special Concern) are all listed on Schedule 1 of SARA. It is possible that small numbers of these birds may migrate through the Project Area as transients. All three species are able to take off from the deck of a vessel should they land on a Project vessel. With appropriate monitoring and mitigation measures in place (see Table above), the residual effects of vessel lights on SARA-listed birds were judged to be *not significant*.

Wolffishes (northern and spotted wolfish listed as Threatened; Atlantic wolfish listed as Special Concern) lack a swim bladder and are therefore, not sensitive to the pressure component of underwater sound. Given this characteristic and the fact that wolffishes typically occur at or near the sea bottom, there will be little, if any, effect on them from exposure to airgun array sound. With mitigation measures in place, the residual effects of airgun array sound on wolffishes were judged to be *not significant*.

White sharks (Endangered) also lack a swimbladder and are therefore, only sensitive to the particle displacement component of underwater sound. Whereas wolffishes typically occur at or near the sea bottom, white sharks are pelagic much of the time and do occur in the upper water column. While there is potential for behavioural effects of exposure to airgun array sound on white sharks, it is most likely that these types of effects would include slight changes in swimming direction and speed. Such effects would not pose a threat to the white shark. With mitigation measures in place, the residual effects of airgun array sound on white sharks were judged to be *not significant*.

*Migratory Birds.*—The only notable potential interaction between routine Project activities and migratory birds is attraction of birds to lights on Project vessels. In Nova Scotia waters, the species most prone to stranding on vessels are Leach’s Storm-Petrel and Wilson’s Storm-Petrel. It is likely that some storm petrels will be attracted to vessel lights especially during times of low visibility. Some of these may become stranded, and some may collide with the vessel superstructure or become fouled on deck. A few may suffer mortality but the majority should be able to be released alive following the Canadian Wildlife Service protocols for stranded seabirds. Effects on the population size are expected to be negligible given that storm petrels are likely the most numerous seabird in the northwest Atlantic. With monitoring and mitigation measures in place, the residual effects of vessel lights on migratory birds were predicted to be *not significant*.
Special Areas

Designated Protected Areas identified in the Scoping Document and an Ecologically and Biologically Significant Area (EBSA) relevant to the Project were assessed.

The Gully Marine Protected Area.—The Gully is a large and deep submarine canyon located ~200 km off Nova Scotia that was designated as a MPA to primarily provide protection for northern bottlenose whales. Critical habitat for northern bottlenose whales has been identified within The Gully MPA. The Gully MPA is at its closest point 45.7 km, 67.8 km, and 108.7 km from the Project Area, WATS Area, and NATS East Area, respectively. Given these distances, cetaceans, including northern bottlenose whales, in the Gully MPA will not be exposed to airgun array sound levels that could cause hearing impairment. Sound levels from the airgun array in the Gully MPA were predicted to be well below the 160 dB rms criterion for disturbance effects in cetaceans. Based on these considerations, residual effects (hearing impairment, disturbance in cetaceans), were judged to be not significant for the Gully MPA.

Sable Island National Park Reserve.—Sable Island lies 290 km east of Nova Scotia near the edge of the Scotian Shelf and in July 2013 it was designated a National Park Reserve. The island provides important habitat for numerous bird species (including nesting habitat for Roseate Tern and Savannah Sparrow, princeps subspecies) as well as seals, notably the grey seal. Given the large distance (>43 km) between the Project Area where seismic vessel(s) and their attending picket and support vessels will occur, there is no potential for interaction of the Project with birds and seals while they are on Sable Island. Seals that occur in nearshore waters around Sable Island are not expected to be affected by airgun array sound. The residual effects of the Project were judged to be not significant for the Sable Island National Park Reserve.

Haddock Box.—The Haddock Box is a conservation area that occurs over the Emerald and Western Banks. Adult haddock typically aggregate in the Haddock Box to spawn from March to June, with peak spawning in March and April. There is also some indication that the Haddock Box benefits other groundfish species’ abundance, most notably American plaice and winter flounder. Although Project vessels may turn inside the Haddock Box, the WATS and NATS survey areas do not overlap with the Haddock Box. Therefore, airguns will not be activated within the Haddock Box. Given this, eggs and larvae will not be exposed to airgun array sound at close distance and will not be affected. Juvenile and adult fishes with swim bladders might exhibit some minor behavioural responses to the pressure component of airgun array sound but not to a degree that would negatively affect them. With mitigation measures in place, the residual effects of airgun array sound on the Haddock Box were judged to be not significant.

Scotian Slope/Shelf Break EBSA.—Some of the identified attributes of the potential Scotian Slope/Shelf Break EBSA relate to marine invertebrate and fish issues and concerns raised during stakeholder consultations. These attributes include the occurrence of large pelagic fishes such as swordfish; a migratory route for sharks, tunas and swordfish; and an overwintering area for a
number of shelf species such as Atlantic halibut and lobster. Relevant issues and concerns expressed during the consultations include the potential effects on migratory fishes, large pelagic fishes, spawning habitat and invertebrate larvae. Airgun array sound will not result in the disuse of this potential EBSA’s slope area as a migratory route for large pelagic fishes. There could be some slight behavioural responses by the large pelagic fishes but migration will not be interrupted. As for eggs and larvae in the upper water column, some may be physically affected if they occur within a few metres of an active airgun. Affected eggs and larvae would represent an extremely small proportion of all eggs and larvae in the area. With mitigation measures in place, the residual effects of airgun array sound on the potential Scotian Slope/Shelf Break EBSA were judged to be not significant.

Other Ocean Users

Effects of the Project on fisheries, marine shipping, DFO scientific research, and DND operations were assessed. Commercial, aboriginal, and recreational fisheries were considered in the assessment including input from stakeholders; however, focus was given to commercial fisheries.

Commercial Fisheries.—DFO Commercial Fishery Landings database for the period April to November, 2005–2010 was summarized for each of the Study Area, Project Area, WATS Area, NATS West and NATS East areas. In the Study and Project areas, sea scallops, herring, swordfish, Atlantic halibut and silver hake dominated both the catch weight (mt) and catch value ($). Catch weights were highest during May to August. Fishing activity differs substantially in the deeper waters of the WATS Area relative to the NATS West and NATS East areas, which encompass some Shelf waters as well as the Slope.

In the WATS Area, large pelagics accounted for ~65% of the catch weight, followed by groundfish species (~24%), and invertebrates (11%). Catch weight in the WATS Area represented only 2% of the catch weight in the Project Area considering the same months (April to November, 2005–2010). In the NATS West Area and NATS East Area, catch weight accounted for 22% and 24%, respectively, of the catch weight in the Project Area. Most of the commercial fish harvesting in the Project Area occurred shoreward of the 1,000 m isobath.

Airgun array sound does have the potential to affect some commercial fishery catch rates by causing temporary behavioural effects in fish. Such effects are likely to be temporary as fish move away from a sound source and the seismic sound source is also moving. Therefore, any direct effect on catch rates should also be temporary and localized. There is no evidence to support the idea that invertebrate fishery catch rates would be affected. With mitigation measures in place (see Table above), the residual effects of airgun array sound on the commercial fisheries were judged to be not significant.
The presence of seismic vessel(s) and towed gear has potential to affect the commercial fishery in terms of conflict with fishing gear, particularly fixed gear. Again, with appropriate mitigation measures in place (e.g., program planning, good communication between the seismic operator and fishers, VMS, picket vessels, FLOs; see Table above), the residual effects of the presence of seismic vessels and gear on the commercial fisheries were judged to be not significant.

*DFO Scientific Research.*—As is the case with commercial fisheries, airgun array sound does have the potential to affect DFO Research Vessel (RV) survey catch rates by causing behavioural effects in fish. With mitigation measures in place (see Table above), the residual effects of airgun array sound on the RV surveys were judged to be not significant.

The presence of the seismic vessels and gear has potential to affect other DFO science initiatives such as the AZMP and RAPID Programs, which have fixed stations on and off the Shelf. However, as long as good communication between the seismic operator and DFO is maintained, the residual effects of the presence of seismic vessels and gear on the DFO AZMP and RAPID programs were judged to be not significant.

*DND Operations.*—DND has noted that they would likely be operating in the vicinity of the Study Area in a non-interference manner. Given this and with mitigation measures in place (see Table above), the residual effects of the presence of seismic vessels and gear on DND training and other operations were judged to be not significant.

*Malfunctions and Accidental Events*

A scenario for an accidental release of fuel (100 L) during routine bunkering of a seismic vessel was assessed to address the Scoping Document requirement to consider a “light” fuel spill.

Residual effects on all VECs related to a small volume fuel release, were judged to be not significant. These predictions considered the mitigation measures in place for spill prevention and cleanup, the location of refueling in offshore areas (away from Special Areas and critical habitat), the rapid degeneration of fuel, and the relatively small volume of fuel which may be released during a refuelling accidental event.

*Cumulative Effects*

Cumulative effects from the Project in combination with other users and activities, with an emphasis on other seismic programs, military operations and increased vessel presence were assessed as stipulated in the Scoping Document. Based on present knowledge, no other seismic programs are planned offshore Nova Scotia in 2014 or 2015 and military operations are not expected to spatially overlap with BP’s surveying activities. Given that the Project Area is seaward of the highest concentrations of marine traffic off Nova Scotia, and the number of vessels
transiting through the Project Area is comparatively low, it is judged that residual cumulative effects on VECs from increased vessel traffic as a result of the Project will be *not significant*.

**Effects of the Environment on the Project**

Wind and waves have the greatest potential to affect the Project. Seismic vessels typically suspend surveys once wind and wave conditions reach certain levels (i.e., typically wave heights of ≥3 m). During April to September, wind direction is most frequently from the southwest with an average wind speed in September of 17.5 km/h. Weather conditions during the summer typically result in wave heights under 2 m, but they have exceeded 5 m.

The Project’s temporal scope of April to November should avoid the more frequent extreme weather conditions typically encountered over the winter. BP’s geophysical contractors are familiar with east coast operating conditions and written procedures will be in place under the Adverse Weather procedures for the continuous monitoring of actual and predicted weather conditions. With monitoring and mitigation measures in place, the residual effects of the environment on the Project are predicted to be *not significant*.

**Summary**

BP is committed to the monitoring and mitigation measures included in the EA, which have in part been developed during stakeholder engagement. BP recognizes that ongoing communication with stakeholders and regulatory agencies is key in minimizing effects of the Project on the environment. A summary of the residual effects of Project activities on the environment are provided in Table 12.3 at the end of the EA. With monitoring and mitigation measures in place, Project activities were judged to have *no significant residual effects* on VECs.
1.0 Introduction

BP Exploration (Canada) Limited (hereafter referred as “BP”) intends to conduct a three dimensional (3D) seismic program (the Tangier 3D Seismic Survey) over Exploration Licences 2431, 2432, 2433 and 2434 located 230 to 370 km southeast of Halifax, Nova Scotia (Figure 1.1). These licences cover an area of approximately 1.4 million hectares and were awarded to BP by the Canada Nova Scotia Offshore Petroleum Board (CNSOPB) on 15 January 2013.

Figure 1.1. BP’s Exploration Licences, Seismic Acquisition Areas, and Project Area Offshore Nova Scotia (see Section 2.2 for a description of the Acquisition and Project areas).

This document is an environmental assessment (EA) which applies to BP’s proposed 3D seismic surveys to be conducted in 2014 and 2015. It is intended to enable the CNSOPB to fulfill its responsibilities under Section 142(1)(b) of the Canada-Nova Scotia Offshore Petroleum Resources Accord Implementation Act. This EA has been primarily guided by a Scoping Document released by the CNSOPB in August 2013. Other guidance has been provided by Strategic Environmental Assessments (SEA) of the Scotian Slope (Hurley 2011, 2012; Stantec 2012a,b) as well as input obtained during stakeholder engagement.
1.1 The Proponent

BP’s Canadian operations are based in Calgary, Alberta. BP owns a 100% working interest in and is the operator of ELs 2431, 2432, 2433 and 2434 off Nova Scotia.

Also, a BP affiliate, BP Canada Energy Group ULC (“BPCEG”), holds interests in three oil sands assets in northeastern Alberta, with BPCEG operating one of these assets. BP Exploration Operating Company Limited (“BPEOC”) is exploring parts of the Beaufort Sea in Canada’s Arctic under a joint operating agreement with Imperial Oil Ventures Resources Ltd. and ExxonMobil Canada Ltd. BPEOC also holds 100% ownership of two other exploration blocks in the Beaufort Sea.

1.1.1 BP’s Objectives for the Project

BP proposes to conduct a 3D seismic survey of these licences beginning in April 2014. The results from this 3D seismic acquisition will help evaluate the subsurface geology of the target area and potentially identify rock structures that may contain oil and/or natural gas. This is accomplished by sending acoustic waves through the water column and by recording the echoes from the rock layers deep beneath the ocean floor.

1.2 Health, Safety and Environment

BP values safety. BP is also committed to protecting the environment and respecting the rights and dignity of communities around the world where they do business. BP’s health, safety, security and environment (HSSE) goals are no accidents, no harm to people and no damage to the environment. When conducting seismic operations in offshore Nova Scotia, BP will require its seismic survey contractor to comply with HSSE regulatory requirements and BP’s HSSE policy.

1.3 Canada-Nova Scotia Benefits

For the project, BP is committed to benefits for Canadian companies with emphasis on organizations from Nova Scotia. A benefits plan is being finalized by BP which will govern all company operations in the future with its guiding principles as follows:

- Companies from Nova Scotia and Canada will be given fair opportunity to provide goods and services to BP;
- BP will make decisions based on what optimizes value to its projects; and
- Value to BP will be quantified through vendor impact on project economics, product and/or service quality, timing, vendor experience and reputation and other similar metrics.
1.4 Stakeholder Engagement

BP recognizes that safe and environmentally sound operations require early and ongoing stakeholder engagement that continues over the full life-cycle of a project. BP believes that it is important to build relationships with stakeholders in the areas where it operates. Listening and responding to concerns which stakeholders have about BP’s activities are an important part of maintaining BP’s privilege to operate in Nova Scotia. BP is committed to:

- Listen and respond to stakeholder’s expectations and concerns about our operations;
- Seek to have a positive influence on communities where BP operates; and
- Identify and manage the environmental, health and social impacts of operating activities on key communities and stakeholders.

1.5 Contact Information

1.5.1 The Operator

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2.0 Project Description

2.1 Name and Location

BP is proposing to conduct the Tangier 3D Seismic Survey (hereafter referred to as “the Project”) in and near Exploration Licences (ELs) 2431, 2432, 2433, and 2434, which are located approximately 230 to 370 kilometres (km) southeast of Halifax (Figure 1.1).

2.2 Project Overview

The seismic survey program will be conducted in a phased approach occurring over two years. The first phase of acquisition is planned to commence in April 2014 and will involve a multi-vessel Wide Azimuth Towed Streamer (WATS) 3D survey. There will also be a program of conventional or single vessel Narrow Azimuth Towed Streamer (NATS) 3D survey in 2015. Combined, the two 3D acquisition areas will total approximately 12,000 km$^2$.

2.2.1 Spatial and Temporal Boundaries

2.2.1.1 Spatial Boundaries

The spatial boundary of the Project Area, the area within which geophysical data could be acquired plus an additional area around the outer perimeter of the data acquisition area to accommodate the ships’ turning radii, is shown in Figure 1.1. The maximum latitude and longitude extents for the four cardinal directions of the Project Area (Easting and Northing, NAD27, Zone 20N) are presented in Table 2.1. Water depth in the Project Area ranges from approximately 100 m to 4,000 m.

Table 2.1. Project Area “Extents” (mapping projection: NAD27, UTM, Zone 20).

<table>
<thead>
<tr>
<th>Project Area “Extent”</th>
<th>NAD27, UTM Zone 20</th>
</tr>
</thead>
<tbody>
<tr>
<td>Northern</td>
<td>4831025 Northing</td>
</tr>
<tr>
<td>Eastern</td>
<td>775008 Easting</td>
</tr>
<tr>
<td>Southern</td>
<td>4640665 Northing</td>
</tr>
<tr>
<td>Western</td>
<td>573685 Easting</td>
</tr>
</tbody>
</table>

Note: “Extents” presented for descriptive purposes only.

2.2.1.2 Temporal Boundaries

Seismic surveys will be conducted between the April to November timeframe in 2014 and 2015 (see Section 2.3.2 for more details).
2.2.2 WATS Survey

The 3D WATS seismic survey area proposed for 2014 is indicated in Figure 1.1. The WATS configuration involves the use of multiple seismic vessels to gain a wider range of reflection angles from the subsurface geology between the airgun array and the receivers in order to improve imaging. It is typically employed in areas where the geological setting is complex, particularly when salt is present within the subsurface stratigraphy.

The WATS survey will involve five seismic vessels actively involved in surveying, all five seismic vessels will tow airgun source arrays with the two outer vessels also towing streamers (which contain the hydrophone receivers; Figure 2.1). Seismic vessels will be separated laterally or in the cross-line direction by 1200 m during surveying. Though the WATS configuration includes multiple vessels towing airgun arrays, the arrays are not activated simultaneously but instead are activated sequentially (i.e., only one airgun array is activated at a time across all vessels; see Section 2.3.5). A spare seismic (source) vessel will be used during the WATS program to backfill for the source vessel that returns to Halifax for crew changes and re-supply.

Figure 2.1. Potential Configuration of the WATS 3D Seismic Survey (triangles, circles, blue and red lines represent seismic vessels, airgun arrays, and streamers, respectively)
2.2.3 NATS Survey

The 3D NATS seismic survey areas proposed for 2015 are shown in Figure 1.1. The conventional NATS 3D survey will involve one seismic vessel that tows airgun arrays and multiple streamers. It is anticipated that the 5085 in$^3$ airgun array will also be used during the NATS survey in 2015. The NATS survey acquires seismic data from a relatively narrow range of angles from the airgun arrays to the receivers (i.e., hydrophones in the streamers) and thus, is most effective in areas where the geological setting is considered relatively simple.

2.2.4 Project Phases, Scheduling, and Planning

As noted earlier, BP anticipates that the Project will occur in two phases.

2.2.4.1 Phase 1

Phase 1 involves the proposed 3D WATS survey in 2014. It is anticipated that the 3D WATS seismic survey will be about 140 days in duration with data acquisition requiring about 125 days. The seismic survey will occur during the 1 April to end of November period.

2.2.4.2 Phase 2

Phase 2 involves the proposed 3D NATS survey in 2015. It is anticipated that the 3D NATS seismic survey will be about 113 days in duration with data acquisition requiring about 85 days. The seismic survey will occur during the 1 April to end of November period.

2.2.5 Seismic Survey Site Plans

Seismic data will be collected over two areas (see Figure 1.1): WATS 3D Acquisition Area and NATS 3D Acquisition Area. Combined, the two 3D acquisition areas will total approximately 12,000 km$^2$.

2.2.5.1 WATS Survey

In 2014, BP is proposing to acquire 3D seismic data in the “WATS 3D Acquisition Area” (7,752 km$^2$) shown in Figure 1.1. The approximate water depth range in this area is 700–4,000 m. The WATS 3D survey vessel fleet will have survey lines running along a 246.6 degree azimuth (parallel to the shelf break) and spaced ~600 m apart. Minimum, average and maximum survey line lengths are 90 km, 138 km, and 156 km, respectively. Total survey line length is 12,943 km.

Line changes are likely to take about 5.5 hours (minimum 5 hours) to complete. The distance travelled by the vessels from the end of one seismic line to the beginning of the subsequent line
may be as long as 55 kilometres with a nominal 8 km run-in at the beginning and a 4 km run-out at the end of the line. Line changes will follow an anti-parallel turn pattern.

**Program Planning**

The BP Operating Management System (OMS) sets out BP’s principles for operating and provides a systematic and consistent way for managing all the company’s operating activities, while meeting BP’s commitment to HSSE performance. In program planning, BP follows a rigorous process that governs the procurement of the seismic contractor, identifies and addresses potential risks, verifies conformance with BP internal HSSE procedures and considers regulatory compliance.

The Environmental and Social Practices are an integral part of the OMS and support the delivery of some of the BP Group Essentials defined by the OMS. This assures consistent and systematic approach for the management of impacts and risks across the BP Group. The Group Defined Practices and Group Recommended Practices include actions that BP requires projects to undertake together with a series of defined and recommended practices that might be relevant depending on the type of project. They provide a consistent methodology to help projects deliver the intent of the relevant sections of the OMS and the BP code of conduct in regard to environmental and social issues.

Early identification of environmental and social impacts conducted as risk screening enables this Project to gain an early understanding of the key environmental and social sensitivities and the potential Project impacts on those sensitivities. Screening is the first in a series of seven Impact Management Processes. Responding to identified potential impacts and environmental and social requirements leads to alternative means to the Project. Planning aspects addressed in the Statement of Canadian Practice are embedded in BPs recommended practices screening process and include: using the minimum amount of energy necessary to achieve operational objectives; minimize the proportion of the energy that propagates horizontally; and minimize the amount of energy at frequencies above those necessary for the purpose of the survey; avoiding a significant adverse effect for an individual marine mammal or sea turtle of a species listed as endangered or threatened on Schedule 1 of the SARA; and avoiding a significant adverse population-level effect for any other marine species.

BP discussed temporal aspects with stakeholders to identify potential time periods to carry out the survey, taking into consideration key factors such as environmental conditions (*i.e.*, the seasonal presence of commercially important fish, marine mammals, and sea turtles), weather conditions, equipment, and optimal timing for other proposed seismic surveys. Some marine mammal species are expected to occur in the area year-round, so altering the timing of the proposed project likely would result in no net benefits for those species. BP intends to use an industry standard 24-airgun array. This tuned array features spectral content and power
appropriate for the objectives of the survey. Given the research goals, location of the survey and associated deep water, this energy source level was viewed appropriate.

The dates of the surveys have been selected based primarily on vessel availability, weather considerations, timing and sensitivities associated with biological and socio-economic constraints. Mitigative options to minimize impacts include modification of the operations schedule within specific areas (e.g., scheduling of specific lines so as to minimise fishery interactions). Seismic surveying will start in the north and proceed southwards in the WATS Area. This approach was adapted based on feedback received from several fishing groups (see Table C-2 in Appendix C for details) during consultations. The request was made to accommodate halibut and swordfishers that fish on the shelf break in summer. The second seismic survey in 2015 could occur in the spring to summer months depending on operational and environmental considerations.

2.2.5.2 NATS Survey

In 2015, BP is proposing to acquire 3D seismic data in the “NATS 3D Acquisition Area” (4,114 km²; see Figure 1.1). The approximate water depth range in this area is 50–2,700 m. The NATS survey will likely have survey lines running along a North - South azimuth and spaced ~600 m apart. Line changes are expected to take 2–3 hours with a nominal 6.6 km run–in at the beginning and a 3.3 km run-out at the end of a survey line.

2.2.6 Seismic Vessel(s)

WesternGeco has been selected as the seismic contractor for both the WATS and NATS surveys. Five seismic vessels will be used during the WATS survey and one seismic vessel will be used during the NATS 3D survey. The WesternGeco seismic vessel(s) used during the program will be approved for operation in Canadian waters and will be typical of the worldwide seismic fleet. Seismic vessels will likely range from 80-150 m in length and use some form of diesel-electric propulsion system. Each vessel will have a crew of about 50-70 people with non-streamer vessels having less personnel. During the WATS survey, the fuel capacity of the seismic vessels towing streamers is 1,600 m³ and 3,550 m³ and the seismic vessels that will only be towing airgun arrays have a fuel capacity ranging from 1,017–1,400 m³. Typical survey speed is 4.5 knots (8.3 km/h) to 5 knots (9.3 km/h) for both the WATS and NATS surveys.

For the WATS 3D survey, the seismic vessels will operate side-by-side, with a 1,200 m separation between adjacent vessels (Figure 2.1). This will result in a maximum vessel/streamer swath size of 6 km x 8.1 km.
2.2.7 Seismic Energy Source Parameters

The seismic energy source consists of individual airguns arranged in an array. The airgun size and location in the array are designed to direct most of the energy vertically downward rather than sideways (see Section 1.3 in Appendix D for a review of airgun sound characteristics). The parameters of the airgun arrays for the 2014 3D WATS and 2015 NATS survey are provided below and detailed in Appendix A.

For the 3D WATS survey in 2014, each vessel’s source array will be activated individually, cycling from one array vessel to the next in succession every 31.25 m or about every 13.5 seconds along the survey line. Therefore, the source point interval for a single vessel is 156.25 m (5 x 31.25 m). Each vessel’s airgun arrays will not be activated simultaneously. A 24 airgun, 5,085 in$^3$ array will be used. The 5,085 in$^3$ array consists of three sub-arrays, each with a volume of 1,695 in$^3$ and consisting of 8 airguns ranging in volume from 105 in$^3$ to 290 in$^3$. The array length and width are 15 m and 16 m, respectively. The airgun array will be deployed at a depth of 10 m and approximately 100 m to 150 m astern of the seismic vessel. The estimated source level (horizontal at 1 m) of the array is 248.2 re 1 µPa (zero to peak; endfire direction). Airguns will be operated at 2,000 pounds per square inch (psi).

In 2015, the NATS 3D seismic survey vessel will operate two airgun arrays, which will be activated alternately (flip-flop arrangement) along the survey lines, typically every 10 seconds. It is anticipated that the 5085 in$^3$ airgun array will be used during the NATS survey. The airgun arrays will be towed at depths of about 8 to 10 m, approximately 100 m to 150 m astern of the seismic vessel. Airguns will be operated at 2,000 psi.

2.2.8 Seismic Streamers

All streamers towed by WesternGeco’s seismic vessels will be solid (i.e., contain no fluids). It is anticipated that the seismic vessels will tow 10-12 streamers (strings of hydrophone sound receivers) to record the reflection of the airgun pulses from the earth’s subsurface during the seismic surveys. As noted earlier, only the two outermost seismic vessels used in the WATS survey will tow streamers (see Figure 2.1). Streamers used in the WATS and NATS surveys will be 8.1 km and 6.6 km in length, respectively. These streamers can be towed at depths ranging from 5 to 50 m below the water surface, but are expected to be towed 11 m or greater below the surface. Streamers will be separated by 120 m. A tail buoy with radar reflectors will be installed at the end of each streamer to act as a warning beacon to nearby vessels. Tail buoys will also be equipped with turtle/debris guards to reduce the risk of entanglements.

WesternGeco will deploy streamers for each seismic vessel towing streamers while enroute to the survey area. This will be a one-time event and will occur in waters >200 m in depth.
2.2.9 Logistics and Support

Offshore seismic operations will be supported by picket vessel(s) (sometimes referred to as a guard vessel) and supply vessel(s). A spare seismic source vessel will be used during the WATS program for crew changes and re-supply in port.

Helicopters will not be used for re-supply or crew changes. JRCC helicopters may be used in the event of a life threatening emergency situation.

2.2.9.1 Picket Vessel(s)

The seismic vessel(s) will be accompanied by a picket vessel(s) with responsibilities that include communications with other vessels (primarily fishing vessels) that may be operating in the area and scouting for hazards. In 2014, two picket vessels will be used to support the WATS seismic fleet. In 2015, the NATS seismic vessel will require one picket vessel. A typical picket vessel has a fuel capacity of 100–190 m$^3$.

2.2.9.2 Supply Vessel

Supply vessels will be typical of those that regularly service the offshore oil and gas industry in Atlantic Canada and will have a crew of about 6 to 12 marine qualified personnel. During the WATS program, heavy re-supply (including water, food, parts and fuel) to the seismic vessels towing streamers will occur at sea and will be conducted by two offshore supply vessels throughout the duration of the program. If required, re-supply of the seismic vessels not towing streamers may also occur at sea. It is anticipated that one supply vessel will be required for the NATS seismic survey. A typical supply vessel has a fuel capacity of 250 m$^3$.

2.2.9.3 Shore Base, Support and Staging

BP will maintain an office in Halifax and it is anticipated that vessel mobilization/demobilization and resupply will occur in Halifax. No new shore base facilities will be established as part of the Project.

2.2.10 Waste and Discharge Management

Wastes produced from the seismic, supply and picket vessels, including grey and black water, bilge water, deck drainage, discharges from machinery spaces and hazardous and non-hazardous waste material will be managed in accordance with MARPOL (International Convention for the Prevention of Pollution from Ships), CNSOPB Offshore Waste Treatment Guidelines (OWTG), and WG’s waste management plan. The contracted vessels’ policies and procedures will be reviewed against BP’s Operating Management System and associated policies. A Licence waste contractor will be used for any waste returned to shore.
2.2.11 Air Emissions

Air emissions will be those associated with standard operations for marine vessels, including the seismic vessels, picket vessels, and supply vessels. Vessels will adhere to MARPOL Annex VI, Regulations for the Prevention of Air Pollution from Ships.

2.2.12 Malfunctions and Accidental Events

In the unlikely event of an accidental release of hydrocarbons during the Project, BP and WesternGeco will implement the measures outlined in the Shipboard Oil Pollution Emergency Plan (SOPEP) and project emergency response plan. BP will develop bridging documents for emergency response with WesternGeco for approval by the CNSOPB prior to commencement of the seismic program.
3.0 Environmental Assessment Scoping

The CNSOPB provided a Scoping Document (dated 12 July 2013) for the Project, which outlined the factors to be considered in this EA. The Scoping Document is provided in Appendix B. In addition, various stakeholders were contacted for input on their potential issues and concerns (see Section 3.4 below). Scoping for the EA also involved reviewing recent EAs that included several Strategic Environmental Assessments (SEA) for petroleum exploration activities on the Scotian Slope and Shelf (see Section 3.5 below), and the Scoping Document and EA for Shell Canada’s Shelburne 3D seismic program on the western Scotian Slope (CNSOPB 2012; LGL 2012a). Reviews of the literature and the present state of knowledge on potential adverse effects from seismic operations were also conducted.

3.1 Regulatory Context and Considerations

The *Canadian Environmental Assessment Act, 2012* or CEAA 2012 came into force on 6 July 2012. The “Regulations Designating Physical Activities” lists physical activities which require an environmental assessment under the Act. Marine seismic surveys are not included on the list and therefore do not require an environmental assessment under CEAA 2012.

The CNSOPB has confirmed that although seismic surveys do not fall under CEAA 2012, an environmental assessment is required before an authorization can be issued under paragraph 142(1) (b) of the *Canada-Nova Scotia Offshore Petroleum Resources Accord Implementation Act*. The CNSOPB has delegated the preparation of the EA to the proponent and will make the determination of whether or not the Project may result in significant adverse environmental effects based on the EA.

A Project Description for the Tangier 3D seismic program was submitted to the CNSOPB on 5 July 2013 (LGL 2013a). Pursuant to Section 79(1) of the *Species at Risk Act* (SARA), the CNSOPB notified Fisheries and Oceans Canada (DFO) and Environment Canada (EC) that several Schedule 1 Species at Risk were identified by BP as having a reasonable likelihood of occurring in the Project Area. Both departments determined that they were in possession of specialist or expert knowledge and will be participating in the EA process. The Department of National Defence (DND) advised the CNSOPB that they are likely to be operating in the area in a non-interference manner during the project timeframe. DND asked to be informed of dates and locations of seismic activities.

The SEA for the Eastern Scotian Slope (Stantec 2012a) provides an overview of legislation that is relevant to the environmental planning and assessment of the Project. This legislation includes:

- *Oceans Act*;
- *Fisheries Act*;
• Canada National Parks Act;
• Migratory Birds Convention Act;
• Canada Shipping Act; and
• Canadian Environmental Protection Act.

In addition, the “Statement of Canadian Practice with respect to the Mitigation of Seismic Sound in the Marine Environment” (Statement of Canadian Practice) specifies the mitigation requirements that must be met during the planning and conduct of marine seismic surveys. These requirements are set out as minimum standards, which apply in all non-ice covered marine waters in Canada, including the Project Area. The Statement has been developed to complement existing environmental assessment processes. BP will comply with the mitigation measures outlined in the Statement of Canadian Practice.

3.2 Scoping Document

The CNSOPB, in consultation with DFO, EC and DND, released a Scoping Document (CNSOPB 2013) that included a description of the scope of the project to be assessed, the factors to be considered in the assessment, and the scope of those factors related to the EA of the Project. The Scoping Document provides the primary guidance for the completion of this EA and is attached as Appendix B for reference.

Based on previous EAs involving similar projects, the CNSOPB focused the scope of the factors to be considered to those with the potential for significant adverse environmental effects (see Section 4.1 for a definition of significant adverse effects). Regulations, guidelines, and standard mitigation were also considered in determining the scope of the EA.

Sections 3.2.1 and 3.2.2 of this EA summarize the guidance provided by the Scoping Document, particularly the environmental assessment requirements for each Valued Environmental Component (VEC).

3.2.1 Factors to be Considered and Key Interactions

The Scoping Document identified the following factors to be considered in this EA:

• The environmental effects of the project, including the environmental effects of malfunctions or accidental events that may occur in connection with the project, and any cumulative environmental effects that are likely to result from the project in combination with other projects or activities that have been or will be carried out;
• The significance of the environmental effects;
• Any comments from the public that are received; and
• Measures that are technically and economically feasible and that would mitigate any significant adverse environmental effects of the project.

The Scoping Document provides clear guidance on the key interactions between Project activities and VECs (see Section 3.2.2 below) that require assessment including: underwater sound from the airgun source arrays, collisions between vessels or equipment and marine mammals and sea turtles, vessel lighting and seabirds and Project interactions with other users of the Project Area. In addition, malfunctions and accidental events require assessment.

Appendix A of the Scoping Document sets out specific components that are considered by the CNSOPB to be outside the scope of this EA. These include air emissions, marine benthos and detailed assessments of marine birds, marine fish, marine mammals and sea turtles.

3.2.2 Identification of Valued Environmental Components

The Scoping Document issued by the CNSOPB listed the following VECs:

• Species of Special Status;
• Special Areas;
• Malfunctions and Accidental Events;
• Other Ocean Users; and
• Cumulative Effects.

Assessment requirements specific to each of these VECs, as provided in the Scoping Document, are included below. For the purposes of this assessment, Malfunctions and Accidental Events and Cumulative Effects are assessed as separate sections as each may result in potential effects on Species of Special Status, Special Areas, and Other Ocean Users.

3.2.2.1 Species of Special Status

The EA will identify all species listed on Schedule 1 of the SARA and their critical habitat, migratory birds and all species assessed as Endangered, Threatened, or of Special Concern by the Committee on the Status of Endangered Wildlife of Canada (COSEWIC) that are likely to occur within the Project Area while seismic activities are occurring. The EA shall evaluate all potential environmental effects, including cumulative effects, of the Project on species listed on Schedule 1 of the SARA and their critical habitat, and any migratory birds protected by the Migratory Birds Convention Act, 1994.

The EA shall include a description of estimated sound levels within the Study Area as a result of the seismic survey activity, and an assessment of the resultant potential effects on marine mammal, fish, sea turtle, and bird species-at-risk and migratory birds. BP shall also assess the means by which potential adverse effects on species-at-risk and their critical habitat, and
migratory birds, will be mitigated through design and/or operational procedures, including those listed in the “Statement of Canadian Practice with Respect to the Mitigation of Seismic Sound in the Marine Environment”.

BP shall indicate whether the Project will be in compliance with the SARA prohibitions (SARA Sections 32, 33 and 58) and shall identify whether any SARA Section 73 permits will be requested. In addition, a CWS Migratory Bird Handling Permit for migratory birds potentially stranded on the vessels will be obtained prior to survey start. Additional mitigation may be required should new species-at-risk be added to Schedule 1 during the lifetime of the assessment.

### 3.2.2.2 Special Areas

Assessment of potential effects on areas designated of special interest due to their ecological and/or conservation sensitivities that could be affected by seismic exploration activities are to be included in the EA. The Scoping Document listed the Haddock Box, Sable Island National Park and The Gully Marine Protected Area (MPA) as being sufficiently close to the project to warrant an assessment of potential adverse effects.

### 3.2.2.3 Other Ocean Users

An assessment of the potential effects of the Project on other ocean users in the Project Area, including any new activities that develop during the life of the program, shall be included in the EA. The proponent shall determine the potential for interactions with other oil and gas exploration and development activities, fisheries (commercial, recreational and/or aboriginal), DND training exercises, marine shipping and subsea cables. BP shall contact DFO to determine if any fisheries research survey vessels are expected to be in the Project Area at the time of the surveys.

### 3.2.3 Malfunctions and Accidental Events

Hydrocarbon releases from seismic streamers\(^1\) have occurred on the Scotian Shelf and there is the possibility of light spills, such as fuel oil, from seismic vessels. BP shall provide information on the sources and volumes of petroleum products expected to be on board all vessels and to be used for the Project to the CNSOPB. The proponent shall also be required to state the measures to be used to minimize the potential for accidental release of these materials into the environment including a Spill Response Plan specific to the Project.

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\(^1\) All streamers towed by WesternGeco’s seismic vessels will be solid (i.e., contain no fluids; see Section 2.2.8).
3.2.4 Cumulative Effects

The EA is required to assess the potential cumulative effects of the Project and other significant sources of sound in the marine environment, such as other seismic programs and military exercises, as well as the cumulative effects of increased vessel presence as a result of the Project on the above listed VECs. The assessment shall include the means by which design and/or operational procedures, including follow-up measures, will be implemented to mitigate significant adverse environmental effects as a result of cumulative effects.

3.2.5 Additional Guidance

The Scoping Document also provides guidance for assessing the potential effects of the environment on the Project, follow-up requirements, spatial and temporal boundaries, significance of environmental effects and a detailed summary of the EA.

3.3 Spatial and Temporal Assessment Boundaries

For the purposes of this EA, spatial and temporal boundaries are defined below.

3.3.1 Temporal Boundaries

The temporal boundaries of the Project are between 1 April to 30 November in 2014 and 2015.

3.3.2 Spatial Boundaries

3.3.2.1 Project Area

The Project Area is the area where the vessels will be acquiring seismic data. The Project Area also includes an additional area for both the WATS and NATS 3D seismic surveys to accommodate the ships’ turning radii (see Figure 2.1). The WATS 3D Acquisition Area and the NATS 3D Acquisition Area are the areas in which 3D seismic data are proposed to be acquired in 2014 and 2015, respectively.

3.3.2.2 Study Area

The Study Area is an area larger than the Project Area where potential effects from the Project may occur (see Figure 3.1). The results of acoustic modelling of the airgun array (Appendix A) were used to establish the Study Area. The 160 dB re 1 µPa (rms) sound level was used as the basis for establishing the Study Area because this sound level is often used (in Canada and the U.S.) when assessing behavioural effects of pulsed sound on marine mammals (see Section 4.2.1 later). Maximum distance (range) estimates ($R_{max}$) where received sound levels were estimated to be 160 dB rms or higher, were reviewed for each of the six acoustic modelling sites and for each
modelled month (April and August; see Section 5 for a summary of modelling methods). As shown in Table 3.1, there was variation in 160 dB rms estimated ranges (i.e., 7.0 km to 22.1 km) depending on the physical characteristics (e.g., water depth, bottom type) of where in the Project Area a modelling site was located and what month (April or August) was modelled (i.e., variation in sound speed profile). A 25 km “buffer” was selected to represent the maximum range (22.1 km at Site 5 rounded up) where estimated sound levels were ≥160 dB rms. This 25 km distance was applied uniformly to the Project Area. However, it should be noted that in many parts of the Project Area, the 25 km buffer is much larger than the distance where one would expect sound levels to exceed 160 dB rms. Also, although not specifically included within the boundary of the Study Area, the Special Areas that required assessment as per the Scoping Document are assessed in Section 7.2 of this EA (Gully MPA, Haddock Box, and Sable Island National Park Reserve).

Figure 3.1. Locations of the WATS 3D Acquisition, NATS 3D Acquisition, Project, and Study Areas, as well as the BP Exploration Licences
Table 3.1. Maximum horizontal distance estimates for received sound levels ≥160 dB re 1 μPa (rms) at each of the six acoustic modelling sites for April and August.

<table>
<thead>
<tr>
<th>Acoustic Modelling Site (Survey Area: Water depth)</th>
<th>Distance (km) to ≥160 dB rms (R\text{max} in April)</th>
<th>Distance (km) to ≥160 dB rms (R\text{max} in August)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Site 1 (WATS: 1,700 m)</td>
<td>21.2</td>
<td>18.8</td>
</tr>
<tr>
<td>Site 2 (WATS: 3,200 m)</td>
<td>19.4</td>
<td>19.3</td>
</tr>
<tr>
<td>Site 3 (NATS: 100 m)</td>
<td>18.9</td>
<td>12.2</td>
</tr>
<tr>
<td>Site 4 (NATS: 500 m)</td>
<td>12.8</td>
<td>12.1</td>
</tr>
<tr>
<td>Site 5 (WATS/NATS: 2,400 m)</td>
<td>22.1</td>
<td>15.9</td>
</tr>
<tr>
<td>Site 6: (WATS/NATS: 1,300 m)</td>
<td>9.6</td>
<td>7.0</td>
</tr>
</tbody>
</table>

See Figure 5.1 for locations of acoustic modelling sites.

3.4 Stakeholder Engagement

Stakeholder engagement was undertaken with relevant government agencies, representatives of the fishing industry and other interested groups. Additionally, information sharing has been conducted with the First Nations. Appendix C provides an overview of engagements that have taken place to date during the preparation of the EA document. The primary objective of these engagement activities has been to provide potentially interested parties with information regarding the Project as well as the opportunity to provide feedback.

Parties contacted in regards to the EA for the Project were those identified to be interested in Project activities, those holding specific knowledge in regards to the Project, and those that could be potentially affected by the Project. The EA has been compiled in consideration of the input and information received to date (see Table C-2 in Appendix C).

Government agencies were engaged via email, phone and face-to-face meetings following submission of the Project Description (LGL 2013a). This was done to identify issues and concerns, acquire departmental knowledge and information relevant to the EA, as well as to determine their preferred manner of engagement for the Project. All non-governmental stakeholder and interest groups that were engaged were provided a project information package and/or engaged in face-to-face meetings. Information packages included a description of the proposed Project and relevant location maps. Recipients not engaged in face-to-face meetings were asked to review the information package and encouraged to contact BP with any comments regarding the Project activities.
The following agencies, stakeholders and interest groups were engaged in face-to-face meetings. Other groups contacted by phone and/or email are listed in Appendix C.

- CNSOPB
- Fisheries and Oceans Canada
- Department of National Defence
- Environment Canada
- Canadian Environmental Assessment Agency
- Parks Canada
- Defence Construction
- Transport Canada
- Canadian Coast Guard
- Nova Scotia Department of Environment
- Nova Scotia Office of Aboriginal Affairs
- Nova Scotia Department of Energy
- Nova Scotia Department of Fisheries and Aquaculture
- Halifax Port Authority
- Seafood Producers Association of Nova Scotia
- Eastern Fishermen’s Federation
- Guysborough County Inshore Fishermen’s Association
- Nova Scotia Swordfish Association
- Area 24 Crab Fishing Association
- Eastern Shore Protective Fisheries Association
- Halifax West Commercial Fisherman’s Association
- Atlantic Shark Association
- Nova Scotia Fish Packers Association
- Native Council of Nova Scotia Netukulimkewe’l Commission
- Mi’Kmaq Kwilmu’kq Maw-Klusuaqn Negotiation Office

Engagement will be ongoing throughout the seismic Project and BP will continue to work with stakeholders to identify and seek to address issues and concerns. BP will also seek to provide information about the Project to stakeholders as it becomes available through information sessions or follow up information packages. Groups that requested notification of when the EA is available on the CNSOPB website will be contacted by BP. Also, meetings with BP’s seismic contractor will be held in early 2014 for groups that requested this meeting.

Appendix C provides an overview of engagements that have taken place to date during the preparation of the EA document. This overview is inclusive of issues and concerns identified as part of the engagement process (see Appendix C, Table C-2).
3.5 Strategic Environmental Assessment (SEA)

The CNSOPB conducts SEAs in areas that may have the potential for offshore petroleum exploration activity but were either not subject to a recent SEA or to recent and substantial project-specific environmental assessments.

The SEA incorporates a broad-based approach to environmental assessment 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 (CEAA 2010). The 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.

Information from SEAs assists the CNSOPB in its determination in respect to the potential issuance of future exploration rights within the SEA areas and may identify general restrictive or mitigative measures that should be considered for application to consequent exploration activities. Each SEA also undergoes a public review process, providing an opportunity for interested or potentially affected groups or individuals to raise any issues or provide comments to the CNSOPB prior to the issuance of a Call for Bids and/or ELs for a specific offshore area. Comments are typically addressed in the final SEA reports.

The SEA does not replace the requirement for a project-specific EA. Each Project requires the specific approval of the CNSOPB, including a project specific assessment of its associated environmental effects, and may also be subject to review by Federal Government Departments, such as DFO and EC for compliance with applicable legislation and/or regulations.

The SEA assists in focusing project specific 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.

Several recently completed SEAs provide background information and overviews of issues of concern for this EA. These include the SEA for petroleum exploration activities on the southwestern Scotian Slope (Hurley 2011) and its associated Addendum (Hurley 2012), the SEA for the Eastern Scotian Slope (Stantec 2012a), and the SEA for the Eastern Scotian Slope-Middle and Sable Island Banks (Stantec 2012b).
4.0 Effects Assessment Approach and Methodology

This section provides a description of the approach and methodology used in the effects assessment process. It involves an integration of the description of the Project, results of acoustic modelling, descriptions of the VECs, the issues identified by stakeholders during consultations (see Appendix C for a summary of consultations), public comments, and review of related EA documents—particularly the relevant SEAs (Hurley 2011, 2012; Stantec 2012a,b). Written descriptions of the nature of the potential effects are presented, as are magnitude ratings using similar terminology, definitions, and ranking system developed in the generic EA of seismic exploration on the Scotian Shelf (Davis et al. 1998) and used in site-specific seismic EAs on the Scotian Slope (Moulton et al. 2003; LGL 2013b). The assessment of the potential effects of the Project on VECs is made considering the application of regulatory requirements, and of general industry and project-specific mitigation measures. These residual effects, including mitigation measures are summarized in Section 12.

4.1 Effects Definitions and Evaluation of Significance

Three primary types of effects definitions were used in the assessment: magnitude, geographic extent, and duration. Other definitions that have been used in EAs include ecological/social-cultural and economic context, frequency, and reversibility. Note that frequency and reversibility have not been included in our effects definitions. Frequency was not included given that geophysical data acquisition is expected to be a near-continuous activity with short operational shutdowns of the airgun arrays during line changes or in the event of sightings of marine mammals or turtles within the safety zone. Where frequency matters it is discussed in more detail in the assessment. Unless otherwise indicated, all effects from the Project are considered reversible given the seasonal nature of the seismic surveys. The assessment of significance is evaluated on the basis that BP will implement the mitigation measures included in this EA and detailed in Section 12 (i.e., it is an assessment of residual effects).

4.1.1 Magnitude of Potential Effects

Magnitude describes the nature and extent of the environmental effects for each activity considered in this EA. The biological measures to be included in the definition of magnitude are not clearly established and provided in any single document of authority. After careful consideration, definitions of magnitude similar to those used for numerous seismic EAs in Atlantic Canada, including Nova Scotia were used (e.g., Moulton et al. 2003; LGL 2013b).

For this EA, the magnitude of effect is categorized as:

- **Major** - An effect from the Project on a VEC is rated major if it is judged to result in at least a 10% change in the size or health of a population, the carrying capacity of its habitat, or a commercial harvest. A change in a population can result from an absolute
reduction in population size or from displacement of animals to areas outside the area of consideration.

- **Moderate** - An effect from the Project on a VEC is rated moderate if it is judged to result in a 1% to less than 10% change in the size or health of a population, the carrying capacity of its habitat, or a commercial harvest.
- **Minor** - An effect from the Project on a VEC is rated minor if it is judged to result in a less than 1% change in the size or health of the population, the carrying capacity of its habitat, or a commercial harvest.
- **Negligible** - Negligible effects result from interactions that are judged to have either no or very minimal effects.

It should be noted that the percentage changes cannot be measured in practice as field studies are beyond the scope of this environmental assessment and there would be difficulty in attributing any observed changes to the Project as opposed to changes from natural variability or other sources. However, these percentage levels are used to provide the reader with an understanding of the expected relative magnitude of potential effects from the Project.

When evaluating the magnitude of predicted effects, certain VECs have special status. For example, effects on endangered species such as right whales, were given more weight than were similar effects on other species.

Project activities are not expected to result in the mortality of species listed on Schedule 1 of SARA. A reduction in population size of species listed as Endangered or Threatened on Schedule 1 of SARA (i.e., mortality of an individual) is considered “major” in magnitude.

The categorization of magnitude includes consideration of scientific literature, acoustic modelling results, and the use of professional judgement. The magnitude ranking contributes to the assessment of significance.

### 4.1.2 Geographic Extent of Potential Effects

The geographic extent or scale of effect refers to the specific area (km²) affected by a Project activity, which may vary by VEC. Geographic extent is categorized as:

- < 1 km²
- 1-10 km²
- 11-100 km²
- 101-1,000 km²
- 1,001-10,000 km²
- >10,000 km²
For further clarity, an area of 100 km² is equal to a circle around the airgun array with a radius of 5.6 km. Similarly, circular areas of 1,000 km² and 10,000 km² would have radii equal to 17.8 km and 56 km, respectively.

4.1.3 Duration of Potential Effects

The duration of effect refers to the time period during which an effect persists. As noted earlier, these categories (short-, medium-, and long-term) were based on the generic EA of seismic exploration on the Scotian Shelf (Davis et al. 1998) and those used in site-specific seismic EAs on the Scotian Slope (Moulton et al. 2003; LGL 2013b). Duration of effect is categorized as:

- < 1 month (short-term)
- 1 – 12 months (short-term)
- 13 – 36 months (medium-term)
- 37 – 72 months (medium-term)
- 72 months (long-term)

When possible, the duration of a potential effect is discussed in more detail.

4.1.4 Ecological/Social-cultural and Economic Context

The ecological, socio-cultural and economic context describes the current status of the area affected by the proposed seismic project in terms of existing environmental effects. Three levels are considered:

- pristine area;
- area affected by human activity, and
- area showing existing evidence of adverse effects.

Based on the presence of shipping, fishing activity and oil and gas exploration and production activity within and near the Study Area, the ecological, socio-cultural and economic context was classified as an area affected by human activity.

4.1.5 Significance of Environmental Effect

A significant environmental effect is one that is considered to be of sufficient magnitude, geographic extent and duration to cause a change in a VEC that would alter its status or integrity beyond an acceptable level. Establishment of the significance criteria is based on professional judgement including experience during similar seismic programs. An effect can be considered significant (negative by definition), not significant, or positive. In this EA, a significant effect is defined as one having either:
- major magnitude; or
- moderate magnitude over a geographic extent >100 km² for a time period >1 year

For this assessment, effects are judged assuming the implementation of Project mitigation measures (i.e., an assessment of residual effects).

### 4.1.6 Level of Confidence

An assessment of scientific certainty (i.e., low, medium, and high levels of confidence) is based on the confidence in the available scientific evidence related to a Project activity judged to have a negative effect on a VEC. Level of confidence can be assessed as:

- **Low** - Based on incomplete understanding of cause-effect relationships and/or incomplete data specific to the Study Area (or similar area);

- **Medium** - Based on good understanding of cause-effect relationships using data from elsewhere or incompletely understood cause-effect relationships using data specific to the Study Area (or similar area); and

- **High** - Based on good understanding of cause-effect relationships and data specific to the Study Area (or similar area).

### 4.2 Sound Criteria for Assessing Potential Effects

There is no single standard for defining which sound levels or criteria are appropriate for assessing effects on marine VECs. This assessment considers the most relevant and available scientific information. A summary of the criteria used in this assessment and the rationale for the selection is provided below for marine mammals and sea turtles. Specific criteria were not used for fishes.

#### 4.2.1 Marine Mammals

There are four types of potential effects of seismic sounds on marine mammals considered in this assessment. These include the following.

1. Masked communication;
2. Permanent hearing impairment, evident as Permanent Threshold Shift (PTS);
3. Temporary reduction in hearing sensitivity, evident as Temporary Threshold Shift (TTS); and
4. Change in behaviour and distribution (i.e., “disturbance”) considered “biologically significant” (see Section 4.2.1.3 and Section 1.5 of Appendix D).
A detailed description of the current and available scientific knowledge of the potential effects of seismic sound on marine mammals, as it relates to these four types of potential effects, is overviewed below and provided in more detail in Appendix D, Sections 1.4 (Masking), 1.5 (Disturbance), and 1.6 (Hearing Impairment).

### 4.2.1.1 Masking

Masking is the obscuring of sounds of interest by interfering sounds, generally at similar frequencies. Masking can occur if the frequency of the source is close to that used as a signal by the marine mammal and if the anthropogenic sound is present for a significant fraction of time (Richardson et al. 1995; Clark et al. 2009). Conversely, masking is not expected if little or no overlap occurs between the introduced sound and the frequencies used by the species or if the introduced sound is intermittent. Because of the intermittent nature and low duty cycle of seismic pulses, animals can emit and receive sounds in the relatively quiet intervals between pulses (see Section 1.4 of Appendix D). However, in some situations, multi-path arrivals and reverberation cause airgun sound to arrive for much or all of the interval between pulses (e.g., Simard et al. 2005; Clark and Gagnon 2006), which could mask calls. Situations with prolonged strong reverberation are considered infrequent. However, it is common for reverberation to cause some lesser degree of elevation of the background level between airgun pulses (e.g., Gedamke 2011; Guerra et al. 2011, 2013), and this weaker reverberation presumably reduces the detection range of calls and other natural sounds to some degree. The potential for masking of marine mammal calls and/or important environmental cues from the proposed WA TS and NATS seismic program where airgun arrays will be activated individually every 13.5 and 10 seconds, respectively is considered to be low. As a result of these considerations, masking is therefore not considered further in this assessment.

### 4.2.1.2 Hearing Impairment

As discussed in detail in Appendix D (Section 1.6), temporary or permanent hearing impairment is possible when marine mammals are exposed to very high sound levels.

TTS is the mildest form of hearing impairment that can occur during exposure to a strong sound (Kryter 1985). While experiencing TTS, the hearing threshold rises and a sound must be stronger in order to be heard. It is a temporary phenomenon, and (especially when mild) has not been considered to represent physical damage or “injury” (Southall et al. 2007; Le Prell 2012). However, recent research has shown that sound exposure (in terrestrial mammals) can cause cochlear neural degeneration, even when threshold shifts in hearing and hair cell damage are reversible (i.e., temporary; Liberman 2013). These findings have raised some doubts as to whether TTS should continue to be considered a non-injurious effect.
When PTS occurs, there is physical damage to the sound receptors in the ear. In some cases, there can be total or partial deafness, whereas in other cases, the animal has an impaired ability to hear sounds in specific frequency ranges (Kryter 1985). There is no specific evidence that exposure to pulses of airgun sound can cause PTS in any marine mammal, even with large arrays of airguns. However, given the likelihood that some mammals close to an airgun array might incur at least mild TTS (see Section 1.6.1 in Appendix D), there has been further speculation about the possibility that some individuals occurring very close to airguns might incur PTS (e.g., Richardson et al. 1995, p. 372ff; Gedamke et al. 2011).

Criteria Used in the Assessment

The scientific recommendations provided in Southall et al. (2007) were used to establish hearing impairment criteria for marine mammals (included in the Species of Special Status VEC) assessed in this EA. These recommendations made by a group of experts in acoustic and marine mammal research were based on best available scientific data.

Southall et al. (2007) noted that TTS onset in marine mammals may be more closely correlated with the received energy levels than with SPL (rms)\(^2\) that have previously been used to assess hearing impairment effects. In odontocetes (mid-frequency species) exposed to impulsive sounds, the TTS threshold\(^3\) can be as low as \(~183\) dB re 1 \(\mu\)Pa\(^2\) \(\cdot\) s. There are no specific data concerning the levels of underwater sound necessary to cause permanent hearing damage (PTS) in any species of marine mammal. A conservative estimate of the offset between TTS and PTS, when sound exposure is measured on an SEL basis (received energy level), is 15 dB (Southall et al. 2007). Thus, available data indicate that the lowest cumulative received SEL that could elicit auditory injury (PTS) in cetaceans is 198 dB re 1 \(\mu\)Pa\(^2\) \(\cdot\) s (i.e., 183 dB + 15 dB) (Southall et al. 2007). In addition, Southall et al. concluded that PTS might occur if cetaceans (as exemplified by belugas and bottlenose dolphins) were exposed to peak pressures exceeding 230 re 1 \(\mu\)Pa (peak; flat or unweighted). These injury criteria were proposed for cetaceans exposed to single or multiple pulses.

This remains a very complex issue and regulatory bodies (e.g., NMFS and DFO) have not formulated new policy directions in response to these proposed criteria. It should be noted that

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2 The numerical value of the level or “strength” of a received seismic pulse varies depending on the methods used to measure the sound pulse, and the units in which it is expressed. Thus, it is important to be clear about the basis of the measurement when quoting received levels of seismic pulses. “rms” or “root mean square” refers to a particular method of measuring the pulsed sounds, and represents an average level over the duration of the received pulse. Pulse levels measured in this way are lower than peak or peak-to-peak levels (typically by 10–12 dB and by 16–18 dB, respectively), but higher than sound exposure levels (SEL), typically by 10–15 dB. (SEL is a measure of the energy in the pulse, and has different units: dB re 1 \(\mu\)Pa\(^2\) \(\cdot\) s.)

3 As noted in Southall et al. (2007) and discussed in Section 1.6 of Appendix D, this approach is considered precautionary for mid- and low-frequency species, but caution is warranted in applying it to some high-frequency species like harbour porpoise (cf. Lucke et al. 2009).
the suggestion by Southall et al. (2007) that sound exposure be cumulated over 24 hours was very much a subjective judgement, with no specific empirical or other scientific basis insofar as marine mammals are concerned (W. John Richardson, LGL Limited, pers. comm., 2012). There is much uncertainty regarding the exposure period that should be used to calculate cumulative SEL for purposes of assessing potential auditory effects.

The following received levels (RL) of sound (or criteria) were used to assess potential risk of hearing impairment effects of airgun array sound on cetaceans (those species on Schedule 1 of SARA that require specific assessment as per the requirements outlined in the Scoping Document).

- Received energy level (SEL) ≥198 dB re 1 μPa² · s (M-weighted) for PTS
- Received energy level (SEL) ≥183 dB re 1 μPa² · s (M-weighted) for TTS

M-weighting is a method of quantitatively compensating for the differential frequency response of marine mammal hearing (see Section 1.3 of Appendix A for more details).

This EA does not use the 180 dB re 1 uPa (rms) criterion for hearing impairment in cetaceans (exposed to impulsive sounds) currently used by the U.S. NMFS for the reasons detailed in Section 1.6 of Appendix D. Most notably, the criterion was established before there was any information about the minimum received levels of sounds necessary to cause auditory impairment in marine mammals. This is discussed further in Section 12.1.3. NMFS is currently moving toward adoption of new procedures taking at least some of the Southall et al. recommendations into account (Scholik-Schloemer 2012; NMFS 2013).

4.2.1.3 Behaviour

Southall et al. (2007) concluded that available data on marine mammal behavioural responses to multiple pulses (like airgun array sound) are simply too variable and context specific to justify proposing a single disturbance criterion. Therefore, this assessment considers a sound level criterion commonly used in EAs of seismic programs in Canada and currently used by the U.S. NMFS for assessing behavioural effects on marine mammals.

Sound levels ≥160 dB re 1 μPa (rms) have commonly been used in EAs of seismic programs in Atlantic Canada and in the Canadian Beaufort Sea for assessing behavioural effects on marine mammals. These are the levels of sound that are often assumed to elicit behavioural disturbance in marine mammals based on observations of mysticetes reacting to airgun pulses (Malme et al. 1983, 1984; Richardson et al. 1986). The U.S. NMFS currently uses the ≥160 dB re 1 μPa (rms) criterion for assessing possible behavioural effects from exposure to airgun pulses. Specifically, NMFS considers 160 dB re 1 μPa (rms) to be the received level above which there is potential to disturb a marine mammal or marine mammal stock in the wild by causing disruption of behavioural patterns, including, but not limited to, migration, breathing, nursing, breeding,
feeding, or sheltering, but not at which there is the potential to injure a marine mammal or marine mammal stock in the wild. Although applied by NMFS to all marine mammals, there is variation in response thresholds, with some species reacting at RLs lower than 160 dB re 1 μPa (rms) and others not reacting unless levels are higher (see Section 1.5 of Appendix D).

4.2.1.4 Auditory Weighting Function

For the purposes of assessment, flat-weighting (i.e., no weighting to account for the hearing sensitivities of marine mammals) was applied when calculating the distances within which RLs would diminish to 160 dB re 1 μPa (rms) (disturbance effect). Most available literature on marine mammal behavioural response to sound, including airgun pulses, has been reported as SPL rms. M-weighting was applied when estimating the distances within which the RLs would diminish to 198 dB re 1 μPa² · s (PTS for cetaceans) and 183 dB re 1 μPa² · s (TTS for low- and mid-frequency cetaceans).

4.2.2 Sea Turtles

Based on available data, it is possible that leatherback sea turtles could exhibit temporary hearing loss if the turtles are close to the airguns (see Appendix E). However, there is not enough information on sea turtle temporary hearing loss and no data on permanent hearing loss to reach any definitive conclusions about received sound levels that would trigger TTS or PTS.

Relative to marine mammals, there are limited data on sea turtle behavioural response to airgun array sound. Based on behavioural observations of captive green and loggerhead sea turtles (see Section 2 of Appendix E; primarily McCauley et al. 2000a,b), it is assumed for the purposes of this assessment that behavioural effects of an airgun array may occur at received sound levels ranging from >166–175 dB re 1 μPa (rms). At RLs >166 dB re 1 μPa (rms), increases in sea turtle swim speed were observed in caged sea turtles. At RLs >175 dB re 1 μPa (rms), caged sea turtles exhibited erratic behaviour, which McCauley et al. (2000a,b) suggested would likely be expressed as an avoidance response in unrestrained turtles.

4.2.3 Fishes

Available research indicates considerable inter- and intra-specific differences in received sound levels that evoke either subtle or more overt behavioural responses in fishes (Appendix F). Therefore, a single criterion for behavioral response in fishes has not been used in this assessment. Based on evidence from existing research, any substantial physical/physiological effects of exposure to seismic sound on fishes considered in this assessment can be confidently dismissed (Appendix F). While there is evidence for physical and physiological effects on all fish life stages, these effects were observed only when the subject was exposed in close proximity to the seismic sound source (i.e., within metres) and in many cases could not move away from the seismic sound source (i.e., captive subject; Appendix F). In natural conditions,
juvenile and adult fish stages can move away from a seismic source. While eggs and larvae do not have the ability to actively move away, a very small proportion of all the eggs and larvae in an area would be exposed to the seismic source at very close range.

4.3 Cumulative Effects

Cumulative effects refer to the effect a project or activity has on the environment when combined with the effects of other past, existing and reasonably foreseeable projects and activities. Projects and activities that will be considered in the cumulative effects assessment include other human activities in Nova Scotia offshore waters. These human activities include the following as indicated in the Scoping Document (see Appendix B).

- **Other “significant sources of sound”** — Based on guidance received from the CNSOPB, this includes other seismic surveys and DND operations that use military sonar. During preparation of this EA, there were no other seismic surveys planned offshore Nova Scotia in 2014 or 2015. Details on DND operations were not available. If other “significant sources of sound” are identified following submission of this EA, BP will consider further acoustic modelling and assessment.

- **Vessel presence** — Based on guidance received from the CNSOPB, this includes an assessment of effects from the vessels (i.e., vessel presence) associated with the Project plus other vessels operating in the area.

4.4 Follow-up Monitoring

In the event of a malfunction or accidental event, the need for follow-up monitoring will be assessed in consultation with the CNSOPB.
5.0 Acoustic Modelling

Acoustic modelling of the airgun array (5,085 in$^3$) was undertaken to allow for a description and assessment of potential sound exposure levels and to provide estimates of the distances and areas where the sound level criteria used in this assessment would be exceeded. This information is used to assist in the assessment of the spatial extent of potential effects of sound from the airgun array on VECs. In short, acoustic modelling predicts the source level of the airgun array (i.e., the nominal sound level referenced at 1 m from the airgun array). This information is then used as input into a propagation model, which predicts the distances (or ranges) where received sound levels are expected to occur. Many factors (e.g., water depth, bottom type, temperature and salinity, and position in the water column) influence how far sound will propagate or travel and these factors are key inputs into the propagation model.

Appendix A provides a detailed description of the modelling approach and results; it also provides the sound speed profile information and assumptions used in the models. The modelling methods are summarized below.

5.1 Modelling Per-Pulse Sound Levels

Two complementary acoustic models were used to predict the underwater acoustic field of the 5085 in$^3$ airgun array proposed for use in the seismic surveys for the Project: (1) airgun array pressure signatures and directional source levels (SL) were predicted with an Airgun Array Source Model (AASM) (MacGillivray 2006), and (2) propagated acoustic fields were modelled with a Marine Operations Noise Model (MONM), based on the computed signatures (as described below) and SLs.

AASM is based on the physics of the oscillation and radiation of airgun bubbles. It produces a set of “notional” signatures for each array element (i.e., airgun) based on:

- Array spatial layout,
- Volume, tow depth, and operating pressure of each airgun, and
- Interactions between airguns in the array.

The signatures are summed with the appropriate phase delays to obtain the far-field source signature$^4$ of the entire array in different directions. This far-field array signature is then filtered into 1/3-octave pass-bands to compute the SLs of the array as a function of frequency band and azimuthal angle in the horizontal plane.

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$^4$ The far field is the zone where, to an observer, sound originating from a spatially-distributed source appears to radiate from a single point. The distance to the acoustic far field increases with frequency. Note that predicted source levels very close to the array (i.e., within the near field) will be overestimated due to near field interactions.
Combined with the SL prediction, MONM computes the received per-pulse SEL for the airgun array at frequencies of 10 Hz to 2 kHz. MONM treats sound propagation in range-varying acoustic environments through a wide-angled parabolic equation (PE) solution to the acoustic wave equation, based on a version of the U.S. Naval Research Laboratory’s Range-dependent Acoustic Model (RAM) (Collins et al. 1996). The model accounts for depth and/or range dependence of several environmental variables, including bathymetry and sound speed profiles in the water column and the sub-bottom.

Processing the modelled received levels involves gridding all data points in each horizontal plane separately (i.e., at each modelled depth). The resulting stack of grids is collapsed into a single grid using a maximum-over-depth rule. This means that the sound level at each horizontal planar point is taken to be the maximum value occurring over all modelled depths for that point.

Since MONM provides the received sound level estimates as an SEL metric, an additional step is required to obtain convert SEL results to an SPL (rms and peak) metric. A third acoustic model, the Full-Waveform Range-dependent Acoustic Model (FWRAM), was used to determine the acoustic pulse time integration periods as a function of range from the sources, and consequently, the range-dependent conversion factor between SEL and rms SPL.

Based on a literature review of marine mammal hearing and on physiological and behavioural responses to anthropogenic sound, Southall et al. (2007) proposed standard frequency-weighting functions—referred to as M-weighting functions—for functional hearing groups of marine mammals. This marine mammal frequency weighting (M-weighting) was applied to four functional hearing groups to weight the importance of received sound levels at particular frequencies. These four functional hearing groups include:

- Low-frequency cetaceans (LFCs)—mysticetes (baleen whales);
- Mid-frequency cetaceans (MFCs)—most odontocetes (toothed whales);
- High-frequency cetaceans (HFCs)—odontocetes specialized for using high-frequencies;
- Pinnipeds in water (Pw)—seals, sea lions, and walrus. [Sea lions and walrus do not occur in the Study Area.]

The predicted distances to specific sound levels were computed from the planar grids of the maximum-over-depth sound fields. Two distances from the source are reported for each sound level: (1) \( R_{\text{max}} \), the maximum range at which the given sound level was encountered in the modelled field grid; and (2) \( R_{95\%} \), the maximum range to a grid point at which the given sound level was encountered after exclusion of the 5% farthest such points. \( R_{\text{max}} \) ranges were used for assessing effects because these results are more precautionary.
Six sites were selected to represent the range of environmental parameters such as water depth, geoacoustic properties of the sea bottom, and the water column sound speed profile in the Project Area (Figure 5.1). Modelling sites were also selected based on proximity to Special Areas.

Figure 5.1. Locations of the Acoustic Modelling Sites Within the Project Area

- Site 1 is located on the slope within the WATS Area and is proximate to the Gully MPA (1,700 m water depth);
- Site 2 is in the deeper waters of the WATS Area and also represents areas with a flat bottom (3,200 m water depth);
- Site 3 is located on the Scotian Shelf in the NATS West Area and is proximate to the Haddock Box (100 m water depth);
- Site 4 is located on the Scotian Slope in the NATS East Area (500 m water depth);
- Site 5 represents mid-point water depth between Sites 1 and 2 (2,400 m); and
- Site 6 represents the shallowest water depth of the WATS Area (1,300 m).
For each modelling site, two sound speed profiles were used (April and August); each representing an extreme in the profiles during the temporal period of the Project (April to November).

5.1.1 Precautionary Steps

A conservative or precautionary approach was taken when predicting sound levels from the airgun array. There is uncertainty in acoustic modelling results given the numerous inputs in the models and underlying assumptions about these inputs. Sound verification tests of previous acoustic modelling completed by JASCO in the Beaufort and Chukchi seas were on average 3 dB higher than the modelled predictions (Aerts et al. 2008; Funk et al. 2008; Ireland et al. 2009; O’Neill et al. 2010; Warner et al. 2010). Therefore, a correction factor of 3 dB was added to the predicted received levels to provide precautionary results reflecting the inherent variability of sound levels in the modelled area. In addition, a maximum-over-depth approach was used. Received sound levels were determined for various water depths at each modelled distance from each of the six sites. Whereas received sound levels varied with depth at each distance from the source, the maximum received value was always used for the purposes of assessing environmental effects in this report. In addition, the most reflective geoacoustic profile (i.e., the profile resulting in the least acoustic attenuation; April) was used for effects predictions.
6.0 Summary of Marine Biota Anticipated to Occur in the Study Area

As indicated in the Scoping Document (CNSOPB 2013), a description of marine biota anticipated to occur within the Study Area is required in this EA. For this EA, the principal species are listed along with the most likely period of occurrence within the Study Area. The Study Area for this Project is captured by the study areas of three recently prepared SEAs: (1) Strategic Environmental Assessment – Petroleum Exploration Activities on the Southwestern Scotian Shelf (Hurley 2011), (2) Strategic Environmental Assessment for Offshore Petroleum Exploration Activities – Eastern Scotian Shelf-Middle and Sable Island Banks (Phase 1A) (Stantec 2012a), and (3) Strategic Environmental Assessment for Offshore Petroleum Exploration Activities – Eastern Scotian Slope (Phase 1B) (Stantec 2012b). This summary information is presented under the following sections:

- Phytoplankton;
- Zooplankton;
- Benthic invertebrates;
- Commercial invertebrates;
- Commercial fishes;
- Birds;
- Sea turtles; and
- Marine mammals.

Note that Species of Special Status (i.e., certain fish, birds, sea turtles and marine mammals) are discussed in greater detail in Section 7.0.

6.1 Phytoplankton

As the base of the marine food web, phytoplankton production sets limits on the production of all higher trophic levels. On the Scotian Shelf and Slope, diatoms and dinoflagellates are the largest and most common phytoplankton groups. There is a distinctive cycle to phytoplankton abundance. It is typically characterized by spring and fall blooms related to high concentrations of nutrients and sunlight in the water column. In recent years, the spring bloom on the Scotian Shelf and Slope has commenced earlier and has been more intense and longer in duration than what was observed in the 1960s and 1970s (Worcester and Parker 2010 in Stantec 2012a,b).

6.2 Zooplankton

Herbaceous zooplankton (e.g., calanoid copepods, the dominant component of NW Atlantic zooplankton) feed on phytoplankton, a process called secondary production. The herbivores in turn are fed upon by predators (i.e., tertiary production) such as predacious zooplankton (e.g., chaetognaths, jellyfish, etc.), all of which may be grazed by higher predators including invertebrates,
fishes, seabirds, sea turtles and marine mammals. This food web also links to the benthic ecosystem through bacterial degradation processes, dissolved and particulate carbon, and direct predation. An understanding of plankton production is important because areas of enhanced production and (or) biomass are areas where marine biota tend to congregate for feeding.

Zooplankton can be divided into three main categories based on size:

1. Microzooplankton (20-200 μm in length), which includes ciliates, tintinnids, and the eggs and larvae of larger taxa;
2. Mesozooplankton (0.2-2 mm in length), which includes copepods, larvaceans, pelagic molluscs, and larvae of benthic organisms; and
3. Macrozooplankton (> 2 mm), 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. However they are beginning to recover from the lows observed in the 1990s. The dominant copepods on the Scotian Shelf and Slope are as follows (DFO 2011 in Stantec 2012a,b).

- *Calanus finmarchicus*;
- *Pseudocalanus minutus*;
- *Centropages typicus*; and
- *Scolecithricella minor*.

### 6.3 Benthic Invertebrates

Benthic invertebrates are bottom-dwelling organisms that can be classified into three categories (Barrie et al. 1980):

1. Infaunal species;
2. Sessile species; and
3. Epibenthic species.

Infaunal organisms live on or are buried in soft substrates and include bivalves, polychaetes, amphipods, sipunculids, ophiuroids, and some gastropods. Sessile organisms live attached to hard substrates and would include barnacles, tunicates, bryzoans, holothurians, and some anemones. The epibenthic organisms are active swimmers that remain in close association to the seabed and include mysiids, amphipods, and decapods.

Benthic invertebrate communities can be spatially variable because of physical habitat characteristics such as water depth, substrate type, currents, and sedimentation. The primary
factors affecting the structure and function of such communities in high latitude communities are water mass differences, sediment characteristics, and ice scour (Carey 1991).

Included in the sessile benthic invertebrate category are corals and sponges. The following subsections provide some description of corals and sponges that occur within the Study Area (Stantec 2012a,b).

6.3.1 Corals

- Two major groups of corals occur on the Scotian Shelf: (1) hard/stony corals (Scleractinia) and (2) Octocorals (i.e., sea pens, sea whips, sea fans and ‘soft’ corals);
- The largest octocorals on the Scotian Shelf are the gorgonians (e.g., bubblegum coral, seacorn coral);
- Large gorgonians typically occur in the channels between banks and in canyons;
- A few large concentrations of gorgonians occur near the Gully and on the edge of Sable Island Bank; and
- Sea pens and small gorgonians typically occur on soft sediments.

6.3.2 Sponges

- Significant sponge concentrations occur on Middle Bank; and
- A protected glass sponge ground (Russian Hat Sponge Area) is located in the Emerald Basin, almost 100 km from the Study Area.

6.4 Commercially-harvested Invertebrates

The principal commercially-harvested invertebrates anticipated to occur in the Study Area are indicated in Table 6.1 (Hurley 2011; Stantec 2012a,b). The likely times of occurrence of these invertebrates in the Study Area are also provided in Table 6.1.

Table 6.1. Commercially-important invertebrates with reasonable likelihood of occurrence in the Study Area.

<table>
<thead>
<tr>
<th>Common Name</th>
<th>Scientific Name</th>
<th>Likely Time of Occurrence in Study Area</th>
</tr>
</thead>
<tbody>
<tr>
<td>Atlantic sea scallop</td>
<td><em>Placopecten magellanicus</em></td>
<td>Year-round</td>
</tr>
<tr>
<td>Cockles</td>
<td>Family <em>Cardiidae</em></td>
<td>Year-round</td>
</tr>
<tr>
<td>Iceland scallop</td>
<td><em>Chlamys islandica</em></td>
<td>Year-round</td>
</tr>
<tr>
<td>Northern shrimp</td>
<td><em>Pandalus borealis</em></td>
<td>Year-round</td>
</tr>
<tr>
<td>Propeller clam</td>
<td>Family <em>Hiatellidae</em></td>
<td>Year-round</td>
</tr>
<tr>
<td>Quahog</td>
<td><em>Mercenaria mercenaria</em></td>
<td>Year-round</td>
</tr>
<tr>
<td>Sea cucumbers</td>
<td>Class <em>Holothuroidea</em></td>
<td>Year-round</td>
</tr>
<tr>
<td>Snow crab</td>
<td><em>Chionoecetes opilio</em></td>
<td>Year-round</td>
</tr>
</tbody>
</table>
6.5 Commercially-harvested Fishes

The principal commercially-harvested fishes are presented separately as groundfishes and pelagic fishes.

6.5.1 Groundfishes

The principal commercially-harvested groundfishes anticipated to occur in the Study Area are indicated in Table 6.2 (Hurley 2011; Stantec 2012a,b). The likely times of occurrence of these fishes in the Study Area are also provided in Table 6.2.

Table 6.2. Commercially-important groundfishes with reasonable likelihood of occurrence in the Study Area.

<table>
<thead>
<tr>
<th>Common Name</th>
<th>Scientific Name</th>
<th>Likely Time of Occurrence in Study Area</th>
</tr>
</thead>
<tbody>
<tr>
<td>Acadian redfish</td>
<td>Sebastes fasciatus</td>
<td>Year-round</td>
</tr>
<tr>
<td>American plaice</td>
<td>Hippoglossoides platessoides</td>
<td>Year-round</td>
</tr>
<tr>
<td>Atlantic cod</td>
<td>Gadus morhua</td>
<td>Year-round</td>
</tr>
<tr>
<td>Atlantic halibut</td>
<td>Hippoglossus hippoglossus</td>
<td>Year-round</td>
</tr>
<tr>
<td>Atlantic wolfish</td>
<td>Anarhichas lupus</td>
<td>Year-round</td>
</tr>
<tr>
<td>Cusk</td>
<td>Brosme brosme</td>
<td>Year-round</td>
</tr>
<tr>
<td>Deepwater redfish</td>
<td>Sebastes mentella</td>
<td>Year-round</td>
</tr>
<tr>
<td>Greenland halibut</td>
<td>Reinhardtius hippoglossoides</td>
<td>Year-round</td>
</tr>
<tr>
<td>Haddock</td>
<td>Melanogrammus aeglefinus</td>
<td>Year-round</td>
</tr>
<tr>
<td>Hagfish</td>
<td>Myxine glutinosa</td>
<td>Year-round</td>
</tr>
<tr>
<td>Monkfish</td>
<td>Lophius americanus</td>
<td>Year-round</td>
</tr>
<tr>
<td>Pollock</td>
<td>Pollachius virens</td>
<td>Year-round</td>
</tr>
<tr>
<td>White hake</td>
<td>Urophycis tenuis</td>
<td>Year-round</td>
</tr>
<tr>
<td>Witch flounder</td>
<td>Glyptocephalus cynoglossus</td>
<td>Year-round</td>
</tr>
<tr>
<td>Yellowtail flounder</td>
<td>Limanda ferruginea</td>
<td>Year-round</td>
</tr>
</tbody>
</table>

6.5.2 Pelagic Fishes

The principal commercially-harvested pelagic fishes anticipated to occur in the Study Area are indicated in Table 6.3 (Hurley 2011; Stantec 2012a,b). The likely times of occurrence of these fishes in the Study Area are also provided in Table 6.3.
Table 6.3. Commercially-important pelagic fishes with reasonable likelihood of occurrence in the Study Area.

<table>
<thead>
<tr>
<th>Common Name</th>
<th>Scientific Name</th>
<th>Likely Time of Occurrence in Study Area</th>
</tr>
</thead>
<tbody>
<tr>
<td>Albacore tuna</td>
<td>Thunnus alalunga</td>
<td>May to December</td>
</tr>
<tr>
<td>Atlantic herring</td>
<td>Clupea harengus</td>
<td>Summer and fall</td>
</tr>
<tr>
<td>Atlantic mackerel</td>
<td>Scomber scombrus</td>
<td>Year-round</td>
</tr>
<tr>
<td>Bigeye tuna</td>
<td>Thunnus obesus</td>
<td>July to November</td>
</tr>
<tr>
<td>Black dogfish</td>
<td>Centroscyllium fabricii</td>
<td>Year-round</td>
</tr>
<tr>
<td>Blue marlin</td>
<td>Makaira nigricans</td>
<td>Summer</td>
</tr>
<tr>
<td>Blue shark</td>
<td>Prionace glauce</td>
<td>Late spring and summer</td>
</tr>
<tr>
<td>Bluefin tuna</td>
<td>Thunnus thynnus</td>
<td>June to December</td>
</tr>
<tr>
<td>Common dolphinfish</td>
<td>Coryphaena hippurus</td>
<td>Summer and fall</td>
</tr>
<tr>
<td>Porbeagle shark</td>
<td>Lamna nasus</td>
<td>Year-round</td>
</tr>
<tr>
<td>Shortfin mako shark</td>
<td>Leurus oxyringus</td>
<td>Late summer and fall</td>
</tr>
<tr>
<td>Swordfish</td>
<td>Xiphias gladius</td>
<td>May to December</td>
</tr>
<tr>
<td>White marlin</td>
<td>Tetraprurus albidus</td>
<td>Summer</td>
</tr>
<tr>
<td>Yellowfin tuna</td>
<td>Thunnus albacares</td>
<td>Summer</td>
</tr>
</tbody>
</table>

6.6 Birds

There are numerous marine and coastal bird species that occur in the Study Area, including both resident and migratory species. Resident species are present throughout the year, whereas migratory species may be present only during breeding and wintering seasons, or they may only migrate through the area. There are three distinct taxonomic and ecological groups: seabirds, waterfowl, and shorebirds, which consist of 35 taxonomic families. Species within a given taxonomic family of birds share common physical and behavioral characteristics that allow these birds to be presented and assessed in this document by family (see Section 7.1.2) rather than by individual species. Because of these common characteristics, the potential for interaction with the Project would be similar for species within a given family that share similar behavioral characteristics. The principal bird species (listed in Article I of the Migratory Birds Convention Act) with reasonable likelihood of occurring in the Study Area are provided in Table 6.4.

Table 6.4. Bird species included in bird families listed in Article I of the Migratory Birds Convention Act (1994) with reasonable likelihood of occurrence in the Study Area, and their months of occurrence. Also, included are bird species considered at risk and which may occur in the Study Area.

<table>
<thead>
<tr>
<th>Common Name</th>
<th>Scientific Name</th>
<th>Months Present in Study Area</th>
</tr>
</thead>
<tbody>
<tr>
<td>Procellariidae</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Northern Fulmar</td>
<td>Fulmarus glacialis</td>
<td>All year</td>
</tr>
<tr>
<td>Cory’s Shearwater</td>
<td>Calonecrtis diomedea borealis</td>
<td>July to September</td>
</tr>
<tr>
<td>Great Shearwater</td>
<td>Puffinus gravis</td>
<td>April to November</td>
</tr>
<tr>
<td>Sooty Shearwater</td>
<td>Puffinus griseus</td>
<td>April to November</td>
</tr>
<tr>
<td>Manx Shearwater</td>
<td>Puffinus puffinus</td>
<td>April to November</td>
</tr>
<tr>
<td>Hydrobatidae</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Common Name</td>
<td>Scientific Name</td>
<td>Months Present in Study Area</td>
</tr>
<tr>
<td>------------------------------</td>
<td>----------------------------------------</td>
<td>-------------------------------------------------------</td>
</tr>
<tr>
<td>Leach's Storm-Petrel</td>
<td>Oceanodroma leucorhoa</td>
<td>April to October</td>
</tr>
<tr>
<td>Wilson's Storm-Petrel</td>
<td>Oceanites oceanicus</td>
<td>May to October</td>
</tr>
<tr>
<td><strong>Sulidae</strong></td>
<td><strong>Sulidae</strong></td>
<td></td>
</tr>
<tr>
<td>Northern Gannet</td>
<td>Morus bassanus</td>
<td>late-March to November</td>
</tr>
<tr>
<td><strong>Charadriidae</strong></td>
<td><strong>Charadriidae</strong></td>
<td></td>
</tr>
<tr>
<td>Black-bellied Plover</td>
<td>Pluvialis squatarola</td>
<td>mid-April to early June; early July to mid-November</td>
</tr>
<tr>
<td>American Golden-Plover</td>
<td>Pluvialis dominica</td>
<td>late July to October</td>
</tr>
<tr>
<td>Semipalmated Plover</td>
<td>Charadrius semipalmatus</td>
<td>late April to May; July to early October</td>
</tr>
<tr>
<td><strong>Scolopacidae</strong></td>
<td><strong>Scolopacidae</strong></td>
<td></td>
</tr>
<tr>
<td>Spotted Sandpiper</td>
<td>Actitis macularius</td>
<td>late April to early June; July to October</td>
</tr>
<tr>
<td>Willet</td>
<td>Tringa semipalmata</td>
<td>late July to October</td>
</tr>
<tr>
<td>Greater Yellowlegs</td>
<td>Tringa melanocephus</td>
<td>mid-July to mid-November</td>
</tr>
<tr>
<td>Whimbrel</td>
<td>Numenius phaeopus</td>
<td>mid-August to September</td>
</tr>
<tr>
<td>Lesser Yellowlegs</td>
<td>Tringa flavipes</td>
<td>mid-August to September</td>
</tr>
<tr>
<td>Hudsonian Godwit</td>
<td>Limosa haemastica</td>
<td>mid-August to mid-September</td>
</tr>
<tr>
<td>Ruddy Turnstone</td>
<td>Arenaria interpres</td>
<td>August to mid-September</td>
</tr>
<tr>
<td>Red Knot, rufa subspecies*</td>
<td>Calidris canutus rufa</td>
<td>May to early June; July to October</td>
</tr>
<tr>
<td>Sanderling</td>
<td>Calidris alba</td>
<td>mid-May to late May; mid-July to October</td>
</tr>
<tr>
<td>Semipalmated Sandpiper</td>
<td>Calidris pusilla</td>
<td>mid-July to mid-September</td>
</tr>
<tr>
<td>Least Sandpiper</td>
<td>Calidris minutilla</td>
<td>May; July to September</td>
</tr>
<tr>
<td>White-rumped Sandpiper</td>
<td>Calidris fuscicollis</td>
<td>late July to September</td>
</tr>
<tr>
<td>Pectoral Sandpiper</td>
<td>Calidris melanotos</td>
<td>late July to early October</td>
</tr>
<tr>
<td>Short-billed Dowitcher</td>
<td>Limnodromus griseus</td>
<td>mid-July to mid-September</td>
</tr>
<tr>
<td>Wilson’s Snipe</td>
<td>Gallinago delicata</td>
<td>mid-August to October</td>
</tr>
<tr>
<td>Red Phalarope</td>
<td>Phalaropus fulicarius</td>
<td>May to October</td>
</tr>
<tr>
<td>Red-necked Phalarope</td>
<td>Phalaropus lobatus</td>
<td>May to September</td>
</tr>
<tr>
<td><strong>Laridae</strong></td>
<td><strong>Laridae</strong></td>
<td></td>
</tr>
<tr>
<td>Black-legged Kittiwake</td>
<td>Rissa tridactyla</td>
<td>All year</td>
</tr>
<tr>
<td>Ivory Gull*</td>
<td>Pagophila eburnea</td>
<td>December to April</td>
</tr>
<tr>
<td>Herring Gull</td>
<td>Larus argentatus</td>
<td>All year</td>
</tr>
<tr>
<td>Iceland Gull</td>
<td>Larus glaucoides</td>
<td>November to April</td>
</tr>
<tr>
<td>Lesser Black-backed Gull</td>
<td>Larus fuscus</td>
<td>May to December</td>
</tr>
<tr>
<td>Glaucous Gull</td>
<td>Larus hyperboreus</td>
<td>October to April</td>
</tr>
<tr>
<td>Great Black-backed Gull</td>
<td>Larus marinus</td>
<td>All year</td>
</tr>
<tr>
<td>Roseate Tern*</td>
<td>Sterna dougallii</td>
<td>mid-May to late September</td>
</tr>
<tr>
<td>Common Tern</td>
<td>Sterna hirundo</td>
<td>mid-May to late September</td>
</tr>
<tr>
<td>Arctic Tern</td>
<td>Sterna paradisaea</td>
<td>mid-May to late September</td>
</tr>
<tr>
<td><strong>Stercorariidae</strong></td>
<td><strong>Stercorariidae</strong></td>
<td></td>
</tr>
<tr>
<td>Great Skua</td>
<td>Stercorarius skua</td>
<td>May to October</td>
</tr>
<tr>
<td>South Polar Skua</td>
<td>Stercorarius maccormicki</td>
<td>May to October</td>
</tr>
<tr>
<td>Pomarine Jaeger</td>
<td>Stercorarius pomarinus</td>
<td>May to October</td>
</tr>
<tr>
<td>Common Name</td>
<td>Scientific Name</td>
<td>Months Present in Study Area</td>
</tr>
<tr>
<td>------------------------</td>
<td>-----------------------</td>
<td>------------------------------</td>
</tr>
<tr>
<td>Parasitic Jaeger</td>
<td>Stercorarius parasiticus</td>
<td>May to October</td>
</tr>
<tr>
<td>Long-tailed Jaeger</td>
<td>Stercorarius longicaudus</td>
<td>May to September</td>
</tr>
<tr>
<td><strong>Alcidae</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dovekie</td>
<td>Alle alle</td>
<td>Late October to April</td>
</tr>
<tr>
<td>Common Murre</td>
<td>Uria aalge</td>
<td>All year</td>
</tr>
<tr>
<td>Thick-billed Murre</td>
<td>Uria lomvia</td>
<td>All year</td>
</tr>
<tr>
<td>Razorbill</td>
<td>Alca torda</td>
<td>mid-April to November</td>
</tr>
<tr>
<td>Atlantic Puffin</td>
<td>Fratercula arctica</td>
<td>All year</td>
</tr>
<tr>
<td><strong>Parulidae</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Blackpoll Warbler</td>
<td>Setophaga striata</td>
<td>mid-September to late October</td>
</tr>
<tr>
<td><strong>Emberizidae</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ipswich Savannah Sparrow*</td>
<td>Passerculus sandwichensis princeps</td>
<td>early April to mid-April; late September to mid-October</td>
</tr>
</tbody>
</table>

*Species at risk.
Sources: McNeil and Burton (1977); Williams and Williams (1978); Richardson (1979); McLaren (1981); Brown (1986); Lock et al. (1994); Nisbet et al. (1995); Skeel and Mallory (1996); Harrington (2001); Moulton et al. (2003); COSEWIC (2009a,b); LGL (2009); McLaren (2012).

### 6.7 Sea Turtles

Two species of sea turtles regularly occur in the Study Area, leatherback sea turtles and loggerhead sea turtles (Table 6.5). Kemp’s Ridley sea turtle is primarily a sub-tropical and tropical species, although there has been an occasional sighting in Nova Scotia waters. This species may occur in and near the Study Area as juveniles are known to move northwards, however; more likely sightings would be coastal. They certainly occur in shallower waters in the Gulf of Mexico, and they fed primarily on shallow water crab species (NOAA 1992a). This species tends to have poor survivorship once they get outside of the warmer waters of the Gulf Stream (Spotila 2004). Green sea turtles (*Chelonia mydas*) are considered rare in the Study Area.

#### Table 6.5. Sea turtle species with reasonable likelihood of occurrence in the Study Area.

<table>
<thead>
<tr>
<th>Common Name</th>
<th>Scientific Name</th>
<th>Likely Time of Occurrence in Study Area</th>
</tr>
</thead>
<tbody>
<tr>
<td>Leatherback sea turtle</td>
<td>Dermochelys coriacea</td>
<td>May to November</td>
</tr>
<tr>
<td>Loggerhead sea turtle</td>
<td>Caretta caretta</td>
<td>Spring, summer and fall</td>
</tr>
<tr>
<td>Kemp’s Ridley sea turtle</td>
<td>Lepidochelys kempii</td>
<td>Summer</td>
</tr>
</tbody>
</table>

### 6.8 Marine Mammals

Marine mammals known to occur in the Study Area were overviewed in each of the SEAs relevant to this EA (Hurley 2011; Stantec 2012a,b). Other information sources were also reviewed, as indicated in Table 6.6. Table 6.6 provides a list of odontocetes, mysticetes, and seals most likely to occur in the Study Area.
Beluga whales (*Delphinapterus leucas*), Blainsville’s beaked whales (*Mesoplodon densirostris*), True’s beaked whales (*Mesoplodon mirus*), Cuvier’s beaked whales (*Ziphius cavirostris*), dwarf sperm whales (*Kogia simus*), Pygmy sperm whales (*Kogia breviceps*), killer whale (*Orcinus orca*), Risso’s dolphin (*Grampus griseus*), North Atlantic right whales (*Eubalaena glacialis*), and ringed seals (*Pusa hispida*) are considered rare in the Study Area.

Table 6.6.  Marine mammal species with reasonable likelihood of occurrence in the Study Area.

<table>
<thead>
<tr>
<th>Common Name</th>
<th>Scientific Name</th>
<th>Likely Time of Occurrence in Study Area</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Order Cetacea (Suborder Odontoceti – Toothed Whales)</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Atlantic long-finned pilot whale</td>
<td><em>Globicephala melaena</em></td>
<td>Year-round</td>
</tr>
<tr>
<td>Northern bottlenose whale</td>
<td><em>Hyperoodon ampullatus</em></td>
<td>Year-round</td>
</tr>
<tr>
<td>Sowerby’s beaked whale</td>
<td><em>Mesoplodon bidens</em></td>
<td>Summer</td>
</tr>
<tr>
<td>Sperm whale</td>
<td><em>Physeter macrocephalus</em></td>
<td>Year-round</td>
</tr>
<tr>
<td>Atlantic harbour porpoise</td>
<td><em>Phocoena phocoena</em></td>
<td>Spring, summer, fall</td>
</tr>
<tr>
<td>Atlantic white-sided dolphin</td>
<td><em>Lagenorhynchus acutus</em></td>
<td>Summer, perhaps year-round</td>
</tr>
<tr>
<td>Bottlenose dolphin</td>
<td><em>Tursiops truncatus</em></td>
<td>Summer</td>
</tr>
<tr>
<td>Common dolphin</td>
<td><em>Delphinus delphis</em></td>
<td>Summer, fall</td>
</tr>
<tr>
<td>Striped dolphin</td>
<td><em>Stenella caeruleoalba</em></td>
<td>Summer</td>
</tr>
<tr>
<td>White-beaked dolphin</td>
<td><em>Lagenorhynchus albirostris</em></td>
<td>Spring, summer, fall</td>
</tr>
<tr>
<td><strong>Order Cetacea (Suborder Mysteceti – Baleen Whales)</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Blue whale</td>
<td><em>Balaenoptera musculus</em></td>
<td>Spring, summer, fall</td>
</tr>
<tr>
<td>Fin whale</td>
<td><em>Balaenoptera physalus</em></td>
<td>Year-round (likely)</td>
</tr>
<tr>
<td>Humpback whale</td>
<td><em>Megaptera novaeangliae</em></td>
<td>Spring, summer, fall</td>
</tr>
<tr>
<td>Minke whale</td>
<td><em>Balaenoptera acuterostrata</em></td>
<td>Late spring, summer</td>
</tr>
<tr>
<td>Sei whale</td>
<td><em>Balaenoptera borealis</em></td>
<td>June to November</td>
</tr>
<tr>
<td><strong>Order Carnivora (Family Phocidae – Seals)</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Grey Seal</td>
<td><em>Halichoerus grypus</em></td>
<td>Year-round</td>
</tr>
<tr>
<td>Harbour Seal</td>
<td><em>Phoca vitulina</em></td>
<td>Year-round</td>
</tr>
<tr>
<td>Harp Seal</td>
<td><em>Pagophilus groenlandicus</em></td>
<td>Primarily winter-spring</td>
</tr>
<tr>
<td>Hooded Seal</td>
<td><em>Cystophora cristata</em></td>
<td>Primarily winter-spring</td>
</tr>
</tbody>
</table>

7.0 Effects on Valued Environment Components

This section focuses on the assessment of those Project activities identified in the Scoping Document “that have the potential to have significant adverse environmental effects” on VECs. The Project activities requiring assessment include underwater sound from the airgun arrays; ship collisions with marine mammals and sea turtles; vessel lighting on seabirds, and Project interactions with other users of the Project Area. In addition, malfunctions and accidental events required assessment (see Section 8) as well as cumulative effects (see Section 10).

Sound from the airgun arrays is the key Project activity with impact potential and as such, a large portion of the assessment focuses on this topic. Comprehensive literature reviews of the auditory abilities and the potential effects of exposure to seismic airgun sound on marine mammals, sea turtles, fishes, and invertebrates are provided in Appendices D–G, respectively. For birds, the key routine Project activity with impact potential is the lighting on the Project vessels due to the possible attraction of the birds to the lights.

As discussed previously, effects are judged assuming the implementation of Project mitigation measures, i.e., this section provides an assessment of residual effects. Mitigation measures are provided in detail in Section 12 and are summarized below in the effects assessment for each VEC.

7.1 Species of Special Status

The Scoping Document required the evaluation of environmental effects, including cumulative effects, of the Project on the identified SARA Schedule 1 species and their critical habitats, and migratory birds (protected by the Migratory Birds Convention Act, 1994). Table 7.1 presents the species that constitute the SARA portion of the Species of Special Status VEC. Also, provided in this table are the species currently considered at risk by COSEWIC but which are not listed on Schedule 1 of SARA. The migratory bird species/groups that are also considered part of this VEC
Table 7.1. SARA Schedule 1-listed and COSEWIC assessed marine species with reasonable likelihood of occurrence in the Study Area.

<table>
<thead>
<tr>
<th>Species</th>
<th>SARA Schedule 1</th>
<th>COSEWIC</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>SARA Schedule 1 Species</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Blue whale (Atlantic population)</td>
<td>Balaenoptera musculus</td>
<td>X</td>
</tr>
<tr>
<td>North Atlantic right whale</td>
<td>Eubalaena glacialis</td>
<td>X</td>
</tr>
<tr>
<td>Northern bottlenose whale (Scotian Shelf population)</td>
<td>Hyperoodon ampullatus</td>
<td>X</td>
</tr>
<tr>
<td>Leatherback sea turtle</td>
<td>Dermochelys coriacea</td>
<td>X</td>
</tr>
<tr>
<td>Roseate Tern</td>
<td>Sterna dougallii</td>
<td>X</td>
</tr>
<tr>
<td>Red Knot rufa subspecies</td>
<td>Calidris canutus rufa</td>
<td>X</td>
</tr>
<tr>
<td>White shark (Atlantic population)</td>
<td>Carcharodon carcharias</td>
<td>X</td>
</tr>
<tr>
<td>Northern wolfish</td>
<td>Anarhichas denticulatus</td>
<td>X</td>
</tr>
<tr>
<td>Spotted wolfish</td>
<td>Anarhichas minor</td>
<td>X</td>
</tr>
<tr>
<td>Pin whale (Atlantic population)</td>
<td>Balaenoptera physalus</td>
<td>X</td>
</tr>
<tr>
<td>Sowerby’s beaked whale</td>
<td>Mesoplodon bidens</td>
<td>X</td>
</tr>
<tr>
<td>Atlantic wolfish</td>
<td>Anarhichas lupus</td>
<td>X</td>
</tr>
<tr>
<td><strong>Non-SARA Schedule 1 Species Listed by COSEWIC</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Loggerhead sea turtle</td>
<td>Caretta caretta</td>
<td>X</td>
</tr>
<tr>
<td>Atlantic bluefin tuna</td>
<td>Thunnus thynnus</td>
<td>X</td>
</tr>
<tr>
<td>Atlantic cod (Southern population; Laurentian South population)</td>
<td>Gadus morhua</td>
<td>X</td>
</tr>
<tr>
<td>Roundnose grenadier</td>
<td>Coryphaenoides rupestris</td>
<td>X</td>
</tr>
<tr>
<td>Porbeagle shark</td>
<td>Lamna nasus</td>
<td>X</td>
</tr>
<tr>
<td>Atlantic salmon (Nova Scotia Southern Upland population)</td>
<td>Salmo salar</td>
<td>X</td>
</tr>
<tr>
<td>Cusk</td>
<td>Brosme brosme</td>
<td>X</td>
</tr>
<tr>
<td>Shortfin mako shark (Atlantic population)</td>
<td>Isurus oxyrinchus</td>
<td>X</td>
</tr>
<tr>
<td>Acadian redfish (Atlantic population)</td>
<td>Sebastes fasciatus</td>
<td>X</td>
</tr>
<tr>
<td>Winter skate (Eastern Scotian Shelf population)</td>
<td>Leucoraja ocellata</td>
<td>X</td>
</tr>
<tr>
<td>American plaice (Maritime population)</td>
<td>Hippoglossoides platessoides</td>
<td>X</td>
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<tr>
<td>American eel</td>
<td>Anguilla rostrata</td>
<td>X</td>
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<tr>
<td>Harbour porpoise (Northwest Atlantic population)</td>
<td>Phocoena phocoena</td>
<td>X</td>
</tr>
<tr>
<td>Spiny dogfish (Atlantic population)</td>
<td>Squalus acanthis</td>
<td>X</td>
</tr>
<tr>
<td>Roughhead grenadier</td>
<td>Macrourus berglax</td>
<td>X</td>
</tr>
<tr>
<td>Basking shark (Atlantic population)</td>
<td>Cetorhinus maximus</td>
<td>X</td>
</tr>
<tr>
<td>Blue shark (Atlantic population)</td>
<td>Prionace glauca</td>
<td>X</td>
</tr>
<tr>
<td>Smooth skate (Laurentian-Scottish population)</td>
<td>Malacoraja senta</td>
<td>X</td>
</tr>
<tr>
<td>Thorny skate</td>
<td>Amblyraja radiata</td>
<td>X</td>
</tr>
<tr>
<td>Killer whale (Northwest Atlantic-Eastern Arctic population)</td>
<td>Orcinus orca</td>
<td>X</td>
</tr>
</tbody>
</table>

Sources: * SARA website (http://www.sararegistry.gc.ca/default_e.cfm) (as of 30 August 2013); ** COSEWIC website (http://www.cosewic.gc.ca/index.htm) (as of 30 August 2013); * Leatherback sea turtles were split into two populations (Atlantic and Pacific) in May 2012 and assessed by COSEWIC as Endangered. The current SARA listing for leatherback sea turtles considers both the Atlantic and Pacific populations combined.
are presented in Table 6.4. Biological background summaries, inclusive of spatial and temporal distribution, of the SARA Schedule 1 and migratory bird species/groups are presented in the subsections below, followed by an assessment of residual effects. As noted in the Scoping Document (Appendix B) if new species-at-risk are added to Schedule 1 of SARA during the assessment, additional mitigation measures may be required. BP will continue to monitor Schedule 1 for newly listed species that may be affected by the Project. The Project will be in compliance with SARA prohibitions (SARA Sections 32, 33 and 58) and no permits will be requested (as identified in SARA Section 73).

A number of mitigation measures and monitoring commitments have been developed to minimize the effects of airgun array sound. Many of these measures are applicable to marine mammal and sea turtle Species of Special Status (as well as other marine mammals and sea turtles, and to a lesser extent fish). A summary of these measures and commitments are provided below.

BP is committed to the mitigation measures and monitoring requirements as outlined in the Statement of Canadian Practice, and in many instances will surpass the minimum requirements outlined in the Statement of Canadian Practice to reduce the potential for effects of airgun array sound on marine species. The key mitigation measures and monitoring commitments relative to marine mammals and sea turtles are summarized below and detailed in Section 12.1. For the sake of clarity, the reader is referred to Section 12 for the exclusive and authoritative record of the mitigation and monitoring measures proposed by BP, in response to effects identified in this EA report.

1. Ramp up of the airgun array will occur over a 30 minute period.
2. Shut down all airguns during line changes.⁵
3. Use of a precautionary safety zone. To establish a safety zone for marine mammals (and sea turtles), an approach based on the best available scientific information on hearing impairment (i.e., Southall et al. 2007), acoustic modelling results, consideration of the Statement of Canadian Practice and seismic survey design has been used. After consideration of these factors, a 600 m safety zone will be used during the WATS survey and a 700 m safety zone will be used during the NATS survey. Section 12.1.3 provides the details on the approach and rationale for selecting the safety zone, including an explanation of why different safety zones are proposed for the WATS and NATS surveys.
4. Delay ramp up if a marine mammal or sea turtle is detected inside the “safety zone” during a 30-minute pre ramp up watch. A minimum ramp up delay of 30 minutes will be utilized unless a beaked whale species is detected within the safety zone prior to ramp up, at which point the ramp up delay will be increased to 60 minutes. The

⁵ Note however, that during some line changes individual airguns may be activated for maintenance or other operational purposes. Airguns are ramped up on the run-in. Airguns will not be activated in the Haddock Box.
longer ramp up delay for beaked whales is required (as per the Scoping Document—Appendix B) to account for their deep diving behaviour.

5. Airguns will be shut down if a marine mammal or sea turtle species listed as Endangered or Threatened on Schedule 1 of SARA, is observed within the safety zone. Airgun activation will be delayed until the whale or sea turtle has been determined to leave the safety zone or 30 minutes have passed from the last detection within the safety zone (60 minutes in the case of beaked whales).

6. There will be three Marine Mammal Observers (MMOs) on each seismic vessel to monitor for marine mammals and sea turtles.

7. Passive Acoustic Monitoring (PAM) systems will be installed on all five seismic vessels. PAM will be used to detect marine mammals during periods of poor visibility (e.g., darkness, fog) and during the pre-ramp up watch. If a marine mammal is detected acoustically within the safety zone during the pre-ramp up watch, ramp up will be delayed (as detailed in point 4 above).

7.1.1 SARA Schedule 1 Species

The following sections provide biological overviews, inclusive of spatial and temporal distribution, as well as effects assessments for each of the identified SARA Schedule 1 species with a likelihood of occurrence in the Study Area.

For the purposes of describing marine mammals and sea turtles sightings within the Study Area, a database of sightings in Nova Scotia waters compiled by DFO for sightings made from 1966-2012 (as provided by P. Emery, Species at Risk, Aquatic Science Technician, DFO; 30 October 2012) was used. These data were used to indicate what species have occurred in the region, but do not provide fine-scale descriptions or predictions of abundance or distribution.

As noted by DFO, a number of caveats should be considered when using the DFO marine mammal (and sea turtle) sighting data, and include:

- The sighting data have not yet been completely error-checked.
- Survey effort is not consistent across all data collection areas (i.e., some areas have had greater survey efforts than others).
- The quality of some of the sighting data is unknown. Most sightings are collected on an opportunistic basis and observations may come from individuals with a variety of expertise in marine mammal identification experiences.

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6 An updated marine mammal and sea turtle database including sightings recorded in 2013 was unavailable during preparation of this EA.
Most data have been gathered from platforms of opportunity that were vessel-based. The inherent problems with negative or positive reactions by cetaceans to the approach of such vessels have not yet been factored into the data.

Sighting effort has not been quantified (i.e., the numbers cannot be used to estimate true species density or abundance for an area). Lack of sightings does not represent lack of species present in a particular area.

Numbers sighted have not been verified (especially in light of the significant differences in detectability among species).

For completeness, these data represent an amalgamation of sightings from a variety of years and seasons. Effort (and number of sightings) is not necessarily consistent among months, years, and areas. There are large gaps between years. Thus seasonal, depth, and distribution information should be interpreted with caution.

Many sightings could not be identified to species, but are listed to the smallest taxonomic group possible.

Figure 7.1 and 7.2 show sightings of marine mammals (exclusive of fin whales—see Figure 7.3) and leatherback sea turtles listed on Schedule 1 of SARA. As provided by DFO, sighting locations (Figure 7.1) were restricted to Canadian waters in an area between 41° and 46° N latitude and 56° and 68° W longitude. Raw sighting data from the NARWC database (Figure 7.2) are not effort-corrected and the management documents in which they are used are not peer reviewed. Distributional patterns based on these data are likely biased by where, and when, surveys were conducted.

7.1.1.1 North Atlantic Right Whale

Biological Background Summary

The western North Atlantic right whale population ranges from calving grounds in coastal waters off the southeastern United States to feeding grounds in New England waters and the Canadian Bay of Fundy, Scotian Shelf, and Gulf of St. Lawrence. Research suggests the existence of six major habitats or congregation areas for western North Atlantic right whales: the coastal waters of the southeastern United States; the Great South Channel; Georges Bank/Gulf of Maine; Cape Cod and Massachusetts Bays; the Bay of Fundy; and the Scotian Shelf (COSEWIC 2003; Waring et al. 2013). North Atlantic right whales became severely depleted during industrial whaling and the population is currently in danger of extinction. Based on a census of individual whales identified using photo-identification, the western North Atlantic population size is estimated to be comprised of at least 510 individuals (NARWC 2013). The North Atlantic right whale is currently listed as Endangered on Schedule 1 of SARA and is also considered Endangered by COSEWIC (Table 7.1; COSEWIC 2003). There is a recovery strategy in place for this species (Brown et al. 2009). The North Atlantic right whale is also listed by the United States as endangered throughout its U.S. range (Waring et al. 2013).
Figure 7.1. Sightings of Marine Mammal and Sea Turtle Species Listed on Schedule 1 of SARA (excluding fin whales) Observed From April–November, 1966–2012 (DFO database)
Figure 7.2. Sightings of Marine Mammal and Sea Turtle Species Listed on Schedule 1 of SARA (excluding fin whales) Observed from April–November, 1954–2011 (NARWC)
Two of the six high-use habitat areas for the western North Atlantic right whale are located in Atlantic Canada. In the summer and autumn, North Atlantic right whales nurse, feed and socialize in the lower Bay of Fundy (Grand Manan Basin), and feed and socialize in Roseway Basin between Browns and Baccaro Banks on the western Scotian Shelf about 50 km south of Nova Scotia (Stone et al. 1988; Kraus and Brown 1992; Brown et al. 1995). Roseway Basin may also be a mating area for right whales during the winter (Cole et al. 2013). Roseway Basin and Grand Manan Basin (Figure 7.1) are designated Critical Habitat for right whales pursuant to the SARA (Brown et al. 2009). The Grand Manan Basin is approximately 400 km northwest of the Project Area (linear distance; separated by the landmass of southeastern Nova Scotia), and is thus, sufficiently distanced from the Project to not require assessment (as per the Scoping Document, Appendix B). The Roseway Basin critical habitat is, at its closest point, 260 km, 258 km, 235 km and 210 km from the WATS Area, NATS (West) Area, Project, and Study areas, respectively. Given the distance from the Project Area, Roseway Basin critical habitat is also not assessed specifically as a Special Area but is considered below in the effects assessment for right whales.

Right whales locate aggregations of prey at the surface (skim feeding) or at depth (down to at least 200 m). Research suggests that right whales must locate and exploit extremely dense patches of zooplankton to feed efficiently (Mayo and Marx 1990). In the Bay of Fundy, right whales sometimes swim near the bottom as evidenced by the fact that they surface with mud on their heads (COSEWIC 2003). Right whales in the Bay of Fundy, tracked with timed depth recorders, were recorded on feeding dives to depths of 80–175 m for 5 to 14 minutes (Baumgartner and Mate 2003). Baumgartner et al. (2003) observed right whales feeding on Stage 5 diapausing *Calanus finmarchicus* in Roseway Basin and the lower Bay of Fundy, which were only available in the coldest water, i.e., near the bottom.

Sightings of right whales in the Study Area and to the west of the Study Area indicate that it is possible that right whales may be encountered during the seismic survey but likely in small numbers.

**Effects Assessment**

The following assessment focuses on right whales that may occur in the Study Area. Although the Roseway Basin critical habitat did not require specific assessment in the Scoping Document (Appendix B), consideration of right whales in this area is discussed briefly below.

**Airgun Array Sound**

The hearing abilities of baleen whales (mysticetes) have not been studied directly. Behavioural and anatomical evidence indicates that they hear well at low frequencies below 1 kHz (Richardson et al. 1995; Ketten 2000), where most of the energy from seismic pulses occurs (see Section 1.2.2 and 1.3 of Appendix D). Although there have been no direct studies of right whale
response to airgun array sound, there has been considerable systematic study and monitoring of baleen whale response to airgun sound, which indicates a general trend of avoidance of operating airguns with variable avoidance radii. The results of such studies and monitoring are reviewed in detail in Section 1.5.1 of Appendix D.

As set out in Section 4.2.1, the key types of airgun array sound effects on marine mammals considered in detail in this assessment are hearing impairment (PTS and TTS) and behavioural effects (i.e., disturbance).

**Hearing Impairment:** Given that baleen whales typically exhibit at least localized avoidance of airgun sound (see Appendix D); right whales within the Study Area are unlikely to be exposed to levels of sound from the airgun array high enough to cause hearing damage. Based on precautionary acoustic modelling results, it is estimated that right whales (and other baleen whales) would have to occur <50 m from the airgun array to be exposed to sound levels from a single airgun pulse exceeding the 198 dB SEL criterion for PTS (see Section 4.2, Tables 9-20 in Appendix A). This <50 m distance where airgun array sound is estimated to exceed 198 dB SEL is consistent in both the WATS and NATS areas, at all six modelling sites in both April and August, and for all functional marine mammal hearing groups.

Using 183 dB SEL (M-weighted for low-frequency cetaceans) as a criterion for possible TTS in right whales (and other baleen whales), the range where airgun array sound may elicit a temporary change in hearing is estimated as <300 m at all modelling sites in the WATS and NATS areas, with one exception—the NATS area located on the Shelf (i.e., modelling Site 3 located in 100 m water depth; see Tables 9-20 in Appendix A). In the shallower shelf waters of the NATS West Area, the 183 dB SEL is estimated to increase to <600 m from the airgun array. The higher received sound level closer to the airgun array at the shallow modelling site is generally because cylindrical spreading loss conditions (1/R; where R is range or distance) apply, whereas in deep water spherical spreading loss (1/R²) applies. About 6.6% and 10.7% of NATS West and NATS East areas occur in water depths ≤100 m, respectively. As such, in most of the NATS survey area, sound levels ≥183 dB SEL, would be expected within 300 m from the airgun array. Note that the 300 m and 600 m distances cited above correspond to maximum distance estimates (R_max values from the acoustic modelling) and also correspond to sound levels of 180 dB SEL versus 183 dB SEL. Estimated sound levels of 183 dB SEL would occur closer to the airgun array.

The mitigation measure of ramping-up the airgun array over a 30-minute period is designed to allow whales close to the airgun arrays to move away before the sound become sufficiently strong to have potential for hearing damage. As outlined at the start of this Section and detailed in Section 12.1.3, BP has used a precautionary approach based on best available scientific information for establishing the safety zone around the airgun arrays. Ramp-up will not commence if a right whale is observed within the safety zone (600 m for the WATS survey and 700 m for the NATS survey) and the airgun array will be shutdown if a right whale is sighted.
within this safety zone. In addition to visual monitoring by MMOs, PAM will be used during periods of poor visibility (i.e., when the safety zone cannot be completely seen) and during pre-ramp up watches. If a right whale is acoustically detected within the safety zone during periods of poor visibility or the pre-ramp up watch, airguns will be shut down or ramp up will be delayed until the whale has been determined to leave the safety zone or 30 minutes have passed from the last detection within the safety zone.

Given these mitigation measures and that right whales are expected to exhibit at least localized avoidance of airgun array sound (including during ramp up), there is little potential for right whales being close enough to the airgun array to experience PTS. If some whales did experience TTS, the effects would likely be quite temporary given the short-term nature of temporary shifts in hearing thresholds (see Section 1.6.1 in Appendix D). Additionally, few right whales are expected to occur within the Project Area where hearing impairment has the potential to occur. Based on these considerations, airgun array sound is judged to have negligible to minor hearing impairment effects on right whales, over a short-term duration of <1 month, in an area <1 km$^2$ to 1-10 km$^2$. Therefore, hearing impairment residual effects on right whales are judged to be not significant. The level of confidence associated with this judgement is high.

**Disturbance Effects:** Based on the literature review provided in Appendix D, there could be behavioural or disturbance effects on right whales in the Study Area (includes a 25-km area around the Project Area to encompass areas where airgun array sound may exceed 160 dB rms; see Section 3.3.2.3). Reported behavioural effects for baleen whales range from changes in swimming behaviour to avoidance of seismic vessels operating airgun array(s) (see Section 1.5.1 of Appendix D). There have been no studies on right whale response to seismic sound. Based on precautionary acoustic modelling and utilizing the 160 dB rms sound level as a guide for disturbance (avoidance) response, the range at which disturbance may occur varies depending on location and month—this variation is evident in both the WATS and NATS survey areas. As shown earlier in Table 3.1, sound levels ≥160 dB rms were estimated to range from 7.0 km to 22.1 km in the WATS and NATS areas (see also Tables 9-20 in Appendix A) and there was a consistent trend for lower ranges in August versus April. Sound propagation at distances beyond 5 km from the airgun array was enhanced in April because of a surface duct present in the Project Area (see Section 5.1 in Appendix A). The bottom of the surface duct is 150 m below the surface, which effectively traps the acoustic energy. In August, the upper 50 m of the water column has a negative sound speed gradient, and therefore, refracts the acoustic wave downward resulting in greater sound transmission loss (i.e., reduced sound propagation). Right whales are more likely to occur in the Study Area during summer when airgun array sound propagation at longer ranges (i.e., beyond 5 km) from the array is expected to be reduced.

It is uncertain how many right whales may occur in the Study Area during the period when seismic surveying will occur (April to November)—however, numbers are expected to be low. The Study Area is not known to contain important feeding, breeding, or socializing areas for right whales and it does not contain any identified critical habitat for right whales. The Roseway Basin critical habitat is located at its closest point, 210 km from the Study Area, and 260 km and 258 km, from
the WATS Area and NATS (West) Area, respectively. Sound levels in the Roseway Basin will be much lower than 160 dB rms criterion (likely less than 130 dB rms; see Tables 9-20 in Appendix A), particularly during summer. Modelling results in the WATS and NATS areas for August show that the combination of the downwardly refracting sound speed profile with decreasing water depth effectively prevents the propagation of the acoustic energy from the airgun array into the shallow parts of the Shelf.

It is also important to note here (and for other marine mammal and sea turtle Species of Special Status), that the seismic vessel(s) will move along a survey line so that exposure to certain sound levels that may elicit a disturbance response in a given marine mammal or sea turtle is not constant for the duration of the survey. In the case of the WATS survey, survey lines average 138 km in length and would take almost a day to survey and complete a line change. It is anticipated (based on survey design and turning requirements for the WATS seismic fleet), that it would be several days before surveying occurs in the same area (i.e., adjacent survey line).

During the WATS survey, avoidance of airgun array sounds (corresponding to maximum SPL estimates of $ \geq 160 $ dB rms) is predicted to occur at distances ranging from 7.0 km to 22.1 km. Similarly, during the NATS survey, disturbance effects may occur at these distances from the airgun array. Avoidance of airgun array sounds at distances potentially ranging from 7.0 km to 22.1 km by right whales that may occur within the Study Area is unlikely to constitute a significant effect for right whales. Based on these considerations, airgun array sound is judged to have minor to moderate disturbance effects on right whales, over a short-term duration of $ < 1 \text{ month} $ to 1-12 months and a potential geographic extent ranging from $ 101-1,000 \text{ km}^2 $ to $ 1,001-10,000 \text{ km}^2 $. Therefore, residual effects related to disturbance, are judged to be not significant for right whales. The level of confidence associated with this judgement is medium to high.

**Presence of Vessels**

Much of the literature concerning marine mammals and collisions with ships relates to the North Atlantic right whale. Ship collisions have been identified as a major cause of mortality for this species with more than half (53 %) of the documented right whale deaths resulting from ship collisions (Campbell-Malone et al. 2008). While nearly all species of large whale have been victims of ship collisions (Laist et al. 2001; Glass et al. 2008), right whales are especially vulnerable likely because of certain characteristic behaviours during which they may be less aware of their surroundings. These behaviours include: surface active group (SAG) activity (individuals interacting at the surface with frequent physical contact); skim feeding (swimming slowly at the surface with mouth open); and logging (resting motionlessly at the surface), an activity frequently observed in nursing mothers (Knowlton 1997).

There is evidence suggesting that a greater rate of mortality and serious injury correlates with a greater vessel speed at the time of a ship collision (Laist et al. 2001; Vanderlaan and Taggart 2007; Vanderlaan et al. 2009). Most lethal and severe injuries to large whales resulting from documented
collisions with ships have occurred when vessels were travelling at 26 km/hr (14 knots [kt]) or greater (Laist et al. 2001). Vanderlaan and Taggart (2007) found that if vessel speeds are less than 28 km/hr (15 kt), the probability of a lethal injury (mortality or severely injured) due to a ship-strike substantially decreases. In a review of 58 large whale ship collisions in which the vessel speed was known, the average speed of vessels involved in collisions that resulted in mortality or serious injuries to the whale was found to be 34.4 km/hr (19 kt) (Jensen and Silber 2003). In two documented right whale ship collision mortalities in which the vessel speed was known with some degree of certainty, the vessels were travelling at 40.8 km/hr (22 kt) and 28 km/hr (15 kt) (NOAA Fisheries 2004).

Though there is some risk for a Project vessel to collide with a right whale, the significantly lower (compared to higher speeds known to be related to ship collisions) surveying speed (4.5 to 5 kt; 8.3 to 9.3 km/h) of the seismic vessels and their picket vessels minimizes this risk (Laist et al. 2001; NOAA Fisheries 2004; Vanderlaan and Taggart 2007). Right whales in the Study Area are expected to exhibit at least localized avoidance of vessels, even in the absence of airgun array sound (Appendix D). Effects of the presence of vessels on right whales, i.e., the risk of collisions, are judged to be negligible. Therefore, residual effects related to the presence of vessels, are judged to be not significant for right whales. The level of confidence associated with this judgement is high.

7.1.1.2 Blue Whale

Biological Background Summary

The blue whale has a broad distribution, but tends to be more frequently observed in deep water than in coastal environments (Jefferson et al. 2008). Blue whales became severely depleted during industrial whaling and still occur at relatively low densities in the North Atlantic. The Atlantic population of blue whales is considered Endangered both on SARA Schedule 1 and by COSEWIC. No critical habitat has been identified for this species yet (see Recovery Strategy; i.e., Beauchamp et al. 2009). Off Atlantic Canada, blue whales frequent areas of high plankton productivity, including the Gulf of St. Lawrence (DFO 2012) and shallow coastal zones off Newfoundland, where bottom and surface waters mix; they rely on euphausiids for food. They are migratory animals and travel in close-knit groups of three or four individuals, but at times congregate in larger herds (Mansfield 1985). This species may dive to depths below 150 m (Rutherford and Breeze 2002). Blue whales range widely among their summer feeding grounds (Sears and Larsen 2002). In the spring, summer and fall, they are found in the Gulf of St. Lawrence, off eastern Nova Scotia and along the north shore of the Gulf, from the St. Lawrence River estuary to the Strait of Belle Isle (Waring et al. 2013).

Little is known about the population size of blue whales except for the Gulf of St. Lawrence area. From 1979 to the summer of 2009, a total of 440 blue whales have been photo-identified, most of which were in the St. Lawrence estuary and northwestern Gulf of St. Lawrence (Waring
et al. 2011). A few blue whales have been photographed along the coast of Newfoundland, on the Scotian Shelf and in the Gulf of Maine, some of which are not included among the 440 blue whales that have been identified in the estuary and northwest of the Gulf of St. Lawrence (Sears and Calambokidis 2002; COSEWIC 2002a). Given the small proportion of the distribution range that has been sampled and considering the low number of blue whales encountered and photographed in a given year, the current data, based on photo-identification, do not allow for an estimate of abundance of this species in the Northwest Atlantic with a minimum degree of certainty (Sears et al. 1987, 1990; Hammond et al. 1990; Sears and Calambokidis 2002; DFO 2009; Waring et al. 2011). Mitchell (1974) estimated that the blue whale population in the western North Atlantic may number only in the low hundreds. DFO (R. Sears, pers. comm.) suggests that 400 to 600 individuals may be found in the western North Atlantic (Waring et al. 2011). COSEWIC (2002) estimates the number of mature adults at less than 250.

Blue whales enter the Gulf of St. Lawrence primarily through the Cabot Strait, where they can be found as early as March. From there, they disperse north into the Gulf, reaching the eastern tip of the Gaspé Peninsula by April. Most have left the Gulf of St. Lawrence by December, although some whales have been sighted along the North Shore of the Gulf well into January, and even on rare occasions in February (Sears 1999). Some blue whales are thought to overwinter along the south and west coasts of Newfoundland. Sutcliffe and Brodie (1977) reported that whalers regularly saw blue whales on the Scotian Shelf from June to November, although few have been reported since whaling ceased in 1972 (CETAP 1982). However, the number of historical observations of blue whales in the North Atlantic is too small to infer the routes and timing of this species’ migration (Reeves 2004). In mid and late August, a few blue whales are consistently seen in the deep canyon area of the Gully, and it is the only portion of the Scotian Shelf/Slope where they have been consistently reported (Whitehead et al. 1998).

The sightings of blue whales in and near the Study and Project areas indicate that it is quite possible that blue whales (likely in small numbers) may be encountered during the seismic survey. Blue whales are considered uncommon in the Study Area.

**Effects Assessment**

**Airgun Array Sound**

As discussed for right whales in Section 7.1.1.1, the key issues with respect to airgun array sound effects on marine mammals are the potential for hearing impairment and disturbance. Blue whales are thought to be sensitive to low frequency sounds such as those that contribute most of the energy in seismic pulses (see Section 1.2.2 of Appendix D).

**Hearing Impairment:** Given that blue whales (and other baleen whales), typically exhibit at least localized avoidance of seismic and other strong sound (see Appendix D), blue whales will likely not be exposed to levels of sound from the airgun array high enough to cause hearing damage.
Results from eight ship-based seismic monitoring programs in Atlantic Canada conducted from 2003 to 2008, observed blue whales farther from the seismic ship during periods when the airguns were active vs. silent. The average sighting distance during periods of seismic vs. non-seismic was 1,904 m (n=17) and 1,227 m (n=12), respectively (Moulton and Holst 2010). The mitigation measure of ramping-up the airgun array over a 30-minute period will allow blue whales that may occur close to the airgun array to move away before the sounds become sufficiently strong to have potential for hearing impairment (<50 m estimated for PTS criterion of 198 dB SEL; <300 m estimated for TTS criterion (183 dB SEL) except in a small proportion of the NATS area where water depth is ~100 m and the TTS range is <600 m based on the 183 dB SEL criterion. Also, ramp-up will not commence if a blue whale is sighted within the safety zone (600 m for the WATS survey and 700 m for the NATS survey). The airgun array will be shutdown if a blue whale is sighted within this safety zone at any point when the airgun arrays are active. In addition to visual monitoring by MMOs, PAM will be used during periods of poor visibility (i.e., when the applicable safety zone cannot be seen) and during pre-ramp up watches. If a blue whale is acoustically detected within the safety zone during a 30-minute pre-ramp up watch or during periods of poor visibility, ramp up will not commence or airguns will be shut down until the whale has been determined to leave the safety zone or 30 minutes have passed from the time the blue whale was last detected in the safety zone.

Given these mitigation measures, including the precautionary safety zone, and that blue whales are expected to exhibit at least localized avoidance of airgun array sound (including during ramp up), there is little potential for blue whales being close enough to the array to experience hearing damage. Based on precautionary acoustic modelling results, it is estimated that blue whales (and other baleen whales) would have to occur about <50 m from the airgun array to be exposed to sound levels exceeding the 198 dB SEL criterion for PTS (see Section 4.2 in Appendix A). If some blue whales did experience TTS, the effects would likely be quite temporary given the short-term nature of temporary shifts in hearing thresholds (see Section 1.6.1 in Appendix D). Based on these considerations, airgun array sound is judged to have negligible to minor hearing impairment effects on blue whales, over a short-term duration of <1 month, in an area <1 km² to 1-10 km². Therefore, hearing impairment residual effects on blue whales are judged to be not significant. The level of confidence associated with this judgement is high.

**Disturbance Effects:** Based on the literature review provided in Appendix D, there could be behavioural or disturbance effects on blue whales in the Study Area. Reported effects for baleen whales range from changes in swimming behaviour to avoidance of seismic vessels operating airgun array(s) (see Section 1.5.1 of Appendix D). As noted above, the average sighting distance of blue whales from seismic vessels during periods of seismic vs. non-seismic was 1,904 m (n=17) and 1,227 m (n=12), respectively, in Atlantic Canada (Moulton and Holst 2010). As discussed for right whales, using acoustic modelling results along with the 160 dB rms sound level as a guide for avoidance response, the area where avoidance would most likely occur would have a radius of ~7.0–22.1 km from the airgun array (see Section 4.2 in Appendix A). This estimate is likely conservative given that some baleen whale species, including blue whales
(Moulton and Holst 2010), have been observed in areas relatively close to an active seismic source.

It is uncertain how many blue whales may occur in the Study Area during the period when seismic surveying will occur (April to November). The Study Area does not include any identified critical habitat for blue whales and is not known to be an important feeding or breeding area for blue whales. Most available evidence suggests that their preferred habitat is shallower waters of the Scotian Shelf and the Gulf of St. Lawrence. However, blue whales have been observed in deeper waters on the Scotian Slope west of The Gully (Moulton and Miller 2004) and sightings within The Gully, Shortland and Haldimand canyons are increasing in recent years (Whitehead 2013). [The Gully MPA is assessed in Section 7.2.1.1] It is unlikely that localized and likely temporary displacement from an area within the Study Area constitutes a significant effect for blue whales. The Study Area is not known to be based on these considerations, airgun array sound is judged to have minor to moderate disturbance effects on blue whales, over a short-term duration of <1 month to 1-12 months and a potential geographic extent ranging from 101-1,000 km² to 1,001-10,000 km². Therefore, residual effects related to disturbance, are judged to be not significant for blue whales. The level of confidence associated with this judgement is medium.

Presence of Vessels

There is some risk for collisions between Project vessels and whales, but given the slow surveying speed (4.5 to 5 kt; 8.3 to 9.3 km/h) of the seismic vessels and their picket vessels, this risk is considered minimal (Laist et al. 2001; Vanderlaan and Taggart 2007). In addition, blue whales are expected to exhibit at least localized avoidance of vessels, even in the absence of airgun array sound (see Section 1.5.1 of Appendix D). Effects of the presence of vessels on blue whales, i.e., the risk of collision, are therefore judged to be negligible. Therefore, residual effects related to the presence of vessels, are judged to be not significant for blue whales. The level of confidence associated with this judgement is high.

7.1.1.3 Northern Bottlenose Whale

Biological Background Summary

The distribution of northern bottlenose whales is restricted to the North Atlantic, primarily in deep, offshore areas with two regions of concentration: the Gully and adjacent submarine canyons on the eastern Scotian Shelf, and Davis Strait off northern Labrador (Reeves et al. 1993). Throughout their range, northern bottlenose whales were harvested extensively during industrial whaling, which likely greatly reduced total numbers (COSEWIC 2011; DFO 2011a; Whitehead and Hooker 2012). The Scotian Shelf population is designated as Endangered under Schedule 1 of SARA and by COSEWIC; there is a Recovery Strategy in place for this species (DFO 2010a). The total abundance of northern bottlenose whales in the North Atlantic is
unknown, but the Scotian Shelf population is believed to be comprised of 143 individuals (O’Brien and Whitehead 2013).

The northern bottlenose whales of the Scotian Shelf population are most commonly sighted in three large canyons, The Gully, Shortland Canyon and Haldimand Canyon (Harris et al. 2013). Zone 1 of The Gully Marine Protected Area (MPA), and areas deeper than 500 m in Haldimand and Shortland Canyons have been designated as critical habitat (DFO 2010a). The Project Area, WATS Area, and NATS Areas are a minimum distance of 45.7 km, 67.8 km, and 108.7 km from the Gully MPA, respectively. It is thought that northern bottlenose whales from The Gully population spend 40% of their time in The Gully concentration area, 15% in Shortland Canyon, and 15% in Haldimand Canyon located 50 km and 100 km to the east of The Gully, respectively. It is unknown where whales spend the remaining 30% of their time (Moulton et al. 2003). Also, some individuals seem to show preferences for certain canyons (Wimmer and Whitehead 2004; Whitehead and Wimmer 2005). The encounter rates of northern bottlenose whales during boat surveys were 0.50 encounters/h for the Gully, 0.29 encounters/h for Shortland Canyon, 0.14 encounters/h for Haldimand Canyon, and zero for other Scotian Slope waters (COSEWIC 2011). The Gully is estimated to contain a third to half of the Scotian Shelf population at any given time of year (Gowans et al. 2000). This population is considered to be present in The Gully and adjacent submarine canyons year-round (Whitehead and Wimmer 2002; Moors 2012; Whitehead and Hooker 2012). The calving season of the Scotian Shelf population appears to peak in August (Whitehead et al. 1997a,b).

Waters approximately 1,000 m deep are thought to be the bottlenose whales’ preferred habitat (Whitehead and Wimmer 2002). In The Gully, bottlenose whales are primarily distributed in waters 500–1,750 m deep, with relatively steep slopes; concentrations are greatest in waters from 750–1,500 m (Hooker et al. 2002). Hooker et al. (2002) found a strong relationship between bottlenose distributions and local depths and slopes. It is thought that northern bottlenose whales spend 30% of their time in the upper 150 m of the water column. Foraging apparently occurs at depth, primarily on mesopelagic squid of the genus Gonatus and fish (Hooker et al. 2001; COSEWIC 2011).

Northern bottlenose whales could be present within the Study Area during the seismic survey period (and indeed any time of the year), but they will most likely occur outside of the Study Area on the eastern Scotian Shelf in The Gully and adjacent submarine canyons.

Effects Assessment

Airgun Array Sound

The smaller species of odontocetes that have been studied have exhibited relatively poor hearing sensitivity at the low frequencies that contribute most of the energy in seismic pulses. Sounds from seismic pulses are sufficiently strong that they remain above the hearing threshold of odontocetes (presumably including northern bottlenose whales) at tens of kilometres from the
Source (see Section 1.2.1 of Appendix D). The assessment below considers northern bottlenose whales that may occur in the Study Area. Effects of the Project on northern bottlenose whale critical habitat are assessed in Section 7.2.1.2.

Hearing Impairment: Available data on odontocetes, including northern bottlenose whales, indicates that these marine mammals typically exhibit at least localized avoidance of seismic and other strong sound (see Appendix D). As such, northern bottlenose whales will likely not be exposed to levels of sound from the airgun array high enough to cause hearing damage. Results from eight ship-based seismic monitoring programs conducted in Atlantic Canada from 2003 to 2008, observed northern bottlenose whales (n=3 sightings, totalling 17 individuals), ~0.6–1 km from the seismic vessel during periods when airguns were active (Moulton and Holst 2010). Based on conservative acoustic modelling results, it is estimated that northern bottlenose whales (and other mid-frequency cetaceans) would have to occur <50 m from the airgun array to be exposed to sound levels exceeding the 198 dB SEL criterion for PTS (see Section 4.2 in Appendix A).

Using 183 dB SEL (M-weighted for mid-frequency cetaceans) as a criterion for possible TTS in northern bottlenose whales, the range where airgun array sound may elicit a temporary change in hearing is estimated as <50 m at all modelling sites in the WATS and NATS areas, with one exception—the NATS area located on the Shelf, where the 183 dB SEL range is estimated as <50 m to 100 m (see Tables 9-20 in Appendix A). It is unlikely that northern bottlenose whales will occur in the shallow waters of the NATS areas because they prefer waters ~1000 m deep.

The mitigation measure of ramping-up the airgun array over a 30-minute period will allow northern bottlenose whales close to the airguns to move away before the sounds become sufficiently strong to have potential for hearing impairment. Also, ramp-up will not commence if a northern bottlenose whale is sighted within the precautionary safety zone (600 m for the WATS survey and 700 m for the NATS survey). The airgun array will be shutdown if northern bottlenose whales are sighted within this safety zone. In addition to visual monitoring by MMOs, PAM will be used during periods of poor visibility (i.e., when the safety zone cannot be seen) and during pre-ramp up watches. If a bottlenose whale is acoustically detected within the safety zone during a pre-ramp up watch or during periods of poor visibility, ramp up will be delayed or airguns will be shut down accordingly. Ramp up will not commence until the whale has been determined to leave the safety zone or 60 minutes have passed from the last time the whale was detected within the safety zone.

Given these mitigation measures and that northern bottlenose whales are expected to exhibit at least localized avoidance of airgun array sound (including during ramp up), there is little potential for bottlenose whales being close enough to the array to experience hearing impairment. In addition, this species is most likely to occur outside of the Study Area on the eastern Scotian Shelf in The Gully and adjacent submarine canyons. If some whales did experience TTS, the effects would likely be quite temporary given the short-term nature of temporary shifts in hearing thresholds (see Section 1.6.1 in Appendix D). Based on these considerations, airgun array sound is judged to have negligible hearing impairment effects on
bottlenose whales. Therefore, hearing impairment residual effects on bottlenose whales are judged to be not significant. The level of confidence associated with this judgement is high.

**Disturbance Effects:** Based on the review provided in Appendix D, there could be behavioural or disturbance effects on some northern bottlenose whales in the Study Area. Based on acoustic modelling results and using the 160 dB rms sound level as a guide for avoidance response, the area where avoidance would most likely occur would have a radius of ~7–22.1 km from the airgun array (see Section 4.2 in Appendix A). This estimate is likely conservative given that some odontocetes, including northern bottlenose whales, have been observed in areas relatively close to an active seismic source (i.e., ~0.6–1 km). It is uncertain how many bottlenose whales may occur in the Study Area during the period when seismic surveying will occur (April to November) but numbers are expected to be low given that this species is most likely to occur outside of the Study Area on the eastern Scotian Shelf in The Gully (which is over 67 km from the WATS Area and 108 km from the NATS (East) Area) and adjacent submarine canyons. The Study Area does not contain any designated critical habitat for bottlenose whales and is not known to be an important feeding or breeding area for bottlenose whales. As a result, it is unlikely that displacement from an area within the Study Area constitutes a significant effect for northern bottlenose whales. Based on these considerations, airgun array sound is judged to have minor to moderate disturbance effects on bottlenose whales, over a short-term duration of <1 month to 1-12 months and a potential geographic extent ranging from 101-1,000 km² to 1,001-10,000 km². Therefore, residual effects related to disturbance, are judged to be not significant for northern bottlenose whales. The level of confidence associated with this judgement is medium.

**Presence of Vessels**

As discussed previously, there is some risk for a Project vessel colliding with a whale. This risk is somewhat higher for northern bottlenose whales given that this species is known to approach vessels in contrast to other beaked whales. However, given the slow surveying speed (4.5 to 5 kt; 8.3 to 9.3 km/h) of the seismic vessels and their picket vessels, this risk is considered minimal (Laist et al. 2001; Vanderlaan and Taggart 2007). Also, few northern bottlenose whales are expected to occur in the Project Area. Thus, effects of the presence of vessels on northern bottlenose whales, i.e., the risk of collisions, are judged to be negligible. Therefore, residual effects related to the presence of vessels, are judged to be not significant for northern bottlenose whales. The level of confidence associated with this judgement is high.
7.1.1.4 Fin Whale

Biological Background Summary

Fin whales are widely dispersed in the North Atlantic and likely occur year-round on the Scotian Shelf and Shelf Edge (Meredith and Campbell 1988). This species appears to favour the south-western portions of the Scotian Shelf and the Gulf of Maine, but is also found west of Sable Island, on Sable Island Bank (Kenney 1994). Based on aerial surveys conducted from northern Labrador to the Scotian Shelf in July-August 2007, an estimated 1,967 fin whales (CV = 0.36) occur in this region (J. Lawson and J.-F. Gosselin, DFO, unpublished data). The abundance estimate for the western North Atlantic stock is 3,522 individuals (Coefficient of Variation [CV] = 0.27; Waring et al. 2013). The Atlantic population of fin whale is currently designated as Special Concern under Schedule 1 of SARA and by COSEWIC (Table 7.1).

In eastern Canadian waters, fin whales consume primarily euphausiids and capelin, with euphausiids occurring more frequently early in the year and the capelin proportion increasing later in the summer (Sergeant 1966). Fin whales have also been observed feeding on herring off Nova Scotia. They tend to be found in areas where these prey concentrate, such as in areas of upwelling, shelf breaks, and banks (COSEWIC 2005). Fin whales dive to depths below 450 m (Rutherford and Breeze 2002). Fin whales are found in summer feeding concentrations between the shore and the 1,800 m depth contour.

The stock that summers off Nova Scotia may be distinct from the stock which summers off Newfoundland, with as little as 10% overlap. It is suggested that the Newfoundland and Nova Scotia stocks move southward in the winter, with the Newfoundland stock moving into the summer grounds of the Nova Scotia stock and the Nova Scotia stock moving farther south (Kellogg 1929; Allen 1971; Mitchell 1974; Meredith and Campbell 1988). Little is known of the fall and winter distribution of fin whales, but they are known to move southwards, migrating to winter feeding grounds along the North American coast as far south as 35°N. Some whales remain farther north, and fin whales have been reported off eastern Nova Scotia and along the continental shelf from November to May (Meredith and Campbell 1988).

The sightings of fin whales reported in the Project Area indicate that it is very likely that fin whales will be encountered during the seismic survey.

Effects Assessment

Airgun Array Sound

As discussed for right and blue whales, fin whales are thought to be sensitive to low frequency sounds such as those that contribute most of the energy in seismic pulses (see Section 1.2.2 of
Appendix D). The key considerations with respect to airgun array sound effects on marine mammals are the potential for hearing impairment (PTS and TTS) and disturbance.

**Hearing Impairment:** Given that fin whales (and other baleen whales), typically exhibit at least localized avoidance of seismic and other strong sound (see Section 1.6 of Appendix D), fin whales will likely not be exposed to levels of sound from the airgun array high enough to cause hearing damage. For example, based on the results of eight ship-based seismic monitoring programs conducted in Atlantic Canada from 2003 to 2008, fin whales (n=68), on average, were sighted ~ 2 km from the seismic vessel during periods when airguns were activated (Moulton and Holst 2010). Based on precautionary acoustic modelling results, it is estimated that fin whales (and other baleen whales) would have to occur about <50 m from the airgun array to be exposed to sound levels from a single airgun pulse exceeding the 198 dB SEL criterion for PTS (see Section 4.2 of Appendix A).

Using 183 dB SEL (M-weighted for low-frequency cetaceans) as a criterion for possible TTS in fin whales (and other baleen whales), the range where airgun array sound may elicit a temporary change in hearing is estimated as <300 m at all modelling sites in the WATS and NATS areas, with one exception—the NATS area located on the Shelf (i.e., modelling Site 3 located in 100 m water depth; see Tables 9-20 in Appendix A). In the shallower shelf waters of the NATS West Area, the 183 dB SEL is estimated to increase to <600 m from the airgun array.

The mitigation measure of ramping-up the airgun array over a 30-minute period will allow fin whales close to the airguns to move away before the sounds become sufficiently strong to have potential for hearing damage. Also, ramp-up will not commence if a fin whale is sighted within the safety zone (600 m for the WATS survey and 700 m for the NATS survey). In addition to visual monitoring by MMOs, PAM will be used during pre-ramp up watches (as well as during periods of poor visibility; i.e., when the safety zone cannot be seen). If a fin whale is acoustically detected within the safety zone during a pre-ramp up watch, ramp up will not commence until the whale has been determined to leave the safety zone or 30 minutes have passed since the last detection within the safety zone.

Given these mitigation measures and that fin whales are expected to exhibit at least localized avoidance of airgun array sound (including during ramp up), there is little potential for fin whales being close enough to the array to experience hearing damage. If some whales did experience TTS, the effects would likely be quite temporary (see Section 1.6.1 in Appendix D). Based on these considerations, airgun array sound is judged to have negligible to minor hearing impairment effects on fin whales, over a duration of <1 month, in an area <1 km$^2$ to 1-10 km$^2$. Therefore, hearing impairment residual effects on fin whales are judged to be not significant. The level of confidence associated with this judgement is medium to high.
Figure 7.3. Sightings of Fin Whales Observed From April–November, 1966–2012 (DFO database).
Disturbance Effects: Based on the literature review provided in Appendix D, there could be behavioural or disturbance effects on some fin whales in the Study Area. Reported effects for baleen whales range from changes in swimming behaviour to avoidance of seismic vessels operating airgun array(s) (see Section 1.5.1 of Appendix D). Based on conservative acoustic modelling results and using the 160 dB rms sound level as a guide for avoidance response, the area where avoidance would most likely occur would have a radius of ~7–22.1 km from the airgun array (see Section 4.2 of Appendix A). This estimate is likely precautionary for several reasons. Fin whales are more likely to occur in the Study Area during summer when airgun array sound propagation at longer ranges (i.e., beyond 5 km) from the array is expected to be reduced relative to spring. Modelling results in the WATS and NATS areas for August show that the combination of the downwardly refracting sound speed profile with decreasing water depth effectively prevents the propagation of the acoustic energy from the airgun array into the shallow parts of the Shelf (see Figures 17, 19, 21, 23, 25, and 27 in Appendix A), where fin whales are likely more abundant. Also, based on observations from seismic vessels, fin whales, have been observed in areas relatively close to an active seismic source (~2 km; see Moulton and Holst 2010).

It is uncertain how many fin whales may occur in the Study Area during the period when seismic surveying will occur (April to November). The Study Area does not include any designated critical habitat for fin whales and is not known to be an important feeding or breeding area for fin whales (although this has not been specifically studied). Available evidence suggests that their preferred habitat is shallower waters of the Scotian Shelf where sound levels from the airgun array are much reduced, particularly during the WATS survey. As a result, it is unlikely that displacement from an area within the Study Area constitutes a significant effect for fin whales. Based on these considerations, airgun array sound is judged to have minor to moderate disturbance effects on fin whales, over a short-term duration of <1 month to 1-12 months and a potential geographic extent ranging from 101-1,000 km² to 1,001-10,000 km². Therefore, residual effects related to disturbance, are judged to be not significant for fin whales. The level of confidence associated with this judgement is medium.

Presence of Vessels

As discussed previously, there is some risk for a Project vessel to collide with a baleen whale, but given the slow surveying speed (4.5 to 5 kt; 8.3 to 9.3 km/h) of the seismic vessels and their picket vessels, this risk is considered minimal (Laist et al. 2001; Vanderlaan and Taggart 2007). In addition, fin whales are expected to exhibit at least localized avoidance of vessels, even in the absence of airgun array sound. Based on these considerations, effects of the presence of vessels on fin whales, i.e., the risk of collisions, are judged to be negligible. Therefore, residual effects related to the presence of vessels, are judged to be not significant for fin whales. The level of confidence associated with this judgement is high.
7.1.1.5 Sowerby’s Beaked Whale

Biological Background Summary

The Sowerby’s beaked whale is a small beaked whale found only in the North Atlantic, primarily in deep, offshore temperate to subarctic waters (COSEWIC 2006a). Designated as Special Concern (Schedule 1) under SARA and by COSEWIC, it is unclear if Sowerby’s beaked whales are truly uncommon or just poorly surveyed due to their deep-diving behaviour, small size, and offshore habitat. The cryptic surface behavior of Sowerby's beaked whales makes them very difficult to detect when at the surface thus lack of sightings may be a reflection of the difficulties associated with visually detecting beaked whales as well as lack of effort in the study area. Sowerby’s beaked whales are the most northerly distributed of the Mesoplodon spp. There are an unknown number of Sowerby’s beaked whales in the North Atlantic, but they are occasionally encountered offshore of eastern Canada. In 1997 and 1998 there were four confirmed sightings of Sowerby’s beaked whale in the Gully (located 45.7 km from the Project Area); whales were in groups ranging from 3 to 8-10 individuals (Hooker and Baird 1999). One Sowerby’s beaked whale also stranded on Sable Island in 1997 (Lucas and Hooker 2000). One record occurring in the Northwest Atlantic between New England and Labrador was reported by MacLeod 2000 and MacLeod et al. 2006. Numerous sightings of Sowerby’s beaked whales were made in The Gully, Shortland, and Haldimand canyons between 1999 and 2012; there was a 21% per year increase in sighting rates in the Gully during 1988–2011 (Whitehead 2013). More recently, an United States beaked whale survey data indicate that Mesoplodon spp. can be found all along the shelf break in southern Canadian (Georges Bank) and northern US waters (Waring et al. 2013). The Whitehead Lab database includes several Sowerby's beaked whale sightings on the western Scotian Slope, though outside the study area. This does suggest, however, that the distribution of these whales may be continuous along the Scotian Slope. There are no sightings recorded in the Study Area based on the DFO or NARWC databases (Figure 7.1 and 7.2). This species is most often observed in deep water, along the shelf edge and slope. Based on analysis of stomach contents, they appear to prefer mid to deep-water fish, with squid making up a small portion of the diet (MacLeod et al. 2003; Pereira et al. 2011). Given the relatively few sightings of this species recorded in the offshore waters of Nova Scotia, it is considered rare in the Study Area though survey effort in deep waters off Atlantic Canada have been limited (COSEWIC 2006a).

Effects Assessment

Airgun Array Sound

As discussed for the northern bottlenose whale in Section 7.1.1.3, the smaller species of odontocetes that have been studied have exhibited relatively poor hearing sensitivity at the low frequencies that contribute most of the energy in seismic pulses.
**Hearing Impairment:** Available data on odontocetes, including beaked whales, indicates that these marine mammals typically exhibit at least localized avoidance of seismic (and other strong) sound (see Section 1.6 of Appendix D). A single sighting of four Sowerby’s beaked whales was made during eight ship-based seismic monitoring programs conducted in Atlantic Canada from 2003 to 2008. This group was observed milling in front of a seismic vessel and the vessel approached to within ~1.3 km before the whales dove out of sight (Moulton and Holst 2010). Based on precautionary acoustic modelling results, it is estimated that Sowerby’s beaked whales (and other mid-frequency cetaceans) would have to occur about <50 m from the airgun array to be exposed to sound levels from a single airgun pulse exceeding the 198 dB SEL criterion for PTS as well as the 183 dB criterion for TTS (see Section 4.2 of Appendix A). The one exception is in shallow waters (~100 m) of the NATS areas where sound from a single airgun pulse may be ≥183 dB SEL up to 100 m from the array. As such, Sowerby’s beaked whales will likely not be exposed to levels of sound from the airgun array high enough to cause hearing damage.

The mitigation measure of ramping-up the airgun array over a 30-minute period will allow Sowerby’s beaked whales close to the airguns to move away before the sounds become sufficiently strong to have potential for hearing damage. Also, ramp-up will not commence if a Sowerby’s beaked whale is sighted within the safety zone (600 m for the WATS survey and 700 m for the NATS survey). In addition to visual monitoring by MMOs, PAM will be used during pre-ramp up watches (as well as during periods of poor visibility; i.e., when the safety zone cannot be seen). If a Sowerby’s beaked whale is acoustically detected within the safety zone during a pre-ramp up watch, ramp up will not commence until the whale has been determined to leave the safety zone or 60 minutes have passed since the last detection.

Given these mitigation measures and that Sowerby’s beaked whales are expected to exhibit at least localized avoidance of airgun array sound, there is little potential for this species being close enough to the array to experience hearing impairment. In addition, this species is considered rare in the Study Area. If some whales did experience TTS, the effects would likely be quite “temporary” given the short-term nature of temporary shifts in hearing thresholds. Based on these considerations, airgun array sound is judged to have negligible hearing impairment effects on Sowerby’s beaked whales. Therefore, hearing impairment residual effects on Sowerby’s beaked whales are judged to be not significant. The level of confidence associated with this judgement is high.

**Disturbance Effects:** Based on the literature review provided in Appendix D, there could be behavioural or disturbance effects on some Sowerby’s beaked whales in the Study Area. Based on precautionary acoustic modelling results and using the 160 dB rms sound level as a guide for avoidance response, the area where avoidance would most likely occur would have a radius of ~7 to 22.1 km from the airgun array (see Section 4.2 of Appendix A). This estimate is likely conservative given that some odontocetes, including Sowerby’s beaked whales, have been observed in an area relatively close to an active seismic source (i.e., ~1.3 km).
It is uncertain how many Sowerby’s beaked whales may occur in the Study Area during the period when seismic surveying will occur (April to November) but numbers are expected to be quite low given that this species is considered rare in the Study Area. Additionally, the Study Area does not include any designated critical habitat for Sowerby’s beaked whale and is not known to be an important feeding or breeding area for Sowerby’s beaked whale (although this has not been specifically studied). It is unlikely that displacement from an area within the Study Area constitutes a significant effect for Sowerby’s beaked whales. Based on these considerations, airgun array sound is judged to have minor to moderate disturbance effects on Sowerby’s beaked whales, over a short-term duration of <1 month to 1-12 months and a geographic extent ranging from 101-1,000 km² to 1,001-10,000 km². Therefore, residual effects related to disturbance, are judged to be not significant for this species. The level of confidence associated with this judgement is high.

Presence of Vessels

As discussed previously, there is some risk for a Project vessel to collide with a whale, but given the slow surveying speed (4.5 to 5 knots; 8.3 to 9.3 km/h) and steady course of the seismic vessels and their picket vessels, this risk is considered minimal (Laist et al. 2001; Vanderlaan and Taggart 2007). In addition, Sowerby’s beaked whales are expected to exhibit at least localized avoidance of vessels, even in the absence of airgun array sound. Also, few Sowerby’s beaked whales are expected to occur in the Project Area. Based on these considerations, effects of the presence of vessels on Sowerby’s beaked whales, i.e., the risk of collisions, are judged to be negligible. Therefore, residual effects related to the presence of vessels, are judged to be not significant for Sowerby’s beaked whales. The level of confidence associated with this judgement is high.

7.1.1.6 Leatherback Sea Turtle

The largest and most widely ranging of sea turtles, the leatherback sea turtle occurs from sub-polar and cool temperate foraging grounds to tropical and sub-tropical nesting/wintering areas in all of the world’s oceans (Spotila 2004). Exhibiting wide-ranging oceanic movements, leatherbacks occur in pelagic regions of the North Atlantic to forage on gelatinous zooplankton (Hays et al. 2006). There are an estimated 34,000–94,000 adult leatherback sea turtles in the North Atlantic (TEWG 2007), but there is no current reliable estimate of the number of leatherbacks using eastern Canadian waters (COSEWIC 2012). Nonetheless, James et al. (2006) suggested that Canadian waters support high densities of leatherbacks during the summer and fall, and that Canadian waters should be considered critical foraging habitat for this species. However, critical habitat has not been designated for this species (ALTRT 2006), although a forthcoming amendment to the 2006 recovery strategy will identify critical habitat (DFO 2013a). Leatherback sea turtles were found to forage on jellyfish, such as lion’s mane and moon jellyfish, off Nova Scotia; they consumed an average of 330 kg wet mass of jellyfish per day (Heaslip et al. 2012).
Leatherback sea turtles are currently designated as Endangered by COSEWIC (COSEWIC 2002b, 2012). In May 2012, they were split into two populations (Atlantic and Pacific) and reassessed by COSEWIC—both populations were designated as Endangered; however, they are not currently divided into two designatable units. Leatherback sea turtles are also listed as Endangered on Schedule 1 of SARA; however, there are currently no separate listings for the two populations on Schedule 1 of SARA. The leatherback sea turtle has also been listed by the United States as endangered throughout its range since 1970 (NOAA Fisheries 2013).

Three primary habitats, likely used as foraging areas by leatherback turtles in Atlantic Canada, were identified using satellite tracking data: (1) the area near Georges Bank, (2) southeastern Gulf of St. Lawrence and waters east of Cape Breton, and (3) waters south and east of Burin Peninsula, Newfoundland (DFO 2011b). Most leatherbacks that occur in Atlantic Canadian waters are large sub-adults and adults, with a female-biased sex ratio among mature turtles (James et al. 2007). The leatherback winters off western Africa or in the Caribbean, often crossing the Scotian Shelf during its migration. Genetic analysis on leatherback turtles captured off Nova Scotia revealed that most of them had originated from natal beaches in Trinidad, followed by French Guiana, Costa Rica, St. Croix, and Florida (Stewart et al. 2013). Leatherback distribution correlates to the distribution of the jellyfish that make up their primary prey (Dodge et al. 2011; COSEWIC 2012).

James et al. (2006) noted that increasing sea surface temperatures in Canadian waters result in a substantial increase in turtle sightings. On the east coast of Canada, leatherbacks are often sighted between May and November (O’Boyle 2001; ALTRT 2006; James et al. 2006). They have been found as far north as Labrador with a few animals reported in the Gulf of St. Lawrence (James 2001). In 1998 to 2005, 851 leatherback turtle sightings were documented by a fisher-scientist collaborative venture entitled the Nova Scotia Leatherback Turtle Working Group (NSLTWG; now called the Canadian Sea Turtle Network). The NSLTWG group was initiated in Atlantic Canada to investigate the distribution of leatherback turtles in the northwest Atlantic (James et al. 2006). Sightings peak on average around the first week of August (James et al. 2006). These sightings suggest regular occurrence on the Scotian Shelf as well as on the shelf slope and beyond. They also suggest that leatherbacks are broadly distributed on the Scotian Shelf. A study of satellite tagged leatherbacks in Canadian waters showed that they concentrated their movements in water off eastern Canada and northeastern United States for up to four months (after tagging) (James et al. 2005). They spent the greatest part of their time on areas of the continental shelf and the shelf slope, including the Study Area. Tagged individuals started their southward migration on dates ranging from 12 August to 15 December, but the majority left in October. This migration occurred across a broad expanse of ocean. The satellite tagging study found a mean departure date of 23 October (Sherrill-Mix et al. 2008). A model based on these data predicted departure of 90% of the turtles from Cape Breton Island by 10 October and from Georges Bank by 11 December. On their return, northward migration, tagged leatherbacks typically arrived north of 38°N in June (range: 25 March to 16 August), usually returning to
within several hundred kilometres of the foraging area used the previous summer (James et al. 2005).

Based on the DFO sightings database, there have been four sightings of leatherback sea turtles in the Study Area during the April–November time period. All four sightings were recorded within the Project Area (Figure 7.1) and between July and October. Leatherback sea turtles outfitted with satellite telemetry have also been tracked near or within the Study Area (James et al. 2005; TEWG 2007). The numbers of leatherback sightings each summer suggest that summer leatherback densities in eastern Canada may be higher than the estimate of 100 to 900 leatherbacks per summer reported by Shoop and Kenney (1992) for a much larger study area along the coast of the northeastern United States (James et al. 2006).

Effects Assessment

Airgun Array Sound

The limited available data on sea turtle hearing indicates that the frequency range of best hearing sensitivity of sea turtles extends from ~100 to 700 Hz (see Section 1 of Appendix E). Thus, there is substantial overlap in the frequencies that sea turtles detect and the dominant frequencies produced by airgun pulses. Given that, plus the high energy levels of airgun pulses, it can be concluded that sea turtles hear airgun sounds.

Hearing Impairment: Based on available data, from studies conducted on captive and terrestrial turtles, it is possible that leatherback sea turtles might exhibit temporary hearing loss or perhaps even permanent hearing damage if the turtles are close to the airguns (see Section 4 of Appendix E). However, there is not enough information on sea turtle temporary hearing loss and no data on permanent hearing loss to reach any definitive conclusions about received sound levels that trigger TTS. In general, the received sound must be strong for either to occur, and must be especially strong and/or prolonged for permanent impairment to occur. Also, it is likely that sea turtles will exhibit a behavioural response or avoidance within an area of unknown size around a seismic vessel(s). In the absence of specific hearing impact criteria for sea turtles, it is assumed that sea turtles may experience hearing impairment at similar sound levels as marine mammals.

The mitigation measure of ramping-up the airgun array over a 30-minute period should permit leatherback sea turtles close to the airguns to move away before the sounds become sufficiently strong to have potential for hearing impairment. Also, ramp-up will not commence if a leatherback is sighted within the safety zone (600 m in the WATS area and 700 m in the NATS area) and the airgun array will be shut down if a leatherback sea turtle is sighted within the safety zone.

It is anticipated that a low number of leatherback turtles is likely to occur in the Study Area. Mitigation measures (ramp up delay, ramp up, and shut downs of the airgun arrays) will minimize the exposure of leatherbacks to sound levels that may cause hearing impairment. Based on these
considerations, airgun array sound is judged to have negligible to minor hearing impairment on leatherback sea turtles, over a short-term duration of <1 month, in an area <1 km$^2$ to 1-10 km$^2$. Therefore, hearing impairment residual effects on leatherback sea turtles are judged to be not significant. The level of confidence associated with this judgement is medium.

**Disturbance Effects:** Leatherback sea turtles would likely exhibit avoidance from airgun arrays (see Section 2 of Appendix E). Based on observations of green and loggerhead sea turtles, behavioural avoidance may occur at received sound levels ranging from 166–175 dB re 1 μPa (rms) (see Appendix E). Based on conservative acoustic modelling results and using these sound levels as a guide for avoidance, the area where avoidance would most likely occur would have a radius of ~3-18 km from the airgun array in the WATS and NATS areas (see Section 4.2 of Appendix A). Of note, leatherback sea turtles typically arrive offshore Nova Scotia in June, after the period when surface duct effects are most pronounced. The Study Area does not include any designated critical habitat for leatherback sea turtles and is not specifically known to be an important feeding area or in proximity to any identified nesting sites. As a result, it is unlikely that displacement from an area within the Study Area constitutes a significant effect for leatherback sea turtles. Based on these considerations, airgun array sound is judged to have minor disturbance effects on leatherback sea turtles, over a short-term duration of <1 month to 1-12 months and a potential geographic extent ranging from 11-100 km$^2$ to 101-1,000 km$^2$. Therefore, residual effects related to disturbance, are judged to be not significant for leatherback sea turtles. The level of confidence associated with this judgement is high.

**Presence of Vessels**

Other potential effects of Project activities on leatherback sea turtles include entanglement with seismic gear (e.g., buoys) and collisions with ships (Pendoley 1997; Ketos Ecology 2007; Weir 2007; Hazel et al. 2007). The risk of ship collisions is minimized because of the slow survey speed and constant course of travel of seismic vessels and their accompanying picket vessels. Entanglement of sea turtles with marine debris, fishing gear, and other equipment has been documented; turtles can become entangled in cables, lines, nets, or other objects suspended in the water column and can become injured or fatally wounded, drowned, or suffocated (e.g., Lutcavage et al. 1997). Seismic-survey personnel have reported that sea turtles (number unspecified) became fatally entrapped between gaps in tail-buoys associated with industrial seismic vessel gear deployed off West Africa in 2003 (Weir 2007). However, there have been numerous surveys where no incidents of entanglement of sea turtles have been documented. For example, during U.S. National Science Foundation-funded seismic surveys, which since 2003 have included dedicated ship-based monitoring by trained biological observers (over 74,000 km of monitoring), in some cases in areas with many sea turtles, there were no sea turtle entanglements (e.g., Holst et al. 2005a,b; Holst and Smultea 2008; Hauser et al. 2008). To further reduce the potential of leatherbacks (and other sea turtles) becoming entangled in towed seismic gear during the Project, debris/turtle guards (Ketos Ecology 2009) will be deployed on tail buoys of the streamer vessels.
Based on these considerations, effects of the presence of vessels on leatherback sea turtles, including the risk of ship collisions and gear entanglement, are judged to be negligible to minor, over a short-term duration of <1 month to 1-12 months, in an area 1-10 km². Therefore, residual effects related to the presence of vessels, are judged to be not significant for leatherback sea turtles. The level of confidence associated with this judgement is high.

7.1.1.7 Wolffishes

The status of the northern wolffish and the spotted wolffish for both Schedule 1 of SARA and COSEWIC is Threatened, while the status of the Atlantic wolffish for both Schedule 1 of SARA and COSEWIC is Special Concern (Table 7.1). The combined recovery strategy for northern and spotted wolffishes and management plan for Atlantic wolffish was finalized in 2008 (Kulka et al. 2007). Recently, a report on the progress of the implementation of the recovery strategy and management plan was published (DFO 2013b). It reports that the recovery strategy (Kulka et al. 2007) is presently being updated and will include identified critical habitat for both northern and spotted wolffish. The progress report also states that the status of each of the three wolffish species was re-assessed by COSEWIC in November 2012 and that the recommendation was to retain the current designations. At a 2010 meeting for the Zonal Advisory Process for the Pre-COSEWIC Assessment of these three wolffish species, it was stated that there have not been any significant advances in DFO’s understanding of life history characteristics of the three species in recent times (DFO 2011c).

Biological Background Summary

Northern Wolffish

The northern wolffish is a deepwater fish of cold northern seas that has been caught at depths ranging from 38 to 1,504 m. Observed densest concentrations have been between 500 and 1,000 m where water temperatures range from 2 to 5°C. During 1980-1984, this species was most concentrated on the northeast Newfoundland and Labrador shelf and banks, the southwest and southeast slopes of the Grand Banks, and along the Laurentian Channel. Between 1995 and 2003, the area occupied by this species and its associated density within this area were considerably reduced compared to results of earlier surveys. Northern wolffish are known to inhabit a wide range of bottom substrate types, including mud, sand, pebbles, small rock and hard bottom, with the highest concentrations observed over sand and shell hash in the fall, and coarse sand in the spring. Unlike other wolffish species, both juvenile and adult stages of the northern wolffish have been found in the middle part of the water column, a considerable distance above bottom (Kulka et al. 2007).

While the prey of northern wolffish are primarily bathypelagic (>200 m depth) biota, they also includes mesopelagic biota (<200 m depth) and benthic invertebrates. Pelagic fish represent the largest percentage of stomach contents on the basis of volume. Tagging studies have suggested
limited migratory behaviour by these wolffish. Northern wolffish typically spawn late in the year on rocky bottom. Cohesive masses of fertilized eggs are laid in crevices but are unattached to the substrate. Pelagic larvae hatch after an undetermined egg incubation time, and typically feed on crustaceans, fish larvae and fish eggs (Kulka et al. 2007).

A 2001 review of the status of northern wolffish indicated that this species was near the southern limit of its range in the Maritimes Region. A recent review confirms that conclusion with the composite distribution pattern from all data sources in the Maritimes Region indicating that this wolffish species is restricted primarily to the eastern Scotian Shelf, with some fish found along the shelf edge to the west. Abundance in each survey examined has always been very low with this species occurring in less than 0.5% of the sets (Simon et al. 2011).

Analysis of DFO commercial fishery landings data, April to September 2005-2010, indicates that no northern wolffish were harvested within the Study Area during that six year period.

**Spotted Wolffish**

The life history of the spotted wolffish is very similar to that of the northern wolffish except that it seldom inhabits the deepest areas used by the northern wolffish. Although spotted wolffish have been caught at depths ranging from 56 to 1,046 m, the densest concentrations observed occur between 200 and 750 m where water temperatures range from 1.5 to 5°C. During 1980-1984, spotted wolffish were most concentrated on the northeast Newfoundland and Labrador shelf and banks, the southwest and southeast slopes of the Grand Banks, along the Laurentian Channel, and in the Gulf of St. Lawrence. Between 1995 and 2003, the area occupied by the spotted wolffish and its associated density within this area were considerably reduced compared to results of earlier surveys. As with northern wolffish, spotted wolffish also inhabit a wide range of bottom substrate types, including mud, sand, pebbles, small rock and hard bottom, with highest concentrations observed over sand and shell hash in the fall, and coarse sand in the spring (Kulka et al. 2007).

Prey of spotted wolffish are primarily benthic (>75%) and typically include echinoderms, crustaceans and molluscs associated with both sandy and hard bottom substrates. This species is referred to as an echinoderm specialist (i.e., benthivore) (DFO 2011c). Fish also constitutes part of the spotted wolffish diet (<25%). Tagging studies indicate the spotted wolffish migrations are local and limited. Spotted wolffish reproduction is characterized by internal fertilization. Cohesive masses of eggs are deposited in crevices, remaining unattached to the substrate. After an undetermined incubation time, pelagic larvae hatch and commence feeding on crustaceans, fish larvae and fish eggs within a few days of hatch (Kulka et al. 2007).

A 2001 review of the status of spotted wolffish indicated that this species was near the southern limit of its range in the Maritimes Region. A recent review confirms that conclusion with the composite distribution pattern from all data sources in the Maritimes Region indicating that this wolffish species is restricted primarily to the eastern Scotian Shelf, with some fish found along...
the shelf edge to the west. Abundance in each survey examined has always been very low with this species occurring in less than 0.5% of the sets (Simon et al. 2011).

Analysis of DFO commercial fishery landings data, April to September 2005-2010, indicates that no spotted wolffish were harvested within the Study Area during that six year period.

**Atlantic Wolffish**

Atlantic wolffish are primarily demersal and inhabit shallower areas than the northern and spotted wolffishes. This species has been observed from near shore to a depth of 918 m and at water temperatures ranging from -1 to 10°C. Atlantic wolffish most commonly occur at water depths of 150 to 350 m where water temperatures range from 1.5 to 4°C. During 1980-1984, this species was most concentrated in the same areas as the northern wolffish, with additional concentrations on the southern Grand Banks and the Gulf of St. Lawrence. More recently, the area this species occupied and its relative density within this area was considerably reduced in the northern part of its confirmed range, but has remained relatively constant in the Gulf of St. Lawrence. During feeding, Atlantic wolffish appear to prefer complex reliefs of rocks without algal growth and sand. Shelters in these rock reliefs are typically situated on 15-30° slopes with good water circulation. There is some indication that Atlantic wolffish form colonial settlements during the feeding period (Kulka et al. 2007).

Prey of Atlantic wolffish are primarily benthic (>85%) and typically include molluscs, echinoderms and crustaceans associated with both sandy and hard bottom substrates. This species is referred to as a mollusc specialist (i.e., benthivore) (DFO 2011c). Fish also constitutes part of the Atlantic wolffish diet (<15%; e.g., redfish). Migration by Atlantic wolffish is limited, with seasonal inshore movement in the spring when mature fish are found in areas where water depths are <15 m. The Atlantic wolffish seems to prefer stony bottom substrate for spawning in September and October. After internal fertilization, cohesive masses of eggs are deposited in crevices on the bottom and remain unattached to the substrate. The egg mass is guarded and maintained by the male Atlantic wolffish for the seven to nine month incubation period, after which pelagic larvae hatch and almost immediately commence to feed on crustaceans, fish larvae and fish eggs (Kulka et al. 2007).

Simon et al. (2011) suggest that although Atlantic wolffish are found throughout the Maritimes Region, there are two primary areas of concentration on the Scotian Shelf. On the eastern Scotian Shelf, the abundance of mature individuals has declined by 99% since 1970, while the abundance of immature individuals has increased over the same period. On the western Scotian Shelf, both immature and mature abundance has declined since 1970. Although these two concentrations exhibit differing trends in abundance, there is no evidence to suggest that they are separate designatable units. On the northeast peak of Georges Bank, there is a small aggregation of Atlantic wolffish that appears to be spatially discrete from the remainder of the surveyed area and that has declined dramatically since 1986. Although there are no directed fisheries for wolffish in the Maritimes Region, the species is caught as bycatch in other fisheries. An
examination of wolffish landings in NAFO Division 4X revealed that Atlantic wolffish were concentrated on the western peak of Browns Bank, west of German Bank, and in three isolated areas inshore of the 50 fathom (100 m) line. These inshore areas are not currently surveyed by the DFO Research Vessel (RV) surveys although they are potentially areas of critical habitat. These areas and other areas of potential critical habitat for Atlantic wolffish are not located in either the Project or Study Area (Simon et al. 2011).

Analysis of DFO commercial fishery landings data, April to September 2005-2010, indicates that the harvest of at least one Atlantic wolffish within the Study Area was reported during that six year period.

**Effects Assessment**

Exposure to airgun sound can potentially cause physical (pathological and physiological) and/or behavioural effects on fishes. A literature review related to auditory capabilities of fishes and the potential effects of exposure to seismic airgun sound on fishes is contained in Appendix F. Studies that conclude that there are physical effects typically involve captive subjects that are unable to move away from a fixed sound source and are therefore exposed to higher sound levels than under natural conditions (e.g., Fewtrell and McCauley 2012; McCauley et al. 2003; Santulli et al. 1999) (see Appendix F). Fishes that lack swim bladders are not sensitive to the sound pressure component of sound but are sensitive to the particle displacement component. Other fishes do have swim bladders and are sensitive, at varying degrees, to the sound pressure component as well as to the particle displacement component of sound. The hearing thresholds of the northern wolffish, spotted wolffish and Atlantic wolffish are unknown. It can be speculated that these fishes, like most fishes whose sensitivities to sound have been studied, are most sensitive to low frequency sound (i.e., <1,500 Hz) (see Appendix F).

**Airgun Array Sound**

Wolffishes lack a swim bladder and are therefore sensitive to the particle displacement component of sound only. Since all three wolffish species typically occur at substantial depth (i.e., at least 150 m), it is unlikely that the particle displacement component of the sound being produced by the airgun array will have much if any effect on them. Physical effects of exposure to airgun sound can be confidently dismissed. There is always potential for behavioural effects but, as already stated, any effects are expected to be negligible.

Considering that wolffishes are likely sensitive to the particle displacement component of sound only and that they typically occur near bottom in deeper water, airgun array sound is judged to have negligible effects on wolffishes over a short-term duration of <1 month and a geographic extent of <1 km². Therefore, the residual behavioural effects related to exposure to seismic airgun sound are judged to be not significant for wolffishes. The level of confidence associated with this judgement is high.
7.1.1.8 White Shark

Biological Background Summary

Worldwide, the white shark is rare but does occur with some predictability in certain areas. The white shark is widely distributed in sub-polar to tropical seas of both hemispheres, but it is most frequently observed and captured in inshore waters over the continental shelves of the western North Atlantic, Mediterranean Sea, southern Africa, southern Australia, New Zealand, and the eastern North Pacific. The species is not found in cold polar waters (SARA website accessed September 2013). The status of the Atlantic population of the white shark for both Schedule 1 of SARA and COSEWIC is Endangered (Table 7.1).

Off Atlantic Canada, the white shark has been recorded from the NE Newfoundland Shelf, the Strait of Belle Isle, the St. Pierre Bank, Sable Island Bank, the Forchu Misaine Bank, in St. Margaret’s Bay, off Cape La Have, in Passamaquoddy Bay, in the Bay of Fundy, in the Northumberland Strait, and in the Laurentian Channel as far inland as the Portneuf River Estuary. The species is highly mobile, and individuals in Atlantic Canada are likely seasonal migrants belonging to a widespread NW Atlantic population. It occurs in both inshore and offshore waters, ranging in depth from just below the surface to just above the bottom, down to a depth of at least 1,280 m (SARA website accessed September 2013). The COSEWIC assessment and status report on the white shark (COSEWIC 2006b) indicates that sightings of this shark in Atlantic Canadian waters are rare. There are only 32 official sightings of the white shark in Atlantic Canadian waters since 1874. Therefore, the likelihood of white shark occurrence in the Study Area, especially coincident with Project activity, is low.

The female produces eggs which remain in her body until hatching. When the young emerge, they are born live. Litter size varies, with an average of 7 pups. Length at birth is assumed to be between 109 and 165 cm. Possible white shark pupping areas on the west and east coasts of North America include off southern California and the Mid-Atlantic Bight, respectively (SARA website accessed September 2013).

White sharks are an apex predator with a wide prey base feeding primarily on many types of fish, and marine mammals, as well as squid, molluscs, crustaceans, marine birds, and reptiles (SARA website accessed September 2013).

Effects Assessment

Although the sound detection threshold of the white shark is unknown, hearing thresholds have been determined for other shark species, including the nurse shark (Ginglymostoma cirratum), bamboo sharks (Chiloscyllium sp.), the Atlantic sharpnose shark (Rhizoprionodon terranovae), the horn shark (Heterodontus francisci), and the bull shark (Carcharhinus leucas) (e.g., Casper et al. 2003; Casper and Mann 2006, 2007, 2009) (see Appendix F). These studies concluded that
sharks are most sensitive to underwater sound at low frequencies (i.e., <1,500 Hz) (see Appendix F).

Airgun Array Sound

As is the case with wolffishes, the white shark lacks a swim bladder and is therefore sensitive to the particle displacement component of airgun sound only. Unlike the wolffishes, the white shark often occurs in the upper water column and could be closer to active airguns. This results in greater likelihood that the white shark will detect the particle displacement component of the seismic airgun sound. The potential physical effects of exposure to seismic airgun sound can be confidently dismissed (see Appendix F), and any behavioural effects are still expected to be negligible since the shark is capable of moving away from a seismic airgun sound source without any detrimental biological consequences.

Considering that the white shark is sensitive to the particle displacement component of airgun sound only and that it is highly mobile and able to move away from a seismic sound source, airgun sound is judged to have negligible effects on the white shark over a short-term duration of <1 month and a geographic extent of <1 km$^2$. Therefore, the residual behavioural effects related to exposure to seismic airgun sound are judged to be not significant for the white shark. The level of confidence associated with this judgement is high.

7.1.1.9 Roseate Tern

Biological Background Summary

Roseate Tern (Sterna dougallii) is a migratory bird protected under the Migratory Birds Convention Act, 1994 and is under the management jurisdiction of the federal government (Environment Canada). It was designated as Endangered under SARA in June 2003 and is listed on Schedule 1. The Canadian Wildlife Service, Atlantic Region, Environment Canada has led the development of a Recovery Strategy for Roseate Tern (Environment Canada 2010).

Roseate Tern breeds worldwide on marine islands. In North America, a northeastern population breeds from the Gulf of St. Lawrence (Magdalen Islands) to New York; a disjunct Caribbean population breeds from Florida and the Bahamas to the Lesser Antilles (Environment Canada 2010). In Canada it has nested in Quebec (Gulf of St. Lawrence), Nova Scotia and New Brunswick. Since 1982, it has been known to nest at 28 sites in Canada with a maximum of 12 sites occupied during any one year (Environment Canada 2010). Between 2000 and 2010 only three colonies, all in Nova Scotia, were known to have more than 20 nesting pairs: The Brothers (33-86 pairs), Grassy Island (0-30 pairs) and Country Island (0-53 pairs; all sites >250 km from the Project Area). The number of pairs nesting in Canada represents 3-4% of the northwestern Atlantic population and less than 1% of the world population (Gochfeld et al. 1998).
Roseate Tern requires small coastal islands with low vegetation for nesting. In Canada, it has always been found nesting in colonies of the more abundant Common Tern (*Sterna hirundo*) (Gochfeld et al. 1998). During the breeding season (May to August in Canada) Roseate Tern generally forages for small fish in shallow marine waters close to shore, often near tidal rips and shoals (Gochfeld et al. 1998). After the breeding season Roseate Terns typically collect at staging areas. These locations are unknown in Canada but two birds banded as chicks in Nova Scotia were observed a month later in Great Gull Island, New York. Recoveries of banded birds of this species at sea during late August and early September and the lack of recoveries along the U.S. Atlantic coast suggest that the northeastern breeding population travels south to cross the western part of the Atlantic Ocean and the eastern Caribbean Sea during fall migration (Nisbet 1984). However, band recoveries do not reveal the route or timing of spring migration.

Roseate Tern is probably an occasional transient in the offshore regions of North America. This species is generally expected to occur over shallow coastal waters during the breeding season. However, this species nests on Sable Island in some years, which would require migrating over offshore waters (from southern locations) in order to reach Sable Island (COSEWIC 2009a). There are no known sightings of Roseate Terns in the Study Area, though these areas have not been extensively surveyed. As a result, this species may occur in the Study Area, though likely in small numbers as a transient during the migration periods of May and August-September.

**Effects Assessment**

The effects of airgun sound on diving birds was not assessed because Environment Canada (Canadian Wildlife Service [CWS]) considers light attraction to be the major effect of seismic exploration on seabirds (reflected in the Scoping Document, Appendix B). The CWS position is consistent with the current opinion among scientists that hearing in seabirds is less vulnerable to damage from underwater sound than in marine mammals. This opinion is based on: 1) lack of contact between seawater and the auditory meatus (Dooling and Therrien 2012); 2) shallower, shorter duration dives; and 3) a field study that found no behavioural effect of a seismic survey on Long-tailed Ducks (Lacroix et al. 2003).

The potential effect of the key interaction between lights associated with Project vessels and the Roseate Tern is assessed below.

*Light Attraction*

The attraction of migratory birds to light from vessels and the potential effects are reviewed in Section 7.1.2.2. Birds (primarily petrels) that are attracted to lights of Project vessels may become stranded on a vessel due to their inability to take off from the deck. Stranding may result in bird mortality, usually due to dehydration, starvation, exhaustion, or hypothermia or drowning in fluid-filled cavities on deck. This risk is reduced for Roseate Terns given that they are only expected to occur in small numbers in the Project Area and that they are able to readily take off.
from the deck of a vessel. It is unknown whether Roseate Terns would occur near Project vessels because of potentially increased prey attracted to vessel lights.

MMOs on the seismic vessels and crew on picket vessels will conduct daily searches (typically once per day in the early morning) for stranded birds. If a stranded Roseate Tern is found, the CWS protocols for stranded seabirds (Williams and Chardine n.d.) will be followed. A CWS-issued permit for handling of migratory birds will be in place.

Based on these considerations, light attraction effects on the Roseate Tern are judged to have negligible to minor effects over a short-term duration of 1-12 months and a geographic extent of 11-100 km\(^2\). Therefore, residual effects related to light attraction on Roseate Terns are judged to be not significant. The level of confidence associated with this judgement is high.

### 7.1.1.10 Red Knot, rufa Subspecies

#### Biological Background Summary

Red Knot (Calidris canutus) is a medium-sized sandpiper, the rufa subspecies of which was designated as Endangered on Schedule 1 of the Species at Risk Act in July 2012. This subspecies nests on the islands of the southern Arctic archipelago of Canada and the adjacent mainland (COSEWIC 2007). It winters primarily in Patagonia and Tierra del Fuego in South America. It is uncommon to rare in spring in Nova Scotia, passing through from mid-April to early June (McLaren 2012), most birds passing considerably west of Nova Scotia (COSEWIC 2007). However, a small number of sightings on Sable Island suggest that this subspecies may pass through the Study Area in spring. Those sightings occurred from 9 May to 8 June (McLaren 1981). In contrast, Red Knot is common during southward migration in coastal areas on extensive intertidal sand-flats along the Gulf of St. Lawrence and the Maritime Provinces (COSEWIC 2007). In these areas it feeds on benthic invertebrates including bivalves. In Nova Scotia it first appears in July, peaking in August and again in September-October (McLaren 2012). Important areas for this subspecies in Nova Scotia in fall are southern Cape Breton Island and Cape Sable (COSEWIC 2007). In August, this subspecies departs eastern Canada and the U.S. southeastwards on a trans-oceanic flight to South America (Harrington 2001), which likely takes some individuals over the Scotian Shelf and potentially over the Study Area. This is confirmed by sightings on Sable Island (McNeil and Burton 1977; McLaren 1981). This subspecies has been recorded there during fall migration as early 14 July and as late as 10 November (McLaren 1981). However, the median fall arrival date was 24 August and the median departure date was 15 September.

#### Effects Assessment

The potential effects of the key interaction between lights associated with Project vessels and the Red Knot are assessed in the following section.
**Light Attraction**

The attraction of migratory birds to light from vessels and the potential effects are reviewed in Section 7.1.2.2. Birds (primarily petrels) that are attracted to lights of Project vessels may fly into and strand in partially enclosed spaces on a vessel due to their inability to find their way out of these spaces. Stranding may result in bird mortality, usually due to dehydration, starvation, exhaustion, or hypothermia or drowning in fluid-filled cavities on deck. This risk is much reduced for Red Knots given that they are only expected to occur in small numbers in the Project Area and that they are able to readily take off from the deck of a vessel. In addition, MMOs on the seismic vessels and crew on picket vessels will conduct daily searches for stranded birds. If a stranded bird is found, SARA-listed or otherwise, the CWS protocols for stranded seabirds (Williams and Chardine n.d.) will be followed. A CWS-issued permit for handling of migratory birds will be in place.

Based on these considerations, light attraction effects on Red Knots are judged to have negligible to minor effects over a short-term duration of 1-12 months and a geographic extent of 11-100 km$^2$. Therefore, residual effects related to light attraction on Red Knots are judged to be not significant. The level of confidence associated with this judgement is high.

### 7.1.1.11 Savannah Sparrow, Ipswich (*princeps*) Subspecies

**Biological Background Summary**

The *princeps* subspecies of Savannah Sparrow (*Passerculus sandwichensis*), formerly designated a distinct species known as Ipswich Sparrow, is listed as Special Concern on SARA Schedule 1. Its entire population nests on Sable Island (located 43.1 km from the Project Area), with the occasional exception of a few individuals nesting on the mainland Nova Scotia coast (COSEWIC 2009b). The total population size is about 6000 individuals and has been stable in recent years. It winters on the mainland coast from southern Nova Scotia to northern Florida. In spring, it stages on the mainland shores to the west of Sable Island during the first half of April, making the crossing to Sable Island on westerly winds. Return migration to the mainland begins in late September or early October. Most individuals pass through mainland Nova Scotia in mid-October. Because of the proximity of the Study Area to Sable Island, there is potential for some Savannah Sparrows (*princeps* subspecies) to pass through the Project Area during migration.

**Effects Assessment**

The potential effects of the key interaction between lights associated with Project vessels and the Savannah Sparrow (*princeps* subspecies) is assessed in the following section.
Light Attraction

The attraction of migratory birds to light from vessels and the potential effects are reviewed in Section 7.1.2.2. Birds (primarily petrels) that are attracted to lights of Project vessels may fly into and strand in partially enclosed spaces on a vessel due to their inability to find their way out of these spaces. Stranding may result in bird mortality, usually due to dehydration, starvation, exhaustion, or hypothermia or drowning in fluid-filled cavities on deck. This risk is much reduced for Savannah Sparrows (*princeps* subspecies) given that they are only expected to occur in small numbers in the Project Area and that they are able to readily take off from the deck of a vessel. In addition, MMOs on the seismic vessels and crew on picket vessels will conduct daily searches for stranded birds. If a stranded bird is found, SARA-listed or otherwise, the CWS protocols for stranded seabirds (Williams and Chardine n.d.) will be followed. A CWS-issued permit for handling of migratory birds will be in place.

Based on these considerations, light attraction effects on Savannah Sparrows (*princeps* subspecies) are judged to have negligible to minor effects over a short-term duration of 1-12 months and a geographic extent of 11-100 km². Therefore, residual effects related to light attraction on Savannah Sparrows (*princeps* subspecies) are judged to be not significant. The level of confidence associated with this judgement is high.

7.1.2 Migratory Birds

7.1.2.1 Temporal and Spatial Distributions

The following section details the various species protected by the *Migratory Birds Convention Act* (i.e., species included in bird families named in Article I of the Convention itself) that have a reasonable likelihood of occurrence in the Study Area of the Project based on their spatial and temporal distribution relative to the SW Scotia Shelf. Table 6.4 details the individual species identified to have a reasonable likelihood of occurrence in the Study Area and their temporal occurrence in the Study Area.

Seabird densities on the Scotian Shelf and Laurentian Channel indicate that these adjacent areas form one of several geographic areas in Atlantic Canada that are important to seabirds (Fifield et al. 2009). The area is heavily used by Northwest Atlantic nesting birds during spring and summer, Southern Atlantic nesting from spring to fall, and Arctic and Northeastern Atlantic nesting birds during winter.

**Procellariidae (fulmars and shearwaters)**

Northern Fulmar (*Fulmarus glacialis*) migrates over the Scotian Shelf. Many individuals remain for the winter or summer (Lock et al. 1994). The majority of birds are of the light-phase colour morph, which nests in West and Southeast Greenland and the southern part of its range in
Europe. Fall migration begins in September and fulmars remain common until the end of spring migration in May. Recoveries of banded birds confirm that birds wintering in Atlantic Canada waters come from nesting colonies in west Greenland and the British Isles (Tuck 1971).

Three species of Shearwaters migrate over the Scotian Shelf during the summer months. Great Shearwater (Puffinus gravis) and Sooty Shearwater (P. griseus) migrate in large numbers from South Atlantic nesting islands to circumnavigate the North Atlantic in a clockwise direction. They first appear on the Scotian Shelf in April and are most abundant in early July (Lock et al. 1994). Most have departed northeastward by late summer, although large numbers have been seen in nearby Gulf of Maine and Georges Bank as late as December, suggesting that they may also be present on the Scotian Shelf at that time (reviewed in Huettmann and Diamond 2000). Immature Cory’s Shearwaters (Calonectris diomedea borealis) migrate to the Scotian Shelf from East Atlantic nesting colonies (Lock et al. 1994). LGL (2009) seabird surveys at the Laurentian Channel showed that this species arrives in the region in early July and departs by October.

Hydrobatidae (storm-petrels)

Wilson’s Storm-Petrel (Oceanites oceanicus) also migrates from South Atlantic breeding colonies and reaches the northern end of this migration at the edges of the Grand Banks (Lock et al. 1994). This species arrives on the Scotian Shelf in May and departs in October (LGL 2009). Leach’s Storm-Petrels (Oceanodroma leucorhoa) migrating along the Scotian Shelf to and from nesting colonies on Sable Island, the Bird Islands and Newfoundland probably show their greatest densities along the shelf break.

Charadriidae and Scolopacidae (shorebirds)

During fall, large numbers of shorebirds depart Nova Scotia southeastward on a broad front to begin an offshore migration. Radar studies show that the direction of this migration varies from 110° to 170°, with an average of approximately 134° (Richardson 1979). Most of these flights begin with the arrival of northwest or west winds following the passage of a cold front lying north or northeast of a high pressure area. This heading takes the migrating shorebirds to the Sargasso Sea, where the northeast Trade Winds direct them to South America (Williams and Williams 1978). Most of these flights originate northwest of the Study Area, such as at the Bay of Fundy, a critical shorebird stopover site (Richardson 1979). The average altitude of this migration is 2,000 m but 75% of flocks fly above 1,000 m. Minimum altitudes have not been reported. Altitudes are similar whether during night or day, and whether over land or ocean. Migration occurs intermittently during both day and night. The species tracked in these studies cannot be identified by radar, but may include American Golden-Plover (Pluvialis dominica), Whimbrel (Numenius phaeopus), Hudsonian Godwit (Limosa haemastica), Red Knot (Calidris canutus) and White-rumped Sandpiper (Calidris fuscicollis) (McNeil and Burton 1977; Williams and Williams 1978; McLaren 1981; Morrison 1984). Red Knot is discussed in more detail in the section on Species at Risk. There is no reciprocal northward migration in spring over waters off
the south coast of Nova Scotia (Richardson 1971). Consequently, most shorebird species are unlikely to occur in the Study Area during spring migration. The exceptions are Red Phalarope (*Phalaropus fulicarius*) and Red-necked Phalarope (*P. lobatus*), which nest on Arctic breeding grounds and winter at sea in tropical and subtropical waters. They migrate through the Study Area in May and from July to October, but small numbers may be present in June.

**Laridae (gulls and terns)**

Gull species in the Study Area include Herring Gull (*Larus argentatus*) and Great Black-backed Gull (*L. marinus*). Many individuals of these species nest in colonies on Sable Island, migrate to and from colonies to the north, or winter in the Study Area. Offshore migration of gulls on the Scotian Shelf is poorly understood because of the presence of non-migratory gulls (Huettmann and Diamond 2000). However, fall migration of gulls begins in September and gulls remain common until the end of spring migration in April. Black-legged Kittiwake (*Rissa tridactyla*) appears to migrate primarily along the shelf edge on its way to and from Arctic and sub-Arctic nesting colonies (Baird 1994). This species winters in the Study Area and small numbers of non-breeding kittiwakes may also be present during summer. Arctic Tern (*Sterna paradisaea*) migrates over the Scotian Shelf in May and September (LGL 2009). Common Tern (*S. hirundo*) and Roseate Tern (*S. dougallii*) migrate in May and September to and from nesting colonies on Sable Island (McLaren 1981; COSEWIC 2009a). The latter species is discussed in more detail in the section on Species at Risk.

**Alcidae (murres, and puffins)**

Dovekie (*Alle alle*) migrates from Arctic nesting colonies, arriving to winter on the Scotian Shelf in late October and departing in April (Tufts 1986). It is most abundant on the shelf break and the shallow banks (Lock et al. 1994). A recent study of Dovekies tagged with geolocators at northwest Greenland nesting colonies revealed that one of two main wintering areas of these birds lies about 60 km northeast of the Study Area (Fort et al. 2013). Common Murre (*Uria aalge*) migrates to and from nesting grounds in Newfoundland and Labrador across the Scotian Shelf, many stopping to winter, from October to April (Lock et al. 1994; LGL 2009). Small numbers may be present during summer. Thick-billed Murre (*U. lomvia*) from Arctic nesting colonies winter and may linger into summer. Razorbill (*Alca torda*) migrates over the Scotian Shelf to and from Quebec and Labrador nesting colonies (Clarke et al. 2010). Timing and routes of migration for this species are not well known, but there appears to be a rapid migration to the Gulf of Maine during mid- to late-November and return migration during mid-April to May (Lavers et al. 2009). Atlantic Puffin (*Fratercula arctica*) is an uncommon migrant to the Scotian Shelf; migration takes place in April and from September to December (Tufts 1986). Small numbers may be present during summer and winter.
Passeriformes (songbirds)

A substantial portion of songbirds tracked on radar migrating over Nova Scotia in the fall fly offshore over the open Atlantic Ocean. Songbirds departing for offshore migration fly south-southeast, south or occasionally southwest (Richardson 1972). The modal direction on a given night ranges from 155° to 175° (Richardson 1980). Most of these flights originate well away from the coast. The modal height is 600 m and most individuals migrate below 1,200 m. Songbirds using this route migrate only at night (Richardson 1972). Most offshore departures of songbirds take place with west, northwest or north winds behind a cold front. Although the birds cannot be identified to species by radar, a majority of these songbirds are thought to be species of wood warbler (Parulidae) such as Blackpoll Warbler (Setophaga striata), whose transoceanic migration to South America is well documented (Nisbet et al. 1995). During spring, songbirds arriving in Nova Scotia after overwater flights are first detected over the Gulf of Maine, suggesting that they follow the coastline rather than crossing the western Atlantic from South America (Richardson 1971). Therefore, songbirds are unlikely to pass through the Study Area during spring migration.

Ipswich (Savannah) Sparrow (Passerculus sandwichensis princeps) may migrate through the Study Area on its way to and from nesting grounds on Sable Island (COSEWIC 2009b). This species is discussed in more detail in the section on Species at Risk.

7.1.2.2 Effects Assessment

The effects of airgun sound on migratory birds was not assessed because CWS considers light attraction to be the major effect of seismic exploration on migratory birds (reflected in the Scoping Document, Appendix B). The CWS position is consistent with the current opinion among scientists that hearing in seabirds is less vulnerable to damage from underwater sound than in marine mammals. This opinion is based on: 1) lack of contact between seawater and the auditory meatus (Dooling and Therrien 2012); 2) shallower, shorter duration dives; and 3) a field study that found no behavioural effect of a seismic survey on Long-tailed Ducks (Lacroix et al. 2003). In addition, many of the migratory birds profiled above either feed on the surface or in the case of songbirds fly over offshore waters with no contact with the sea surface.

The only notable potential interaction between routine Project activities and migratory birds is attraction of birds to lights on Project vessels which is assessed in the following section.

Light Attraction

Artificial lighting on ships at sea, offshore oil/gas drilling or production structures, coastal communities and oceanic island communities regularly attracts nocturnally-active seabirds and nocturnally-migrating land- and water-birds, sometimes in large numbers (Montevecchi et al. 1999; Gauthreaux and Belser 2006; Montevecchi 2006). The reasons that such species are
attracted to artificial lighting have not been elucidated. Light-attracted seabirds such as storm-petrels often fly into partially enclosed spaces, such as streamer and airgun decks that are open at the stern, and cannot find their way out. This may result in bird mortality, usually due to dehydration, starvation, exhaustion, or hypothermia or falling into and drowning in water-filled cavities on deck. Birds may be attracted to artificial lighting from a distance of up to 5 km in the case of offshore oil/gas installations with 30 kW of lighting (Poot et al. 2008). Light attraction among seabirds also seems to peak when moonlight levels are lowest, especially with fog, rain or low cloud ceiling (Montevecchi 2006; Rodríguez and Rodríguez 2009; Miles et al. 2010). The attraction of seabirds to artificial lighting occurs at all times of the year, but tends to be more common at the end of the nesting season (i.e., late summer-fall) at which time juveniles account for the majority of stranded birds (Telfer et al. 1987; Le Corre et al. 2002; Rodríguez and Rodríguez 2009; Miles et al. 2010; LGL Limited unpubl. data).

Attraction to artificial lighting and attendant grounding appears to be widespread among procellariiform seabird species (e.g., petrels, shearwaters and storm-petrels), having been observed worldwide in more than 20 species (e.g., Imber 1975; Black 2005; Montevecchi 2006). Light attraction has also been noted in Atlantic Puffin near a nesting colony (Miles et al. 2010). There is also a single anecdotal report of Dovkies circling the Hibernia platform for hours (Wiese et al. 2001). Light attraction has been reported for sandpipers (Scolopacidae) but does not appear to lead to mortality (Russell 2005). Although diurnal collisions of terns with wind turbines have been reported (e.g., Common Tern Sterna hirundo, Everaert and Stienen 2007), nocturnal attraction to artificial lighting has not been described for this group (Gochfeld et al. 1998; Hatch 2002; Montevecchi 2006). During migration small songbirds (Passeriformes) are commonly attracted to artificial lighting on offshore ships and oil installations under the same conditions of moonlight and weather as seabirds, and may suffer mortality as a result (Gauthreaux and Belser 2006; Poot et al. 2008).

In Nova Scotia waters, the species most prone to stranding on vessels are Leach’s Storm-Petrel and Wilson’s Storm-Petrel. For example, 764 of 768 seabirds stranded on seismic vessels in Newfoundland waters (including the mouth of the Laurentian Channel) over 753 nights of monitoring have been storm-petrels (LGL Limited unpubl. data). The remaining were several individuals of Great Shearwater and Sooty Shearwater.

Bird attraction to artificial lighting at sea may be mitigated in a variety of ways. Recovering grounded seabirds and returning them to sea when their plumage has dried greatly reduces mortality (Telfer et al. 1987; Le Corre et al. 2002; Rodríguez and Rodríguez 2009; Williams and Chardine n.d.; Abgrall et al. 2008). For example, in offshore Newfoundland the mitigation of releasing birds by experienced MMOs, according to CWS protocols established by CWS and offshore operators (Williams and Chardine n.d.), appears to typically reduce mortality to a few birds per seismic vessel per season. Reducing, shielding or eliminating skyward radiation from artificial lighting also can achieve great reductions in the numbers of birds stranded (Reed et al. 1985; Rodríguez and Rodríguez 2009; Miles et al. 2010).
It is likely that some storm petrels will be attracted to vessel lights especially during times of low visibility. Some of these may become stranded, and some may collide with the vessel superstructure or become fouled on deck. A few may suffer mortality but the majority should be able to be released alive following the CWS protocols for stranded seabirds (Williams and Chardine n.d.). Effects on the population size are expected to be negligible given that storm petrels are likely the most numerous seabird in the northwest Atlantic (Montevecchi et al. 1992).

Based on these considerations, light attraction effects on migratory birds are judged to have negligible to minor effects (i.e., strandings represent a very small percentage of the overall population and most birds are likely to be released alive) over a short-term duration of 1-12 months and a geographic extent of 11-100 km². Therefore, residual effects related to light attraction on migratory birds are judged to be not significant. The level of confidence associated with this judgement is high given the relatively large volume of observational data on bird strandings on seismic vessels off the east coast of Canada.

7.2 Special Areas

The Special Areas VEC is discussed in two subsections: (1) Designated Protected Areas, and (2) potential Scotian Slope/Shelf Break Ecologically and Biologically Significant Area (EBSA). Note that this EBSA is not a Designated Protected Area and therefore, does not receive the same level of protection as the designated Protected Areas.

7.2.1 Designated Protected Areas

The Designated Protected Areas discussed in this section (Figure 7.4) are as follows:

- The Gully MPA, including Northern Bottlenose Whale Critical Habitat;
- Sable Island National Park Reserve; and
- Haddock Box.

7.2.1.1 The Gully Marine Protected Area (MPA)

Background Summary

The Gully is a large and deep submarine canyon located ~200 km off Nova Scotia, on the edge of the Scotian Shelf. It is ~65 km long, 15 km wide, and deeper than 2.5 km at the canyon mouth (DFO 2013c). The Gully MPA covers an area of 2,364 km² (DFO 2013d) and provides habitat for a rich diversity of species. In addition to the importance of The Gully MPA to the Endangered Scotian Shelf population of northern bottlenose whale, the SARA-listed Sowerby’s, blue, and fin whales also occur there (Whitehead 2013). The Gully MPA also has significant coral communities (~28 species), and it provides habitat for a wide variety of shallow- and deep-water fishes (Westhead et al. 2012; DFO 2013c). Over 500 species of fish and invertebrates have been documented in The Gully, some
of which have not been found anywhere else in Canada (Westhead et al. 2012). The region surrounding The Gully also supports commercial fisheries (DFO 2013c).

In 1994, DFO designated part of the area as a Whale Sanctuary to reduce disturbance from sound and vessel strikes and in 2004 it was designated as an MPA (DFO 2013c). The MPA consists of three management zones that provide different levels of protection according to conservation objectives and sensitivities (DFO 2013d). Zone 1 includes the deep canyon area, including the entire water column and ocean floor, and has full ecosystem protection with no commercial extraction permitted (Westhead et al. 2012; DFO 2013d). Zone 2 protects the canyon head and walls, feeder canyons and the continental slope; a limited number of activities are allowed in this zone (Westhead et al. 2012; DFO 2013d). Zone 3 is a buffer that consists of the adjacent sand banks (Westhead et al. 2012; DFO 2013d). Regulations under the Oceans Act prohibit disturbance, damage, destruction or removal of living organisms or habitat within The Gully and control anthropogenic activities in areas surrounding The Gully (Westhead et al. 2012; DFO

Figure 7.4. Locations of Designated Protected Areas and Identified and Potential Scotian Slope/Shelf Break EBSA in Relation to the Study, Project, WATS, and NATS areas
2013c). The MPA is closed to all activities unless they are included under the general exceptions of the regulations or they undergo an activity approval process (Westhead et al. 2012). Oil and gas activities have not been permitted in The Gully since 1998, and projects adjacent to The Gully have to evaluate the area as a VEC. The Gully MPA is at its closest point 45.7 km, 67.8 km, and 108.7 km from the Project Area, WATS Area, and NATS East Area, respectively.

*Northern Bottlenose Whale Critical Habitat*

Zone 1 of the Gully MPA (and areas deeper than 500 m in Haldimand and Shortland canyons) has been designated as critical habitat for the northern bottlenose whale (DFO 2010a). According to DFO (2010a), “the primary reasons that canyons constitute critical habitat are: (1) they provide exceptional foraging opportunities, (2) they support other critical life-history processes such as socialization, mating and calving, and (3) they are consistently used by a substantial proportion of the population.” Northern bottlenose whales use the entire water column for breathing, socializing, and feeding at or near the bottom on prey such as *Gonatus* squid (DFO 2010a). The Gully critical habitat is at its closest point 58.8 km, 80.7 km, and 119.3 km, from the Project Area, WATS Area, and NATS (East) Area, respectively.

*Effects Assessment*

The following assessment focuses on SARA-listed cetaceans that occur in the Gully MPA, with focus on northern bottlenose whales.

*Airgun Array Sound*

As overviewed previously in Section 4.2.1, the key types of airgun array sound effects on marine mammals considered in detail in this assessment are hearing impairment and behavioural effects (i.e., disturbance).

*Hearing Impairment*: Given the large distances of the WATS and NATS areas from The Gully MPA (closest point is 67.8 km), cetaceans in the Gully MPA, including northern bottlenose whales, will not be exposed to airgun array sound levels that could cause hearing impairment.

Based on these considerations, airgun array sound is judged to have *negligible* hearing impairment effects on cetaceans in The Gully MPA. Therefore, residual hearing impairment effects on cetaceans in The Gully MPA are judged to be *not significant*. The level of confidence associated with this judgement is *high*.

*Disturbance Effects for Sowerby’s Beaked, Blue, and Fin Whales*: Based on the review provided in Appendix D and the results of acoustic modelling of the 5085 in³ array (Section 4.2 of Appendix A), it is unlikely that cetaceans in The Gully MPA will exhibit disturbance or avoidance effects.
Using the 160 dB rms sound level as a guide for disturbance response and based on the acoustic modelling results for Site 1 (northeast corner of the WATS Area), the area where disturbance by cetaceans would most likely occur relative to The Gully MPA, would have a maximum radius of 18.8–21.2 km from the airgun array (see Tables 9 and 10 in Appendix A). Sound levels of ≥160 dB rms are not predicted to occur within The Gully MPA. The area where sound levels are estimated to exceed 160 dB rms is at its closest point over 20 km from The Gully MPA. Sound levels from the 5,085 in$^3$ airgun array in The Gully MPA vary seasonally and sound propagation decreases later in the seasonal window as shown in Figures 7.4 and 7.5.

Based on these considerations, airgun array sound is judged to have minor disturbance effects on cetaceans (Sowerby’s, blue, and fin whales) in The Gully MPA, over a short-term duration of <1 month to 1-12 months and a potential geographic extent ranging from 101-1,000 km$^2$. Therefore, residual effects related to disturbance, are judged to be not significant for the Gully MPA. The level of confidence associated with this judgement is high.

**Disturbance Effects on Northern Bottlenose Whales:** Based on the review provided in Appendix D and the results of acoustic modelling of the 5085 in$^3$ array (Section 4.2 of Appendix A), it is unlikely that northern bottlenose whales in their critical habitat will exhibit disturbance or avoidance effects. Northern bottlenose whales were present in The Gully after seismic surveying (by Marathon Canada Petroleum in 2003) had been underway for weeks in an area immediately south of the Gully (Lee et al. 2005). These whales were exposed to airgun array sound levels of 145 dB rms.

Using the 160 dB rms sound level as a guide for disturbance response and based on the acoustic modelling results for Site 1 (northeast corner of the WATS Area), the area where avoidance would most likely occur relative to the critical habitat, would have a maximum radius of 18.8-21.2 km from the airgun array (see Tables 9 and 10 in Appendix A). Sound levels of ≥160 dB rms are not predicted to occur within the northern bottlenose whale critical habitat, given the distances of the Project Area and WATS and NATS areas from the critical habitat. Sound levels from the 5,085 in$^3$ airgun array in the critical habitat vary seasonally (sound propagation decreases later in the seasonal window as shown in Figures 7.5 and 7.6). Maximum sound levels (~120-140 dB rms) in The Gully critical habitat from the airgun array at Site 1 are predicted to occur in April (Figure 7.5) whereas lower sound levels (~120-130 dB rms) from Site 1 are predicted to occur during August. As discussed earlier, this is because of a sound duct that is more prominent in early spring. Of note, sound levels from the airgun array would be reduced in the Shortland and Haldimand canyon critical habitat relative to those in The Gully given that these canyons are farther away from the WATS and NATS areas.

Based on these considerations, airgun array sound is judged to have minor to moderate disturbance effects on northern bottlenose whales in their critical habitat, over a short-term duration of <1 month to 1-12 months and a potential geographic extent ranging from 101-1,000 km$^2$. Therefore, residual effects related to disturbance, are judged to be not significant for the northern
bottlenose whale critical habitat. The level of confidence associated with this judgement is medium to high.

Figure 7.5. Predicted SPLs (rms) From the 5085 in$^3$ Airgun Array Near The Gully MPA (modelling Site 1, WATS Area) in April (SPLs are maximum-over-depth sound levels [i.e., maximum estimates]).
Figure 7.6. Predicted SPLs (rms) From the 5085 in³ Airgun Array Near The Gully MPA (modelling Site 1, WATS Area) in August (SPLs are maximum-over-depth sound levels [i.e., maximum estimates]).

Presence of Vessels

Project vessels will avoid The Gully MPA, thereby negating the risk of Project ship collisions with whales.

7.2.1.2 Sable Island National Park Reserve

Background Summary

Sable Island lies 290 km east of Nova Scotia near the edge of the Scotian Shelf. The Sable Island National Park Reserve is at its closest point 43.1 km, 58.9 km, and 68.1 km from the Project Area, NATS East Area and WATS Area, respectively. It is long, narrow, low, crescent-shaped and composed of sand dunes. The island receives protection as a Migratory Bird Sanctuary, also under the Canada Shipping Act, the Special Places Protection Act for its archaeological and heritage resources, and in July 2013 it was designated a National Park Reserve. It is also designated an Important Bird Area for its nesting Species at Risk and numbers of nesting
colonial waterbirds (Bird Studies Canada and Nature Canada 2004-2012). The nesting range of Savannah Sparrow (*princeps* subspecies) (Special Concern, SARA Schedule 1) is almost entirely restricted to the island. The Endangered (SARA Schedule 1) Roseate Tern nests on the island in some years. Globally significant numbers of nesting Common Tern, Great Black-backed Gull and Herring Gull also breed here.

Sable Island is an important breeding area for grey seals; harbour seals also breed on Sable Island. Eighty-one percent of grey seal pups in the Northwest Atlantic are born on Sable Island (DFO 2010b) during January–February; an estimated 62,100 pups were born on the island in 2010 (Bowen et al. 2010). In addition, harp seals and hooded seals also haul out on the island. None of these species has been designated status under SARA, and they are considered not at risk by COSEWIC. Grey seal abundance on Sable Island has increased drastically since the 1960s (Bowen et al. 2003; Trzcinski et al. 2007), but is predicted to stabilize at its current level of ~350,000 (O’Boyle and Sinclair 2012). In contrast, harbour seal abundance on the island is declining, perhaps due to increased competition for food from the growing grey seal population (Bowen et al. 2003). It is expected that harbour seals may soon stop using Sable Island as a breeding site (Worchester and Parker 2010). The reasons for the increase in grey seal abundance are uncertain, although decreased predation, reduced bounty kill, increased ice-breeding habitat for pupping, and reduced competition for food may be factors (Bowen et al. 2011). Sand lance dominates the diet of grey seals on Sable Island, and Atlantic cod contributes a variable amount of prey to the diet (Bowen et al. 2011).

**Effects Assessment**

Given the large distance (>43 km) between the Project Area where seismic vessel(s) and their attending picket and support vessels will occur, there is no potential for interaction of the Project with birds while they are on Sable Island. Effects of the Project on Roseate Tern and Ipswich Savannah Sparrow that may occur in the Study Area were assessed in Section 7.1.1 and effects on migratory birds that may occur in the Study Area were assessed in 7.1.2.2.

As described above, Sable Island supports several species of seals but most notably, the majority of grey seals in the Northwest Atlantic are born on Sable Island (in January and February) and use the island year-round for hauling out. Given the large distance between the WATS and NATS areas and Sable Island, it is highly unlikely that seals in the waters near the island will be affected by airgun array sound from the Project. Visual monitoring from seismic vessels has shown only slight (if any) avoidance of airguns by seals, and only slight (if any) changes in behaviour. These studies show that many pinnipeds do not avoid the area within a few hundred metres of an operating airgun array (see Section 1.5.3 in Appendix D for a review of available literature). However, based on the studies with large sample size, or observations from a separate monitoring vessel, or radio telemetry, it is apparent that some seals do show localized avoidance of operating airguns.
Sable Island acts as an acoustic barrier and airgun array sound is not predicted to occur north of the island when survey activities are located in the WATS Area south of the island (see Appendix A). When airgun array sound does reach the nearshore waters of Sable Island, the maximum predicted RLs range from <120 dB rms to 139 dB rms. These sound levels are well below those known to cause hearing impairment in seals (see Section 1.6 in Appendix A for a review).

Based on the consideration described above, airgun array sound is judged to have negligible hearing and disturbance effects on seals on and near Sable Island. Therefore, the residual effects of exposure to airgun array sound are judged to be not significant for the Sable Island National Park Reserve. The level of confidence associated with this judgement is high.

7.2.1.3 Haddock Box

Background Summary

The Haddock Box is a 13,700 km$^2$ conservation area that occurs over the Emerald and Western Banks (DFO 2003). It was initially established in 1987 with the intention of protecting incoming haddock recruits and assisting the rebuilding of the stock by closing the area year-round to mobile gear fisheries. The closure was expanded in 1993 to include fixed gear fisheries for groundfish (DFO 2003). This area represents the largest of all commercial fishery closures on the Scotian Shelf (Stantec 2012b). Adult haddock typically aggregate in the Haddock Box to spawn from March to June, with peak spawning in March and April (Stantec 2012b). Frank et al. (2000) indicated that the Haddock Box appeared to have some benefit to other groundfish species’ abundances, most notably American plaice (*Hippoglossoides americanus*) and winter flounder (*Pleuronectes americanus*). Hurley (2011) noted that the Haddock Box serves as a spawning area for groundfish and is characterized by high benthic species richness and fish diversity.

The Study Area slightly overlaps a southeastern portion of the Haddock Box (5.2% of the Haddock Box) and the Project Area overlaps an even smaller portion of the southeastern part of the Haddock Box (0.8%) of the Haddock Box. At its closest point, the Haddock Box is about 32 km and 24 km from the WATS Area and the NATS East Area, respectively. The northwestern corner of the NATS West Area abuts the Haddock Box (Figure 7.4).

Effects Assessment

Airgun Array Sound

A literature review of auditory capabilities of fishes and the potential effects of exposure to seismic airgun sound on fishes is contained in Appendix F. It is important to note that none of the three acquisition areas overlap with the Haddock Box and, therefore, airguns will not be
activated within the Haddock Box area. According to conservative sound modelling carried out for the Project (Appendix A), the highest sound pressure level that would reach the Haddock Box as a result of a single pulse from a 5,085 in³ airgun array would be about 160-169 dB re 1 µPa (rms) in April when the sound source is located in the northwestern corner of the NATS West Area, <10 km from the Haddock Box (see Figure 20 in Appendix A). Modelling done within the WATS Area concludes that the highest sound pressure level that would reach the Haddock Box is about 150-159 dB re 1 µPa rms in April when the sound source is located about 30 km from the Haddock Box (see Figure 24 in Appendix A). The modelling indicates that maximum SPLs reaching the Haddock Box will be lower during the May to September period. Based on the modelling, only a very small portion of the Haddock Box would be exposed to SPLs > 149 dB re 1 µPa rms. While these SPLs exceed the hearing threshold for haddock (Nedwell et al. 2004) and could possibly elicit some behavioural responses from fishes (e.g., Løkkeborg et al. 2012; Engås et al. 1996), it is unlikely that physical effects on any fish life stage in the Haddock Box would occur given the distance between sound source and the Haddock Box. There is possibility of physical effects on invertebrate/fish eggs and larvae occurring in the upper water column outside of the Haddock Box but only on those eggs and larvae located within a few metres of the active airguns (e.g., Booman et al. 1996; Kostyvchenko 1973) (Appendix F). Note that the Scoping Document (CNSOPB 2013; Appendix B) indicates that the proposed Project Area does not overlap with any known fish spawning grounds.

Specific mitigations that will be in effect to minimize the effects of exposure to airgun sound on the Haddock Box are as follows:

- Compliance with DFO’s Statement of Canadian Practice with Respect to the Mitigation of Seismic Sound in the Marine Environment; and
- Airgun(s) will not be activated during line changes, except during some periods when airguns require testing for maintenance or other operational purposes. Airguns will not be active in the Haddock Box.

Based on these considerations, airgun sound is judged to have negligible to minor disturbance effects on haddock and other fishes in the Haddock Box over a short-term duration of <1 month and a geographic extent ranging from 101–1,000 km². Therefore, the residual behavioural effects of exposure to airgun sound are judged to be not significant for the Haddock Box. The level of confidence associated with this judgement is high.

7.2.2 Scotian Slope/Shelf Break Ecologically and Biologically Significant Area (EBSA)

7.2.2.1 Background Summary

The potential Scotian Slope/Shelf Break EBSA has been included as part of the Special Areas VEC for two reasons: (1) the high degree of overlap it has with the Project Area (Figure 7.4) and,
(2) its attributes that are relevant to marine invertebrate and fish issues. These specific attributes are presented below (Doherty and Horsman 2007):

- Slopes are areas of high finfish diversity due to habitat heterogeneity provided by depth;
- High fish diversity, including demersal, mesopelagic and large pelagic fishes;
- Occurrence of corals, porbeagle shark, tuna, and swordfish;
- Primary migratory route for large pelagic fishes (e.g., sharks, swordfish, tuna);
- High diversity of squid;
- Overwintering area for a number of shelf fish species, including Atlantic halibut and lobster; and
- Occurrence of Greenland sharks.

The invertebrate and fish issues and concerns raised during stakeholder consultations that are relevant to the EBSA attributes include the following (see Appendix C):

- Potential effects on migratory fishes;
- Potential effects on large pelagic fishes; and
- Potential effects on lobster and crab larvae.

The fisheries-related issues and concerns are discussed and assessed in the Other Users VEC section (see Section 7.3.1.1).

### 7.2.2.2 Potential Effects on Migratory Fishes, Including Large Pelagics

Studies indicate that bluefin tuna (*Thunnus thynnus*) migrate annually through the Study Area from about May to October (NOAA unpubl. data; LPRC unpubl. data; Walli et al. 2009; Galuardi et al. 2010; Maguire and Lester 2012). Fonteneau (2009 in Maguire and Lester 2012) states the following:

“Bluefin tuna in the Atlantic has been the tuna species showing the greatest flexibility, and permanently changing its areas of concentration and its apparent migration routes.”

Maguire and Lester (2012) indicate that this statement suggests that usual concepts of habitat and trends in habitat may not be applicable to Atlantic bluefin tuna as long as spawning and larval and juvenile rearing habitats, which are located outside of Canada, are protected.

In Section 7.3.1.1, Figures 7.12, 7.14 and 7.18 show the distributions of harvest locations for large pelagic fishes, swordfish and tunas, respectively, for the 2005-2010 period. The highest concentration of harvest locations for large pelagic fishes is along the upper slope which is
included in the potential Scotian Slope/Shelf Break EBSA. Based on these data, it is fair to conclude that in addition to bluefin tuna, other large pelagics also use portions of the potential EBSA for migration and feeding.

There is no available scientific literature that discusses the potential effects of exposure to airgun sound on swordfish and other large pelagic fishes other than bluefin tuna. Therefore, potential behavioural effects on swordfish and other large pelagics are based on the bluefin tuna scientific literature. In their study of the effect of boat sound on the behaviour of bluefin tuna in the Mediterranean Sea, Sarà et al. (2007) concluded that local noise pollution generated by vessels elicited behavioural responses by the tuna, including changes in swimming direction and increased vertical movement either upwards or downwards in the water column. They also noted that schools of tuna exhibited less concentrated structure and more uncoordinated swimming behaviour. Note that their observations were made on semi-captive tuna.

Seismic and vessel sound generated during the BP survey could affect the behaviour of bluefin tuna and other large pelagic fishes in the Study Area. Considering that these fishes are not constrained, they would most likely move an appropriate distance from the airgun source, thus resulting in temporary and localized behavioural effects that should not cause substantial interruption of the migratory patterns of these large pelagic fishes.

7.2.2.3 Potential Effects on Lobster and Crab Larvae

A limited number of studies on the potential physical effects of exposure to airgun sound on marine invertebrate eggs and larvae have been conducted (e.g., de Soto et al. 2013; Christian et al. 2003, 2004; Pearson et al. 1994; see Appendix G). Results suggest that eggs and larvae exposed to airgun sound within a few metres of the sound source could be physically affected. However, the number of eggs and larvae occurring within the zone of impact represents an extremely small proportion of the total number of eggs and larvae in the water column. In addition, based on the geo-referenced harvest locations for snow crab and lobster during 2005-2010, the concentrations of both species occur outside of the Study Area; snow crab inshore of the northeastern part of the Study Area, and lobster >100 km west of the Study Area. Obviously larvae will drift in the ocean currents and some will likely occur in the Study Area but most will remain outside of the Study Area.

7.2.3 Effects Assessment

7.2.3.1 Airgun Array Sound

According to underwater sound modelling conducted for the Project (Appendix A), the highest sound pressure level that would occur in the potential EBSA as a result of a single pulse from a 5,085 in\(^3\) airgun array would be >200 dB re 1 µPa (rms). Based on the modelling (Appendix A), only a small portion of the potential EBSA would be exposed to SPLs >160 dB re 1 µPa (rms) at
any one time. Most of this area would receive SPLs <150 dB re 1 µPa (rms). As discussed above, behavioural effects on the large pelagics should be temporary and localized, and not cause any serious effect on migration. As indicated in Section 4.2.3, available research indicates considerable inter- and intra-specific differences in received sound levels that evoke either subtle or more overt behavioural responses in fishes. Physical effects on eggs and larvae from exposure to airgun sound will be very localized (i.e, within a few metres of the airgun).

Based on these considerations and the implementation of mitigation measures such as ramp up and compliance with the Statement of Canadian Practice, the effects of airgun array sound on the marine invertebrates and fishes that occur in the potential Scotian Slope/Shelf Break EBSA are judged to be negligible over a short-term duration of <1 month and a geographic extent of 101-1,000 km². Therefore, the residual effects related to exposure to airgun array sound on the marine invertebrates and fishes occurring in the potential Scotian Slope/Shelf Break EBSA are judged to be not significant. The level of confidence associated with this judgement is high.

7.3 Other Ocean Users

The Other Ocean Users VEC includes the following six components.

- Fisheries (commercial, aboriginal, recreational);
- Scientific research;
- Marine shipping;
- Department of National Defence operations;
- Submarine cables; and
- Oil and gas industry.

Each of these VEC components is assessed individually in terms of interaction with routine Project activities.

7.3.1 Fisheries

This section includes three components: (1) commercial fisheries; (2) aboriginal fisheries; and (3) recreational fisheries.

7.3.1.1 Commercial Fisheries

This section describes the commercial fishery catches, both targeted and incidental, in the Study Area, Project Area, the WATS 3D Acquisition (WATS) Area, the NATS West 3D Acquisition Area (NATSW) and the NATS East 3D Acquisition Area (NATSE) during the April to November period, 2005 to 2010. The biological characteristics and status of the principal invertebrate and fish species taken during the commercial fisheries were previously described in DFO (2002), LGL (2005, 2012a), Hurley (2011), O’Boyle (2012) and Stantec (2012a,b).
Overlap of the various Project spatial areas with NAFO Unit Areas (UAs) are provided in Figure 7.7 and Table 7.2.

The UAs are located well within Canada’s 200-mile Exclusive Economic Zone (EEZ); therefore fisheries are expected to be primarily domestic.

The water depths within the WATS Area range from about 1,000 m to 3,500-4,000 m. The water depths within the NATSW and NATSE Areas range from <100 m on Western and Sable Island Banks to 2,000-2,500 m.

Figure 7.7. Locations of Project Spatial Areas in Relation to NAFO Unit Areas
Table 7.2. Overlap of Project Areas with NAFO Unit Areas

<table>
<thead>
<tr>
<th>Spatial Area</th>
<th>NAFO Unit Area</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>4Wf</td>
</tr>
<tr>
<td>Study Area</td>
<td>*</td>
</tr>
<tr>
<td>Project Area</td>
<td>*</td>
</tr>
<tr>
<td>WATS Area</td>
<td>*</td>
</tr>
<tr>
<td>NATSW Area</td>
<td>*</td>
</tr>
<tr>
<td>NATSE Area</td>
<td>*</td>
</tr>
</tbody>
</table>

Data Sources

The fisheries analysis in this section is based on data derived from a DFO multi-region and multi-year catch and effort dataset (DFO 2005 to 2010). The data represent catches landed at Atlantic Canadian ports. Beginning with the 2011 commercial fishery landings data, the format of data delivery has changed. Rather than providing high resolution geo-referenced data, DFO will be providing summary-level commercial fishery landings data at the resolution of 6 minute x 6 minute cells. For the purposes of this EA, the 2005 to 2010 empirical data will be used. The harvesting trends indicated in this EA are unlikely to differ significantly during the temporal scope of the EA.

The primary data used to characterize the fisheries is the quantity of the harvest (i.e., catch weight) rather than its value because quantities are directly comparable from year to year whereas values, negotiated prices, exchange rates and market conditions may vary annually. Catch value is still used in this EA in certain scenarios.

The 2005-2010 harvesting locations can be plotted in relation to the Study, Project, WATS and NATS Areas since many of the DFO catch data in these areas are geo-referenced. Most Figures in this section display harvesting locations represented by dark points. No indication of the quantity of harvest is provided in these figures.

Fisheries engagement included representatives of fisheries organizations and DFO. These engagements were undertaken to inform stakeholders about the proposed Project, to gather information about expected future fishing activities, and to determine any issues or concerns. Those fisheries-related groups engaged and the issues and comments arising from the engagements are included in Appendix C. Fisheries-related information provided, and the issues raised during the consultations are discussed in their respective sections. Ongoing communication will occur between BP and fisheries representatives to ensure coordination between seismic and fisheries activities.

Other sources consulted for this section include fisheries management plans, Canadian Science Advisory Secretariat (CSAS) status reports, and other DFO documents.
Commercial Fisheries in the Study Area

The average annual species harvest statistics for the Study Area, April to November, 2005 to 2010 are indicated in Table 7.3. Annual commercial fisheries catch weight from the Study Area averaged about 1,114 metric tonnes (mt) during April to November, 2005-2010. Sea scallops accounted for about 44% of the landings weight, followed by herring (~19%), swordfish (~12%), silver hake (~11%), Atlantic halibut (~4%), redfish, cusk and white hake (all three ~ 1%). Atlantic wolffish contributed <0.1% to the average catch weight and value in the Study Area. Overall, invertebrates contributed for about 45% of the aggregated catch weight in the Study Area between April and November during this six-year period, followed by groundfish species (~20%), small pelagic species (~20%) and large pelagic species (~15%). In terms of catch value, large pelagics accounted for about 49% of the aggregated catch value in the Study Area between April and November during this six-year period, followed by invertebrates (~26%), groundfish (~24%) and small pelagic species (~1%).

Table 7.3. Average annual commercial harvest by species within the Study Area, April to November, 2005 to 2010.

<table>
<thead>
<tr>
<th>Species</th>
<th>Quantity (mt)</th>
<th>% of Total</th>
<th>Value ($)</th>
<th>% of Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sea scallops</td>
<td>490</td>
<td>44.0</td>
<td>644,592</td>
<td>25.2</td>
</tr>
<tr>
<td>Herring</td>
<td>213</td>
<td>19.1</td>
<td>40,443</td>
<td>1.6</td>
</tr>
<tr>
<td>Swordfish</td>
<td>138</td>
<td>12.4</td>
<td>1,025,592</td>
<td>40.1</td>
</tr>
<tr>
<td>Silver Hake</td>
<td>123</td>
<td>11.1</td>
<td>87,110</td>
<td>3.4</td>
</tr>
<tr>
<td>Atlantic halibut</td>
<td>45</td>
<td>4.1</td>
<td>469,820</td>
<td>18.4</td>
</tr>
<tr>
<td>Redfish</td>
<td>15</td>
<td>1.3</td>
<td>11,080</td>
<td>0.4</td>
</tr>
<tr>
<td>Cusk</td>
<td>12</td>
<td>1.1</td>
<td>11,539</td>
<td>0.5</td>
</tr>
<tr>
<td>White hake</td>
<td>11</td>
<td>1.0</td>
<td>10,912</td>
<td>0.4</td>
</tr>
<tr>
<td>Bigeye tuna</td>
<td>9</td>
<td>0.8</td>
<td>99,056</td>
<td>3.9</td>
</tr>
<tr>
<td>Hagfish</td>
<td>8</td>
<td>0.7</td>
<td>4,451</td>
<td>0.2</td>
</tr>
<tr>
<td>Mako shark</td>
<td>7</td>
<td>0.6</td>
<td>10,907</td>
<td>0.4</td>
</tr>
<tr>
<td>Yellowfin tuna</td>
<td>6</td>
<td>0.6</td>
<td>47,380</td>
<td>1.9</td>
</tr>
<tr>
<td>Porbeagle shark</td>
<td>6</td>
<td>0.6</td>
<td>6,246</td>
<td>0.2</td>
</tr>
<tr>
<td>Mackerel</td>
<td>4</td>
<td>0.4</td>
<td>3,447</td>
<td>0.1</td>
</tr>
<tr>
<td>Snow crab</td>
<td>4</td>
<td>0.4</td>
<td>15,045</td>
<td>0.6</td>
</tr>
<tr>
<td>Greenland halibut</td>
<td>3</td>
<td>0.3</td>
<td>4,731</td>
<td>0.2</td>
</tr>
<tr>
<td>Red hake</td>
<td>3</td>
<td>0.3</td>
<td>1,324</td>
<td>&lt;0.1</td>
</tr>
<tr>
<td>Bluefin tuna</td>
<td>3</td>
<td>0.3</td>
<td>39,486</td>
<td>1.5</td>
</tr>
<tr>
<td>Monkfish</td>
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<td>0.2</td>
<td>2,886</td>
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<tr>
<td>Northern shrimp</td>
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<td>2,170</td>
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<tr>
<td>Pollock</td>
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<td>0.2</td>
<td>1,716</td>
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<tr>
<td>Albacore tuna</td>
<td>1</td>
<td>&lt;0.1</td>
<td>9,179</td>
<td>0.4</td>
</tr>
<tr>
<td>Mahi mahi</td>
<td>1</td>
<td>&lt;0.1</td>
<td>4,382</td>
<td>0.2</td>
</tr>
<tr>
<td>Atlantic wolffish</td>
<td>&lt;0.1</td>
<td>&lt;0.1</td>
<td>&lt;1</td>
<td>&lt;0.1</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>1,114</strong></td>
<td><strong>99.7</strong></td>
<td><strong>2,559,200</strong></td>
<td><strong>99.7</strong></td>
</tr>
</tbody>
</table>


1 Includes all species in database.
The total commercial catch weight in the Study Area during April to November, 2005-2010 accounted for about 85% of the total catch weight in the Study Area during all 12 months, 2005-2010. The total commercial catch value in the Study Area during April to November, 2005-2010 accounts for about 74% of the total catch value in the Study Area during all 12 months, 2005-2010.

**Commercial Fisheries in the Project Area**

The average annual species harvest statistics for the Project Area, April to November, 2005 to 2010 are indicated in Table 7.4. Annual commercial fisheries catch weight from the Project Area averaged about 377 metric tonnes (mt) during April to November, 2005-2010. Sea scallops accounted for about 33% of the landings weight, followed by swordfish (~20%), herring (~14%), Atlantic halibut (~10%), silver hake (~8%), cusk (~3%) and white hake (~3%). In terms of landings value, swordfish accounted for about 45% of the average annual landings value of about $1.25 million, followed by Atlantic halibut (~31%), sea scallops (~13%) and various tunas (~3%). Atlantic wolffish contributed <0.1% to the average catch weight and value in the Project Area. Overall, invertebrates accounted for about 34% of the aggregated catch weight in the Project Area between April and November during this six-year period, followed by groundfish species (~28%), large pelagic species (~23%) and small pelagic species (~15%). In terms of catch value, large pelagics accounted for about 50% of the aggregated catch value in the Project Area between April and November during this six-year period, followed by groundfish (~35%), invertebrates (~14%) and small pelagic species (~1%).

**Table 7.4. Average annual commercial harvest by species within the Project Area, April to November, 2005 to 2010.**

<table>
<thead>
<tr>
<th>Species</th>
<th>Quantity (mt)</th>
<th>% of Total</th>
<th>Value ($)</th>
<th>% of Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sea scallops</td>
<td>126</td>
<td>33.4</td>
<td>165,806</td>
<td>13.3</td>
</tr>
<tr>
<td>Swordfish</td>
<td>75</td>
<td>19.9</td>
<td>565,775</td>
<td>45.3</td>
</tr>
<tr>
<td>Herring</td>
<td>52</td>
<td>13.7</td>
<td>9,838</td>
<td>0.8</td>
</tr>
<tr>
<td>Atlantic halibut</td>
<td>37</td>
<td>9.8</td>
<td>385,707</td>
<td>30.9</td>
</tr>
<tr>
<td>Silver hake</td>
<td>32</td>
<td>8.4</td>
<td>22,336</td>
<td>1.8</td>
</tr>
<tr>
<td>Cusk</td>
<td>10</td>
<td>2.8</td>
<td>9,805</td>
<td>0.8</td>
</tr>
<tr>
<td>White hake</td>
<td>10</td>
<td>2.5</td>
<td>9,443</td>
<td>0.8</td>
</tr>
<tr>
<td>Redfish</td>
<td>7</td>
<td>1.8</td>
<td>5,106</td>
<td>0.4</td>
</tr>
<tr>
<td>Porbeagle shark</td>
<td>5</td>
<td>1.3</td>
<td>5,104</td>
<td>0.4</td>
</tr>
<tr>
<td>Mackerel</td>
<td>4</td>
<td>1.1</td>
<td>3,406</td>
<td>0.3</td>
</tr>
<tr>
<td>Mako shark</td>
<td>4</td>
<td>1.0</td>
<td>5,528</td>
<td>0.4</td>
</tr>
<tr>
<td>Hagfish</td>
<td>3</td>
<td>0.9</td>
<td>3,328</td>
<td>0.3</td>
</tr>
<tr>
<td>Greenland halibut</td>
<td>2</td>
<td>0.6</td>
<td>3,410</td>
<td>0.3</td>
</tr>
<tr>
<td>Red hake</td>
<td>2</td>
<td>0.5</td>
<td>829</td>
<td>&lt;0.1</td>
</tr>
<tr>
<td>Atlantic wolffish</td>
<td>&lt;0.1</td>
<td>&lt;0.1</td>
<td>&lt;1</td>
<td>&lt;0.1</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>377</strong></td>
<td><strong>97.7</strong></td>
<td><strong>1,249,506</strong></td>
<td><strong>95.8</strong></td>
</tr>
</tbody>
</table>


1 Includes all species in database.
The total commercial catch weight in the Project Area during April to November, 2005-2010 accounted for about 75% of the total catch weight in the Project Area during all 12 months, 2005-2010. The total commercial catch value in the Project Area during April to November, 2005-2010 accounts for about 63% of the total catch value in the Project Area during all 12 months, 2005-2010.

The aggregated catch weights of all species in the Project Area during April to November, 2005 to 2010, are shown in Figure 7.8. The catch weights in 2006 were considerably higher than those in the other five years. The total catch weight steadily decreased from 2006 to 2010. Either pelagics or invertebrates accounted for highest catch weights between 2005 and 2009. Groundfish accounted for the highest catch weight in 2010.

![Figure 7.8. Annual Commercial Fishery Proportionate Catch Weights of Invertebrate, Groundfish and Pelagic Species in the Project Area, April to November, 2005 to 2010 Combined](source)

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**Source:** DFO Commercial Fishery Landings Database, 2005 to 2010.

**Figure 7.8.** Annual Commercial Fishery Proportionate Catch Weights of Invertebrate, Groundfish and Pelagic Species in the Project Area, April to November, 2005 to 2010 Combined

**Commercial Fisheries in the WATS Area**

The average annual species harvests from the WATS Area during April to November, 2005 to 2010 are indicated in Table 7.5. Annual commercial fisheries landings weight from the WATS Area averaged 5.8 mt during the six-year period. Swordfish accounted for about 34% of the landings weight, followed by hagfish (~14%), yellowfin tuna (~10%), bigeye tuna (~10%), mako shark (~7%) and northern shrimp, snow crab and Atlantic halibut (all ~5%). In terms of landings value, swordfish accounted for about 44% of the average annual catch value of about $36,275, followed by bigeye tuna (~22%), yellowfin tuna (~13%), Atlantic halibut (~7%) and snow crab.
Atlantic wolffish contributed <0.1% to the average catch weight and value in the WATS Area. Overall, large pelagics accounted for about 65% of the aggregated catch weight in the WATS Area during this six-year period, followed by groundfish species (~24%) and invertebrates (~11%).

**Table 7.5. Average annual commercial harvest by species within the WATS Area, April to November, 2005 to 2010.**

<table>
<thead>
<tr>
<th>Species</th>
<th>Quantity (mt)</th>
<th>% of Total</th>
<th>Value ($)</th>
<th>% of Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Swordfish</td>
<td>2.0</td>
<td>34.5</td>
<td>15,949</td>
<td>44.0</td>
</tr>
<tr>
<td>Hagfish</td>
<td>0.8</td>
<td>13.8</td>
<td>823</td>
<td>2.3</td>
</tr>
<tr>
<td>Yellowfin tuna</td>
<td>0.6</td>
<td>10.3</td>
<td>4,692</td>
<td>12.9</td>
</tr>
<tr>
<td>Bigeye tuna</td>
<td>0.6</td>
<td>10.3</td>
<td>7,924</td>
<td>21.8</td>
</tr>
<tr>
<td>Mako shark</td>
<td>0.4</td>
<td>6.9</td>
<td>672</td>
<td>1.9</td>
</tr>
<tr>
<td>Northern shrimp</td>
<td>0.3</td>
<td>5.2</td>
<td>400</td>
<td>1.1</td>
</tr>
<tr>
<td>Snow crab</td>
<td>0.3</td>
<td>5.2</td>
<td>1,121</td>
<td>3.1</td>
</tr>
<tr>
<td>Atlantic halibut</td>
<td>0.3</td>
<td>5.2</td>
<td>2,692</td>
<td>7.4</td>
</tr>
<tr>
<td>Mahi mahi</td>
<td>0.1</td>
<td>1.7</td>
<td>121</td>
<td>0.3</td>
</tr>
<tr>
<td>Atlantic wolffish</td>
<td>&lt;0.1</td>
<td>&lt;0.1</td>
<td>&lt;1</td>
<td>&lt;0.1</td>
</tr>
<tr>
<td><strong>Overall Total</strong></td>
<td><strong>5.8</strong></td>
<td></td>
<td><strong>36,275</strong></td>
<td></td>
</tr>
</tbody>
</table>


The total commercial catch weight in the WATS Area during April to November, 2005-2010 accounted for about 92% of the total catch weight in the WATS Area during all 12 months, 2005-2010. The total commercial catch value in the WATS Area during April to November, 2005-2010 accounts for about 87% of the total catch value in the WATS Area during all 12 months, 2005-2010.

Catch weight in the WATS Area from April to November, 2005 to 2010, represented ~2% of the catch weight in the Project Area during the same time.

**Commercial Fisheries in the NATS West Area**

The average annual species harvests from the NATS West Area during April to November, 2005 to 2010 are indicated in Table 7.6. Annual commercial fisheries landings weight from the NATS West Area averaged about 85 mt during the six-year period. Herring accounted for about 30% of the landings weight, followed by swordfish (~27%), Atlantic halibut (~15%), silver hake (~12%), cusk (~5%) and white hake (~4%). In terms of landings value, swordfish accounted for about 51% of the average annual catch value of about $341,913, followed by Atlantic halibut (~39%). Atlantic wolffish contributed <0.1% to the average catch weight and value in the NATS West Area. Overall, groundfish accounted for about 40% of the aggregated catch weight in the NATS West Area during this six-year period, followed by small pelagic species (~31%) and large pelagic species (~30%).
The total commercial catch weight in the NATS West Area during April to November, 2005-2010 accounted for about 62% of the total catch weight in the NATS West Area during all 12 months, 2005-2010. The total commercial catch value in the NATS West Area during April to November, 2005-2010 accounts for about 59% of the total catch value in the NATS West Area during all 12 months, 2005-2010.

Catch weight in the NATS West Area from April to November, 2005 to 2010, represented about 22% of the catch weight in the Project Area during the same time.

### Table 7.6. Average annual commercial harvest by species within the NATS West Area, April to November, 2005 to 2010.

<table>
<thead>
<tr>
<th>Species</th>
<th>Quantity (mt)</th>
<th>% of Total</th>
<th>Value ($)</th>
<th>% of Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Herring</td>
<td>25.8</td>
<td>30.5</td>
<td>4,909</td>
<td>1.4</td>
</tr>
<tr>
<td>Swordfish</td>
<td>22.9</td>
<td>27.1</td>
<td>174,904</td>
<td>51.2</td>
</tr>
<tr>
<td>Atlantic halibut</td>
<td>12.9</td>
<td>15.2</td>
<td>133,236</td>
<td>39.0</td>
</tr>
<tr>
<td>Silver hake</td>
<td>10.6</td>
<td>12.5</td>
<td>7,501</td>
<td>2.2</td>
</tr>
<tr>
<td>Cusk</td>
<td>4.2</td>
<td>5.0</td>
<td>3,885</td>
<td>1.1</td>
</tr>
<tr>
<td>White hake</td>
<td>3.7</td>
<td>4.4</td>
<td>3,563</td>
<td>1.0</td>
</tr>
<tr>
<td>Mako shark</td>
<td>0.9</td>
<td>1.1</td>
<td>1,091</td>
<td>0.3</td>
</tr>
<tr>
<td>Greenland halibut</td>
<td>0.8</td>
<td>0.9</td>
<td>1,273</td>
<td>0.4</td>
</tr>
<tr>
<td>Atlantic wolffish</td>
<td>&lt;0.1</td>
<td>&lt;0.1</td>
<td>&lt;1</td>
<td>&lt;0.1</td>
</tr>
<tr>
<td><strong>Overall Total</strong></td>
<td><strong>84.6</strong></td>
<td></td>
<td><strong>341,913</strong></td>
<td></td>
</tr>
</tbody>
</table>


### Commercial Fisheries in the NATS East Area

The average annual species harvests from the NATS East Area during April to November, 2005 to 2010 are indicated in Table 7.7. Annual commercial fisheries landings weight from the NATS East Area averaged about 90 mt during the six-year period. Sea scallops accounted for about 44% of the landings weight, followed by Atlantic halibut (~18%), swordfish (~13%) and redfish (~7%). In terms of landings value, Atlantic halibut accounted for about 50% of the average annual catch value of about $346,474, followed by swordfish (~26%) and sea scallops (~15%). Atlantic wolffish contributed <0.1% to the average catch weight and value in the NATS East Area. Overall, invertebrates accounted for about 45% of the aggregated catch weight in the NATS East Area during this six-year period, followed by groundfish species (~40%) and large pelagic species (~15%).

The total commercial catch weight in the NATS East Area during April to November, 2005-2010 accounted for about 78% of the total catch weight in the NATS East Area during all 12 months, 2005-2010. The total commercial catch value in the NATS East Area during April to November, 2005-2010 accounts for about 62% of the total catch value in the NATS East Area during all 12 months, 2005-2010.
Catch weight in the NATS East Area from April to November, 2005 to 2010, represented about 24% of the catch weight in the Project Area during the same time.

### Table 7.7. Average annual commercial harvest by species within the NATS East Area, April to November, 2005 to 2010.

<table>
<thead>
<tr>
<th>Species</th>
<th>Quantity (mt)</th>
<th>% of Total</th>
<th>Value ($)</th>
<th>% of Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sea scallops</td>
<td>39.7</td>
<td>43.9</td>
<td>52,218</td>
<td>15.1</td>
</tr>
<tr>
<td>Atlantic halibut</td>
<td>16.4</td>
<td>18.1</td>
<td>172,725</td>
<td>49.9</td>
</tr>
<tr>
<td>Swordfish</td>
<td>12.0</td>
<td>13.3</td>
<td>91,621</td>
<td>26.4</td>
</tr>
<tr>
<td>Redfish</td>
<td>6.7</td>
<td>7.4</td>
<td>5,028</td>
<td>1.5</td>
</tr>
<tr>
<td>White hake</td>
<td>4.1</td>
<td>4.5</td>
<td>4,207</td>
<td>1.2</td>
</tr>
<tr>
<td>Cusk</td>
<td>4.1</td>
<td>4.5</td>
<td>3,801</td>
<td>1.1</td>
</tr>
<tr>
<td>Silver hake</td>
<td>3.8</td>
<td>4.2</td>
<td>2,585</td>
<td>0.7</td>
</tr>
<tr>
<td>Atlantic wolffish</td>
<td>&lt;0.1</td>
<td>&lt;0.1</td>
<td>&lt;1</td>
<td>&lt;0.1</td>
</tr>
<tr>
<td><strong>Overall Total</strong></td>
<td><strong>90.4</strong></td>
<td></td>
<td><strong>346,474</strong></td>
<td></td>
</tr>
</tbody>
</table>


**Commercial Fishery Harvest Locations**

Commercial fishery harvest locations for all species in relation to the Study, Project, WATS and NATS Areas during April to November, 2005 to 2010 are displayed in Figure 7.9. Most of the commercial fish harvesting in the Project Area occurred inshore of the 1,000 m contour of the Scotian Slope. While there was relatively little fish harvesting reported within the WATS Area, the NATS Area had substantial commercial harvesting activity due its shallower water depths. Harvesting locations for invertebrates, groundfish and large pelagic species are displayed in Figures 7.10 to 7.12, respectively.

Harvest locations of the principal species caught in the Project Area during April to November, 2005-2010 are displayed in Figures 7.13 to 7.18.

Figure 7.9. Commercial Fishery All Species Harvest Locations, April to November, 2005 to 2010, Combined
Figure 7.10. Commercial Fishery Invertebrate Harvest Locations, April to November, 2005 to 2010, Combined (The dominant commercially caught invertebrate species in the Study Area include: sea scallop, snow crab and northern shrimp)
Figure 7.1. Commercial Fishery Groundfish Harvest Locations, April to November, 2005 to 2010, Combined. (The dominant commercially caught groundfish species in the Study Area include: silver hake, Atlantic halibut, redfish, cusk, white hake, hagfish, Greenland halibut, red hake, monkfish, Pollock, and wolffishes)
Figure 7.12. Commercial Fishery Large Pelagic Fish Harvest Locations, April to November, 2005 to 2010, Combined (The dominant commercially caught large pelagics species in the Study Area include: swordfish, bigeye tuna, yellowfin tuna, bluefin tuna, albacore tuna, unspecified tunas, mako shark (historically), porbeagle shark (historically) and mahi mahi)

Figure 7.13. Commercial Fishery Sea Scallop Harvest Locations, April to November, 2005 to 2010, combined.

Figure 7.14. Commercial Fishery Swordfish Harvest Locations, April to November, 2005 to 2010, Combined.
Figure 7.1. Commercial Fishery Herring Harvest Locations, April to November, 2005 to 2010, Combined.

Figure 7.16. Commercial Fishery Atlantic Halibut Harvesting Locations, April to November, 2005 to 2010, Combined

Figure 7.17. Commercial Fishery Silver Hake Harvesting Locations, April to November, 2005 to 2010, Combined.

Figure 7.18. Commercial Fishery Tuna Harvesting Locations, April to November, 2005 to 2010, Combined

Timing of the Commercial Fisheries

Based on the DFO commercial fisheries landings database, catch weights in the Project Area during 2005-2010 were highest during the May to August period (Figure 7.19). Average monthly catch weight of all species ranged from about 50 to 80 mt during the four month period. The average monthly catch weight was quite consistent during January to April period (~40 mt) while it dropped from September to December.

![Average Monthly Catch Weight of All Species in the Project Area, 2005 to 2010, Combined.](source)

Catch weights in the WATS Area during 2005-2010 were highest during July (Figure 7.20). Average monthly catch weight of all species during all other months was <1 mt, with no catches reported in May and June.

![Average Monthly Catch Weight of All Species in the WATS Area, 2005 to 2010, combined.](source)
Fisheries within the Project and WATS Areas are conducted using both fixed (e.g., pelagic longline for swordfish, demersal longline for Atlantic halibut) and mobile gear (e.g., dredge for sea scallops). Mobile gear accounted for the majority of the average annual catch weight of commercial harvests in the Project Area (~60%) from April to November, 2005 to 2010 (Table 7.8). The predominant mobile gear type was dredge (~33%), followed by bottom otter trawl (~11%), purse seine (~8%) and midwater trawl (~7%; Table 7.8). The dredge was used to harvest sea scallops, the bottom otter trawl fished groundfish species and the mid water trawl and purse seine were used in the herring fishery. The predominant fixed gear used during this time period is the longline which harvested about 39% of the catch weight in the Project Area, principally large pelagic fishes.

Longline fishing uses a long line with baited hooks attached at intervals. Longlines are classified mainly by where they are placed in the water column; they can be set to hang near the surface and drift (i.e., pelagic longline) to catch fish such as tuna and swordfish or set along the seafloor and fixed with anchors (i.e., demersal longline) to catch groundfish such as halibut or cod.

The 100 fathom (183 m) edge along the Shelf Break is considered important habitat for the pelagic longline swordfishery during the months of August to October. About 60 km of pelagic longline gear is set overnight since swordfish are night feeders. This gear is equipped at surface with about 400 floats, ten radio buoys and automatic information (AIS) buoys. The gear is set up with four fathom (about 7 m) drop lines that attached to the subsurface mainline. Hooks are fixed at seven metre intervals.

The practice of swordfishing among the fleets entail two strategies. It is customary to allow one vessel to fish a specific area while other vessels wait for their turn in that area. While only one set of gear is out at a time to prevent entanglement, there are several vessels in an area to consider. Alternatively, four to five swordfishing vessels may stack sets of gear latitudinally, such that they are in parallel at some distance to prevent entanglement. In this arrangement, there are several gear sets and vessels over a much wider area to consider.

Most Atlantic halibut caught by Canadian fishers, including those in the Study Area, use demersal longlines. This type of fishing gear is set along the ocean floor with the aid of anchors and the associated fishing vessel remains with the gear. A demersal longline consists of a main groundline (typically 3-5 km long) equipped with many lighter secondary lines attached several metres apart. The demersal longline is marked on the ocean surface using a float and flagpole, possibly fixed with a radar reflector at each end. Fishers may set several demersal longlines at a time and haul them regularly to land their catch.

Harvest locations using mobile and fixed gear are displayed in Figures 7.21 and 7.22, respectively. Harvest locations with both mobile and fixed gear were most concentrated in the northern parts of the Project Area and NATS Area inside of the 1,000 m depth contour (Figures 7.21 and 7.22). However fixed gear harvest locations are more numerous throughout the Project.
Area than are the mobile gear harvest locations, primarily due to the use of longlines in the areas deeper than 1,000 m (Figures 7.21 and 7.22).

Table 7.8. Average annual Project Area catch weight by gear type, April to November, 2005 to 2010.

<table>
<thead>
<tr>
<th>Gear Type</th>
<th>Quantity (mt)</th>
<th>% of Total</th>
<th>Gear Class</th>
</tr>
</thead>
<tbody>
<tr>
<td>Longline</td>
<td>145.4</td>
<td>38.6</td>
<td>Fixed</td>
</tr>
<tr>
<td>Dredge</td>
<td>125.9</td>
<td>33.4</td>
<td>Mobile</td>
</tr>
<tr>
<td>Bottom otter trawl</td>
<td>41.9</td>
<td>11.1</td>
<td>Mobile</td>
</tr>
<tr>
<td>Purse seine</td>
<td>30.0</td>
<td>8.0</td>
<td>Mobile</td>
</tr>
<tr>
<td>Midwater trawl</td>
<td>25.8</td>
<td>6.9</td>
<td>Mobile</td>
</tr>
<tr>
<td>Trap net</td>
<td>3.3</td>
<td>0.9</td>
<td>Fixed</td>
</tr>
<tr>
<td>Harpoon</td>
<td>2.2</td>
<td>0.6</td>
<td>Mobile</td>
</tr>
<tr>
<td>Pot</td>
<td>1.4</td>
<td>0.4</td>
<td>Fixed</td>
</tr>
<tr>
<td>Shrimp trawl</td>
<td>0.5</td>
<td>0.1</td>
<td>Mobile</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>376.5</strong></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>


Figure 7.21. Commercial Fishery Harvest Locations with Mobile Gear, April to November, 2005 to 2010, Combined

Figure 7.2. Commercial Fishery Harvest Locations with Fixed Gear, April to November, 2005 to 2010, Combined

**Gear Types, Timing and Locations of Principal Fisheries in the Study Area**

The primary gear types, timing and locations of the principal fisheries in the Study Area are indicated in Table 7.9. Dredging for sea scallops in the Study Area during 2005-2010 was conducted primarily during May-September, peaking in June and July. Most of the harvesting occurred in NAFO UA 4Wj (65%), followed by 4Wf (26%) (see Figure 7.13). Pelagic longlining for swordfish in the Study Area during 2005-2010 occurred primarily during July-November, peaking in August and September. Over 80% of the swordfish catch weight was harvested in UAs 4Wj and 4Wg (see Figure 7.13). Demersal longlining for Atlantic halibut in the Study Area during 2005-2010 occurred primarily during January-March (62% of the catch weight for this species), followed by July-September (34%). Over 90% of the Atlantic halibut catch weight was harvested in UAs 4Wj and 4Wg (see Figure 7.16). Other methods of fishing, such as trawling and purse seining, were prosecuted used primarily during winter and spring. Exceptions to this include some bottom otter trawling for groundfish (e.g., silver hake) during...
summer and fall months. Most of the trawling and purse seining was conducted in UAs 4Wj and 4Wl (see Figure 7.21).

Table 7.9. Primary gear types, months and locations of fisheries in the Study Area.

<table>
<thead>
<tr>
<th>Target Group/Species</th>
<th>Primary Gear Types (% of total catch weight of group/species)</th>
<th>Months (% of total catch weight of group/species)</th>
<th>Gear x Month (% of total catch weight of group/species)</th>
<th>NAFO Unit Areas (% of total catch weight of group/species)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Groundfishes</td>
<td>BOT (55%) LL (42%)</td>
<td>July (18%) April (18%) March (15%) February (13%) January (13%) August (9%) September (3%)</td>
<td>BOT/April (17%) BOT/July (12%) BOT/March (10%) LL/January (10%) LL/February (9%) LL/August (8%) LL/July (6%) LL/March (4%) BOT/February (4%) BOT/January (3%) BOT/November (3%) LL/September (3%) BOT/May (2%)</td>
<td>4Wj (51%) 4Wl (24%) 4Wg (22%)</td>
</tr>
<tr>
<td>Invertebrates</td>
<td>D (~99%)</td>
<td>July (30%) June (27%) August (20%) May (13%) September (7%)</td>
<td></td>
<td>4Wj (65%) 4Wf (26%) 4Wg (9%)</td>
</tr>
<tr>
<td>Large pelagics</td>
<td>LL (~98%)</td>
<td>August (41%) September (26%) July (17%) October (6%) November (5%)</td>
<td></td>
<td>4Wj (43%) 4Wg (33%) 4Wm (14%) 4Wl (10%)</td>
</tr>
<tr>
<td>Small pelagics</td>
<td>MWT (59%) PS (40%)</td>
<td>May (62%) April (28%) Jan (10%)</td>
<td>MWT/May (49%) PS/April (28%) PS/May (12%) MWT/January (10%)</td>
<td>4Wj (~99%)</td>
</tr>
<tr>
<td>Sea scallops</td>
<td>D (100%)</td>
<td>July (30%) June (27%) August (20%) May (13%) September (7%)</td>
<td></td>
<td>4Wj (65%) 4Wf (26%) 4Wg (9%)</td>
</tr>
<tr>
<td>Swordfish</td>
<td>LL (~98%)</td>
<td>August (41%) September (26%) July (17%) October (6%) November (5%)</td>
<td></td>
<td>4Wj (48%) 4Wg (36%) 4Wl (12%) 4Wm (4%)</td>
</tr>
<tr>
<td>Atlantic halibut</td>
<td>LL (~100%)</td>
<td>January (27%) February (24%) August (16%)</td>
<td></td>
<td>4Wj (56%) 4Wg (37%) 4Wl (5%)</td>
</tr>
</tbody>
</table>
### Target Group/Species

<table>
<thead>
<tr>
<th>Target Group/Species</th>
<th>Primary Gear Types (% of total catch weight of group/species)</th>
<th>Months (% of total catch weight of group/species)</th>
<th>Gear x Month (% of total catch weight of group/species)</th>
<th>NAFO Unit Areas (% of total catch weight of group/species)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Herring</td>
<td>MWT (60%) PS (40%)</td>
<td>July (12%) March (11%) September (6%)</td>
<td>MWT/May (49%) PS/April (28%) PS/May (12%) MWT/January (10%)</td>
<td>4Wj (~100%)</td>
</tr>
<tr>
<td>Silver hake</td>
<td>BOT (~100%)</td>
<td>April (36%) July (25%) March (19%) February (8%) May (4%) June (2%)</td>
<td>4Wl (48%) 4Wj (36%) 4Wg (14%)</td>
<td></td>
</tr>
<tr>
<td>All Species</td>
<td>D (38%) LL (26%) BOT (17%) MWT (11%) PS (8%)</td>
<td>July (19%) May (17%) August (16%) June (12%) April (11%) September (7%) January (6%) March (5%) February (4%) November (2%) October (1%) December (&lt;1%)</td>
<td>D/July (11%) D/June (10%) MWT/May (9%) LL/August (8%) D/August (8%) PS/April (5%) BOT/April (5%) D/May (5%) LL/September (4%) LL/July (4%) BOT/July (4%) BOT/March (3%) LL/January (3%) LL/February (3%) D/September (3%) MWT/January (2%) LL/March (1%)</td>
<td>4Wj (64%) 4Wg (14%) 4Wf (10%) 4WI (9%) 4Wm (3%)</td>
</tr>
</tbody>
</table>


‘D’ denotes dredge; ‘LL’ denotes longline; ‘BOT’ denotes bottom otter trawl; ‘MWT’ denotes mid-water trawl; ‘PS’ denotes purse seine.

### Effects Assessment

#### Airgun Array Sound

The sound detection thresholds of most of the commercial fisheries target species in the Study Area (e.g., sea scallops, swordfish, Atlantic halibut) are likely lowest for low frequency sound (i.e., <1,500 Hz) (Appendices F and G). Some fishes lack a swim bladder (e.g., Atlantic halibut) and are therefore not sensitive to the sound pressure component of sound, only the particle displacement component. Other fishes do have a swim bladder (e.g., swordfish) and are sensitive, at varying degrees, to the sound pressure component as well as the particle...
displacement component of sound. All marine invertebrates (e.g., sea scallops) are most likely sensitive to only the particle displacement component. Although exposure to airgun sound can cause physical effects on fishes (e.g., Fewtrell and McCauley 2012), studies that suggest physical effects typically involve captive subjects that are unable to move away from the sound source and are therefore exposed to higher sound levels than they would be under natural conditions. Any physical effects of note due to exposure to seismic sound can be confidently dismissed (Appendices F and G). On the other hand, it is possible that airgun sound may result in behavioural effects (e.g., Løkkeborg et al. 2012; Engås et al. 1996). Available research indicates considerable inter- and intra-specific differences in received sound levels that evoke either subtle or more overt behavioural responses in fishes (Appendix F).

Underwater sound modelling (Appendix A) was conducted at six locations in the Project Area, including four in the 2014 WATS 3D Acquisition Area (water depth ranging from 1,300-3,200 m). The shallowest modelling locations were located in the NATS West Area (~100 m depth) and the NATS East Area (~500 m depth). The modelling indicates that SPLs >159 dB re 1 µPa \( \text{rms} \) (about >169 dB re 1 µPa \( 0-p \), assuming a 10 dB difference between 0-\( p \) and \( \text{rms} \)) are limited to relatively small areas after each airgun array pulse (~400 km\(^2\)).

The modelling also indicated that in April, airgun sound is trapped in the upper 100 m of the water column (upward refracting) which in turn reduces interaction with the bottom and sound attenuation. Over time (i.e., May to August), the upper column becomes downward refracting, thereby increasing bottom interactions and sound attenuation. This explains why the higher SPLs of the airgun sound travel furthest in the early spring, with distances decreasing throughout the summer.

Mitigation measures that will be implemented to minimize the effects of airgun sound on the commercial fisheries are as follow:

- Ongoing communication between seismic operator and fishers – BP has agreed to weekly updates to provide information on the location of the seismic vessels and on anticipated plans for the next week;
- Spatial and temporal avoidance of fishing areas as agreed to through ongoing communication – BP has agreed to conduct the 2014 seismic survey from north to south to accommodate Atlantic halibut and swordfish fishers;
- Ramp up;
- Use of Fisheries Liaison Officers (FLOs) (see Section 12.4);
- Use of picket vessels;
- Use of Vessel Monitoring System; and
- Issuance of Notices to Mariners.

With the implementation of these mitigations, airgun sound is judged to have minor effects on commercial fisheries over a duration of 1-12 months and a geographic extent judged to be 101-1,000
Therefore, residual effects of exposure to airgun sound on commercial fisheries are judged to be *not significant*. The level of confidence associated with this judgement is *medium to high*.

**Presence of Seismic Vessel/Streamer Configuration**

The proposed WATS seismic vessel/streamer configuration will be more than 5 km wide, substantially larger than the typical NATS 3D single seismic vessel/streamer configuration (i.e. approx. 1.2 km wide). The fishing gear with the most potential to be physically contacted by the seismic configuration is longline used in the pelagic fishery. This gear is considered to be fixed gear and is typically about 60 km in length. BP has and will continue to engage with the pelagic fisheries or their representatives in advance of commencement of the seismic program to let them know where the seismic vessels will be located at any time. The other dominant gear type used in the Project Area is trawl, a mobile gear. The latter can be more easily moved to avoid the seismic configuration than the fixed gear. As discussed in relation to the potential effects of exposure of target species to airgun sound, good communication between fishers and the seismic operator can mitigate the potential conflict. Once the timing and seismic survey pattern are determined, both fishers and the seismic operator can plan their operations to avoid conflicts at sea. In addition, multiple picket vessels will be sailing in front of the seismic configuration to identify any potential for conflict between fisheries activities and seismic activities.

Streamer deployment logistics will be communicated by BP to those associated with fisheries on the Scotian Shelf, including fisheries outside the Project Area within the potential deployment zone. During streamer deployment and seismic activities, two FLOs will be supporting the seismic fleet, one on each outside streamer vessel, to ensure that both seismic and fisheries activities are coordinated and conflict is avoided. Both FLOs will be active during daylight hours and available (i.e., on call) during nighttime hours. The key responsibilities of the FLOs are (1) to act as liaison(s) between seismic operations and fisheries; and (2) to provide advice on any potential interactions with fisheries activities (e.g., gear, fishing vessels) and/or other ocean users, and to help to either avoid or resolve conflict. The seismic ships will require the use of areas outside of the acquisition areas to come about during line changes. In the event that gear is damaged or lost due to contact with the seismic configuration, the compensation claims process will be activated as per the Compensation Guidelines Respecting Damages Relating to Offshore Petroleum Activity (C-NLOPB/CNSOPB 2002) and the Guideline for the Reporting and Investigation of Incidents (C-NLOPB/CNSOPB 2009).

With mitigations in place and consideration of the fact that most of the Project Area is outside the most heavily fished areas, the presence of the seismic vessel/streamer configuration is judged to have *minor* effects on commercial fisheries, over a duration of 1-12 months and a geographic extent judged to be 11-100 km². Therefore, residual effects related to the presence of the proposed seismic vessel/streamer configuration on commercial fisheries are judged to be *not significant*. The level of confidence associated with this judgement is *medium to high*. 

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*Tangier 3-D Seismic Survey*

*Environmental Assessment* 

*Page 121*
7.3.1.2 Aboriginal Fisheries

This section is quoted verbatim from the Eastern Scotian Slope SEA (Stantec 2012b).

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 (FSC) purposes. The Court found that where an Aboriginal group has a right to fish for 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 2008). 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 (from Stantec 2012b).

The Minister of Fisheries and Oceans issues communal fishing licences to Aboriginal groups, which allows for fishing for FSC purposes. In Nova Scotia, communal licences for food, social and ceremonial purposes are issued to all thirteen First Nations and the Native Council of Nova Scotia. These communal fishing licences are for fishing areas inland and inshore. Currently, DFO does not issue any communal licences for FSC purposes that provide access to offshore areas.

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 (from Stantec 2012b).

There are 47 communal commercial licences for commercial fishing within the Phase 1A and Phase 1B SEA study areas (Stantec 2012a,b). These licences are for snow crab, groundfish, swordfish, tunas, and shrimp (M. Eagles, DFO, pers. comm. 2012). The communal commercial licences are held by Aboriginal groups in the DFO Maritimes Region, and do not include those communal commercial licences 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 (from Stantec 2012b).
In terms of the potential effects of this seismic program, offshore fishing under aboriginal licencing is not different than the non-aboriginal commercial fishing. Any offshore interaction food-social-ceremonial fishery activity in the area will be managed through the FLOs. As with commercial fisheries, the residual effects related to both exposure to airgun sound and the presence of the proposed seismic vessel/streamer configuration on aboriginal fisheries are judged to be not significant.

7.3.1.3 Recreational Fisheries

There are no recreational fisheries in the Study Area (Stantec 2012a,b).

7.3.2 Marine Shipping

7.3.2.1 Background

Nova Scotia’s strategic location close to the Great Circle Route (i.e., shortest distance over the earth’s surface) between eastern North America and Europe makes this region important for international shipping. Commercial shipping is generally in the form of tankers, general bulk and containerized cargo carriers (DFO 2011d). Merchant traffic in the area remains relatively constant over the course of the year but cruise ships are heavily seasonal (summer and fall) (Pelot and Wootton 2004, cited in Walmsley and Theriault 2011). The primary commodities being moved include crude oil and gas, minerals and chemicals, paper and forest products, coal and coke, gypsum, automobiles and various containerized goods (DFO 2011d).

There is no single shipping corridor through the Study Area. Commercial shipping follows dedicated vessel traffic separation lanes upon nearing Halifax, Saint John and the Strait of Canso. Outside of these controlled areas, mariners tend to decide on their preferred routing (Hurley 2011).

Figure 7.23 provides a snapshot of vessel traffic density off Nova Scotia. Shipping traffic within the Study Area is greatest running parallel to the shelf edge. There is no published information on the exact number of vessels traversing the Scotian Shelf, but figures for international ships making use of Nova Scotian ports show a regular pattern of between 1,600 and 2,000 large vessels per annum (Walmsley and Theriault 2011).

Halifax is the largest port in Nova Scotia with the most diverse cargo base. In 2012, it handled 9.5 million tonnes of cargo, largely composed of bulk and containerized cargo. Containerized cargo included a volume of 417,000 sea containers (twenty foot equivalent units – TEUs) (Port of Halifax 2013). Halifax is the largest short sea shipping port in the country, the second largest cruise port in Canada after Vancouver and the third largest container port in Canada (DFO 2011d).
The Strait of Canso Superport, located approximately 200 km north of the Project Area, consists of the Mulgrave Marine Terminal and the Port Hawkesbury Pier. In 2011, the Strait Superport handled 23.8 million tonnes of cargo (Strait Superport 2013) Website - http://www.straitsuperport.com/port/statistics/). Most of the volume was accounted for by a petroleum facility operated by Statia Terminals. Bulk exports of gypsum, paper products, aggregate and imports of coal made up the remainder (DFO 2011d).

In addition to Halifax and Port Hawkesbury there are a number of smaller ports along the Scotian Shelf including Sydney, Liverpool, Shelburne and Sheet Harbour. These ports deal with cargo such as fish, lumber, oil and newsprint (DFO 2011d).

The Port of Saint John, New Brunswick is also important due to the movement of traffic through the Scotian Slope to and from the Bay of Fundy. In 2012, the Port of Saint John handled 26.96 million metric tonnes of cargo, the large majority being crude oil destined for the Irving oil refinery and refined petroleum products delivered from the refinery. Over 50,000 sea containers (TEUs) were also handled in 2012 (Port of Saint John 2013).
The main ports of call for cruise ships near the Study Area are Halifax, Saint John and Sydney, the closest being Halifax approximately 200 km northwest of the Study Area. The number of vessels has been increasing steadily in the last few years, with 134 vessels and 253,000 passengers to Halifax in 2012 (Port of Halifax 2013), up from 89 vessels and 170,000 passengers in 2006 (DFO 2011d). Saint John, located over 650 km from the Project Area, is the second largest cruise port in eastern Canada, and was visited by 75 vessels and 187,000 passengers in 2012 (Port of Saint John 2013). The same vessels often visit the three ports in a single trip. Atlantic Canadian ports have benefited from the growing trend towards four- to five-day cruises along the eastern seaboard (DFO 2011d).

The shipping industry is regulated internationally by the International Maritime Organization (IMO). Much of Canada’s legal framework is from the implementation of international agreements like the International Convention for the Prevention of Pollution from Ships and the International Convention for the Safety of Life at Sea. National governments are required to implement and enforce international regulations through their domestic legislation such as the Canada Shipping Act (DFO 2011d). Vessels must comply with the provisions of the Canada Shipping Act and related regulations. The Act addresses pollution prevention such as national standards for oil concentrations in discharged water (DFO 2008).

Koropatnick et al. (2012) compare Figure 7.23 which was generated from year-round 2000 Canadian Coast Guard’s Eastern Canada Vessel Traffic Services Zone (ECAREG) data and Figure 8 in Koropatnick et al. (2012) which was generated from year-round 2010-2011 (Long Range Identification and Tracking (LRIT) data. Some of the routings in Figure 7.23 are no longer valid while the LRIT generated Figure includes some routings through Canadian waters without a Canadian port of call (e.g., track lines between Europe and the eastern seaboard of the United States) that are not presented in Figure 7.23. Overall, the pattern of track lines through the Study Area is similar for both Figures.

7.3.2.2 Effects Assessment

It is possible that increased vessel presence as a result of the proposed Project may interact with commercial shipping on the Scotian Shelf and Slope although this risk is considered minimal as the main ports of call are substantially distanced from the Project Area and, as shown in Figure 7.23, a relatively low density of shipping traffic is identified in the Project Area and WATS and NATS survey areas. Additionally, a Notice to Mariners will be published to advise shipping interests that seismic operations will be conducted over a specific timeframe in the Project Area. Commercial vessels will likely be seen on radar, and chase or picket vessels will be used to scout for other vessels in the area in order to avoid any potential collision or entanglement of the towed seismic gear. There has not been any documented conflict between seismic operations and commercial vessels off Nova Scotia, therefore any potential residual effects on marine shipping from the Project are judged to be not significant. The level of confidence associated with this judgement is high.
7.3.3 DFO Scientific Research

7.3.3.1 Background

The DFO scientific initiatives on the Scotian Shelf and beyond the Shelf include the following:

- DFO Research Vessel trawl surveys;
- Atlantic Zone Monitoring Program (AZMP); and
- RAPID Program

The primary DFO research activity that has potential to interact with the Project is the annual Research Vessel (RV) multi-species trawl survey. Typically DFO requires a certain temporal and spatial buffer between seismic surveying and trawl surveying to ensure that the airgun sound does not affect survey results. DFO RV surveys in 2014 will occur between 2 July and 18 August but other details are not yet available (D. Clark, DFO, pers. comm.). It is anticipated that RV surveys will not be conducted in areas with water depths >800 m.

Two other DFO scientific research programs, Atlantic Zone Monitoring Program (AZMP) and RAPID (part of UK RAPID Climate Change Program) are currently scheduled to occur during April 4-23 2014 and 20 September 20-October 13 2014 (Andrew Cogswell, DFO, pers. comm.). The RAPID program involves recovery of bottom moorings and deployment of replacement moorings during the early part of the fall cruise, while AZMP involves measurement of oceanographic parameters (e.g., CTD, plankton tows) from the vessel deck during both the spring and fall cruises. While underwater sound is not an issue with the RAPID and AZMP programs, physical presence of the seismic survey vessel/streamer configuration could be an issue. The locations of RAPID moorings and AZMP activities are shown in Figure 7.23. Six of the twelve AZMP stations shown in Figure 7.24 occur within the Project Area. The other six stations occur offshore of the Project Area. Four of the five RAPID stations also occur within the Project Area, the fifth being located just offshore of the WATS Area. Three stations for each of the AZMP and RAPID Programs occur within the 2014 WATS 3D Acquisition Area.

7.3.3.2 Effects Assessment

Conflict between proposed seismic surveying and the DFO research programs can be mitigated through communication between BP and DFO. Although the footprints of the DFO research programs will overlap with the 2014 WATS 3D Acquisition Area, BP will contact DFO in advance of seismic activities to acquire clarity on the 2014 research programs, and to ensure that coordination between both activities is achieved. Based on these mitigations measures, the residual effects of Project activities on DFO scientific research in the Study Area is judged to be not significant. The level of confidence associated with this judgement is high.
Figure 7.24. Locations of Stations for DFO AZMP and RAPID Programs in 2014

7.3.4 Department of National Defence (DND) Operations

7.3.4.1 Background

Canada’s naval presence on the east coast is provided through Maritime Forces Atlantic (MARLANT) from its headquarters in Halifax. Canada’s maritime forces engage in a range of operations 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. To
carry out its missions, MARLANT uses a range of platforms, including patrol frigates, coastal defence vessels, destroyers, submarines, ship-borne helicopters and long-range patrol aircraft (LGL 2012b; MARLANT 2013).

DND conducts training and other operations in designated ‘Operations Areas’ off the south coast of Nova Scotia (Figure 7.25). The Project Area overlaps with the eastern and northeastern edges of areas N1 and N2, respectively. In a letter dated 9 October 2013 to the CNSOPB (Giffin 2013), DND noted that they would likely be operating in the vicinity of the Study Area in a non-interference manner, therefore there would be potential for interaction with naval operations. DND asked to be informed of the dates and locations of the seismic operations (Giffin 2013).

There are also several offshore sites where munitions have been dumped in the past. DND’s records indicate that no known wrecks are present in the immediate vicinity of the survey area, and given the nature of the seismic survey the associated unexploded ordinance risk was assessed by them as negligible (Giffin 2013). The proposed Project will not come into contact with the sea bottom therefore disturbance of unexploded munitions and shipwrecks are not expected to occur. DND advised that should any unexploded ordinances be encountered, they should not be disturbed and BP should mark their location and immediately inform the Canadian Coast Guard (Giffin 2013).

Figure 7.25. Designated DND Operations Areas in and Near the Project Area
7.3.4.2 Effects Assessment

DND operations may include underwater sound monitoring. Therefore, sound produced by the Project, primarily from the activation of the airguns has the potential to interfere with DND underwater noise monitoring operations. Communication between DND and BP should minimize any potential for interference.

To date, there have not been any adverse interactions between seismic activities and DND operations off Nova Scotia. Again, this is due to the requirement for oil and gas proponents to consult with DND (Hurley 2011). DND has been made aware of the Project and the location of the proposed WATS and NATS Acquisition Areas as part of the environmental assessment process. As the location of future military training operations are still being determined, DND will be consulted prior to the commencement of seismic operations. In addition, Notices to Mariners and Notice to Shipping will be issued prior to commencement of seismic surveys.

Given that BP will continue to engage with DND regarding its proposed activities, the potential residual effects from Project activities on DND training and other operations are judged to be not significant. The level of confidence associated with this judgement is high.

7.3.5 Submarine Cables

Given the nature of the proposed activities, existing submarine cables will not be an issue because the proposed seismic surveying will not involve any contact with the ocean bottom. Additionally, there are no reasonably foreseeable submarine cable placement projects planned for the Study Area. Therefore, submarine cables are not considered further in this EA.

7.3.6 Oil and Gas Industry

Besides the proposed BP seismic activities in 2014, offshore oil and gas industry projects listed on the CNSOPB public registry (www.CNSOPB.ns.ca as viewed 6 December 2013) include:

- Sable Offshore Energy Project (ExxonMobil)
- Deep Panuke Project (Encana);
- Shelburne Geohazard Survey (Shell); and
- Shelburne Basin Venture Exploration Drilling Project (Shell)

Section 10.0 on Cumulative Effects discusses the offshore oil and gas industry projects listed on the CNSOPB public registry in more detail. Communication between BP and the other oil and gas operators will minimize any effect of the proposed Project on these other projects. BP commits to respect the 500 m safety exclusion zone around the Exxon Mobil Canada Sable Project and Single Buoy Mooring (SBM) Inc. (on behalf of Encana) Deep Panuke production
facilities and to notify ExxonMobil and Encana/SBM of project vessel traffic. Therefore, the residual effects related to BP’s proposed Project on other oil and gas projects listed on the CNSOPB public registry are judged to be not significant. The level of confidence associated with this judgement is high.
8.0 Malfunctions and Accidental Events

This section provides an assessment of the potential effects on the VECs of a malfunction or accidental event resulting in the release of hydrocarbons to the marine environment during the Project.

8.1 Scenario

The Scoping Document (Appendix B) required consideration of a hydrocarbon release from seismic streamers and a “light” fuel spill from seismic vessels. The proposed WATS and NATS 3D surveys will be undertaken using solid streamers, therefore an accidental release of streamer fluid will not occur.

All Project vessels will use either marine gas oil (MGO) or marine diesel oil (MDO). Considering the requirement of the Scoping Document to assess a “light” fuel spill from a seismic vessel, a scenario for an accidental release of fuel during routine bunkering of a seismic vessel was considered.

Ship-to-ship fueling of the seismic vessels towing streamers will be undertaken during the Project. All Project support boats will have TODO® fuel hoses. These types of fuel hoses have one-way valves and are designed to close if broken or if there is a stoppage of fuel for any reason. The fuel hose holds about 100 L (0.63 barrel) and this is considered the maximum amount of fuel that could be lost during ship-to-ship fueling at sea (A. McGowan, Operations Manager, WesternGeco, pers. comm., December 2013).

Both MGO and MDO would persist in the environment for much shorter periods than would crude oil or heavy fuel oils such as Bunker C. Based on spill modelling of a diesel fuel release (10 barrel) on the Scotian Slope in summer, about 40% of diesel will evaporate (JWEL 2003). A spill of 100 L (<1 barrel) of MGO or MDO would not persist for long periods on the water surface. Based on the 10 barrel release of diesel modelled in JWEL (2003), fuel would disperse or evaporate in 25 hours. This time would be reduced for a smaller release (i.e., <1 barrel). Predominant wind directions in summer would tend to move the fuel to the northeast (JWEL 2003).

8.2 Mitigations

Preventative measures and plans will be in place to avoid any fuel release or other accidental events during the seismic program. Plans and measures include: spill prevention plans, crew training, proper handling and storage requirements, vessel inspections, fuel transfer plan (including use of TODO® fuel hoses), secondary containment and adherence to the safety management procedures including proper bunkering procedures. Project vessels will be equipped
with spill kits as appropriate. In addition, the risk of vessel collision will be minimized by using radar and Vessel Monitoring System (VMS) tracking.

8.3 Effects Assessment

Potential adverse effects from malfunctions and accidental events from seismic operations (and drilling) on marine mammals, marine birds and fish (including larvae) are summarized in the SEAs for the Eastern Scotian Slope (Stantec 2012a,b) and the Southwestern Scotian Slope (Hurley 2011). Information relevant to potential accidental release during refueling is provided below.

8.3.1 Marine Mammals and Sea Turtles

Known effects of oil on marine mammals have been reviewed by Engelhardt (1983, 1985), Geraci and St. Aubin (1990), Richardson et al. (1989), and NRC (2003). It should be noted that most studies of oiling effects on marine animals have considered much heavier fuel than MGO or MDO and as such, effects reported for heavier fuel are considered more severe than those from exposure to MGO or MDO.

Hydrocarbons can be inhaled or ingested and may cause behavioural changes, inflammation of mucous membranes, pneumonia and neurological damage, but many marine mammals seem to show a relatively high tolerance level to exposure to hydrocarbons (see Geraci and St. Aubin 1990). In the Study Area, whales and seals rely on a layer of blubber for insulation, so oil has little effect on thermoregulation when compared to other marine mammals that rely on fur for insulation. The exception is seal pups that have not yet developed insulating blubber. Although oil could have numerous effects on the health or behaviour of marine mammals (MMC 2011), whales and seals do not exhibit large behavioural or physiological responses to limited surface oiling, incidental exposure to contaminated food, or ingestion of oil (St. Aubin 1990; Williams et al. 1994). Although oil could coat the baleen of mysticete whales and reduce filtration efficiency, this effect is considered reversible (Geraci 1990).

Sea turtles may be more susceptible to the effects of exposure to hydrocarbons than marine mammals because they do not respond with avoidance behaviour, they exhibit indiscriminate feeding, and they take large pre-dive inhalations (see Milton et al. 2010). Ingestion of oil is particularly deleterious to sea turtle health (Camacho et al. 2013). However, few, if any sea turtles, are expected to be exposed to the small amount of fuel (100 L) assessed here given the low numbers of sea turtles in the Project Area and size and expected persistence of the fuel release, as well as mitigation measures in place.

Considering the mitigation measures in place for spill prevention and cleanup, the rapid degeneration of MGO or MDO, the location of refueling in offshore areas within the Project Area or at the Halifax port, and that the marine mammals expected to be most vulnerable to
exposure to hydrocarbons (e.g., seal pups) are expected to occur in low numbers, as are sea turtles, the residual effects of malfunctions and accidental events is judged to have negligible to minor effects on marine mammals and sea turtles, over a short-term duration of <1 month and a geographic extent judged to be <1 km$^2$ to 1-10 km$^2$. Therefore, residual effects related to malfunctions and accidental events on marine mammals and sea turtles in the Study Area, are judged to be not significant. The level of confidence in this judgement for a small volume fuel release is high.

8.3.2 Migratory Birds and Birds with Special Status

The main concern about a fuel spill is the resulting surface slick that could contaminate birds that either land on it or swim through it. Even very small amounts of fuel are enough to break down the insulation capability of the feathers and cause the bird to die in cold waters (O’Hara and Morandin 2010). Spills can cause large bird mortalities if they occur near large concentrations of birds or near large nesting colonies (e.g., Joensen 1972; Campbell et al. 1978). Large spills in deep water in the open ocean are expected to have a lesser effect on seabirds that a small spill in an area where birds aggregate (NRC 2003). A review of the effects of hydrocarbon exposure effects on birds, particularly those species found in Atlantic Canada is provided in the Hebron Project Comprehensive Study Report [see Section 9.5.4 in Hebron (2011); which is available at http://www.cnlopb.nl.ca/pdfs/hebron/hebcsrchap6to9en.pdf], and the EA for the White Rose Extension Project (Husky 2012).

It is possible that migratory birds, notably seabirds, may be exposed to hydrocarbons from a small fuel release (i.e., 100 L in the scenario considered here). However, considering the mitigation measures in place for spill prevention and cleanup, the location of refueling in offshore areas away from coastal concentrations of birds and breeding areas, the rapid degeneration of MGO and MDO and relatively small volumes which may be released, the residual effects of malfunctions and accidental events is judged to have minor effects on migratory birds, over a short-term duration of <1 month and a geographic extent judged to be <1 km$^2$ to 1-10 km$^2$. Therefore, residual effects related to malfunctions and accidental events on migratory birds in the Study Area, are judged to be not significant. The level of confidence in this judgement for a small volume fuel release is high.

8.3.3 Invertebrates and Fishes

There is a considerable body of literature related to the effects of exposure to hydrocarbons on marine invertebrates and fishes. Under natural conditions, most juvenile and adult fish can actively avoid contaminated water (e.g., Hjermann et al. 2007). Pelagic marine invertebrates can also avoid contaminated water while the benthic invertebrates would not come into contact with the hydrocarbons in water depths that characterize the Study Area. A number of studies have shown that hydrocarbons can have both lethal and sublethal effects (reduced growth and abnormal development) on eggs and larvae (Stantec 2012a). No known spawning or retention
areas are located within the WATS and NATS acquisition areas (CNSOPB 2013), although the Haddock Box slightly overlaps the Project Area north of the NATS West Area.

Considering the relatively small amount of hydrocarbons that would be released to the marine environment during a malfunction and accidental event, and the application of appropriate mitigation measures, a small volume release of MGO or MDO is judged to have negligible to minor magnitude residual effects on marine invertebrates and fishes (including eggs and larvae) for a short-term duration of <1 month and over a geographic extent <1 km$^2$ to 1-10 km$^2$. Therefore, the residual effects of malfunctions and accidental events on marine invertebrates and fishes in the Study Area are judged to be not significant. The level of confidence in this judgement for a small volume release of fuel is high.

8.3.4 Special Areas

Hurley (2011) identified Sable Island National Park as having the highest risk of adverse consequences from accidental releases from the oil and gas industry. The Haddock Box was determined to have a moderate risk of adverse consequences. Both risk rankings were based on a 100 barrel diesel spill (~12,000 L) during the drilling of an exploratory well—which is not comparable to the small fuel release (100 L) assessed here. The Project Area is 43.1 km southwest from Sable Island at the closest point, therefore potential adverse effects from a 100 L fuel spill on marine birds, including the Roseate Tern and Savannah Sparrow (*princeps* subspecies), are not anticipated. Two key points are that Savannah Sparrows would not land on the water surface and Roseate Terns spend little time on the water’s surface. Similarly, the small quantities of MGO or MDO potentially released from an accidental event are not anticipated to adversely affect the Haddock Box. Most of the Project Area (99.2%) does not overlap with the Haddock Box so it is likely that only a small amount of the 100 L fuel spill, if any at all, would reach the Haddock Box.

The Special Area that would most likely be affected by the accidental release of a small amount of hydrocarbons during the Project is the potential Scotia Slope/Shelf Break EBSA because of the large degree of overlap between the EBSA and the Project, WATS and NATS survey areas. This assessment is referring to the attributes of the EBSA that are relevant to issues brought forward during consultations; namely migration of large pelagic fishes and occurrence of invertebrate larvae in the upper water column. However, as described in Sections 8.3.1 to 8.3.3, the characteristics MGO/MDO as well as the low volumes that would be released would result in minimal effects on the EBSA. In addition, the application of appropriate mitigations measures (noted above) will further reduce the residual effect. Therefore, the residual effects of a malfunction or accidental event resulting in the release of a small volume of hydrocarbons on Special Areas are judged to be not significant. The level of confidence in this judgement for a small volume release of fuel is high.
8.3.5 Commercial Fisheries

The primary effects of hydrocarbon releases on fisheries pertain to physical effects on target species, actual and perceived tainting of target species, and fouling of gear. As noted above, physical effects on marine invertebrates and fishes from a small volume hydrocarbon release are expected to be negligible to minor in magnitude. However, if the release were of sufficient size, it could prevent or impede a fisher’s ability to access fishing grounds because of temporary exclusion areas during the release and/or subsequent clean-up, cause caused damage to fishing gear or resulted result in a negative effect on the marketability of fish products due to actual or perceived tainting.

Considering the relatively small amount of MDO or MGO that would be released to the marine environment during the malfunction and accidental event scenarios, the relatively short half-life of these hydrocarbon types and the application of appropriate mitigation measures (e.g., Shipboard Oil Pollution Emergency Plan (SOPEP)), a small volume release of hydrocarbons is judged to have negligible to minor residual effects on the commercial fisheries for a short-term duration of <1 month, and over a geographic extent of <1 km² to 1-10 km². Therefore, the residual effects of a malfunction and/or accidental event resulting in a small volume release of hydrocarbons on the commercial fisheries are judged to be not significant. The level of confidence in this judgement for a small volume release of fuel is high.

9.0 Effects of the Environment on the Project

The Scoping Document states that factors which could affect the Project design or operation include meteorology and oceanography. BP is required to monitor physical environmental conditions and develop a plan to avoid potential adverse effects on the environment as a result of environmental influences on the Project. An Emergency Response Plan is required to be submitted to the CNSOPB prior to the commencement of operations (CNSOPB 2013) and is discussed further in Section 9.4 below. The joint BP and WesternGeco Project risk assessment and safety plan address adverse weather effects on the survey operations.

Extreme conditions may increase the risk of spills, collisions, entanglement with fishing gear and debris, and may affect program schedule and operations including the timing of the Project and provision of supplies. Environmental constraints on seismic surveys include those imposed by poor visibility, winds, waves, currents and differences in water temperatures. Currents may affect the optimal positioning of the streamers potentially affecting data quality.

The SEA for the Eastern Scotian Slope (Phase 1B) (Stantec 2012a) and the SEA for the Southwest Scotian Slope (Hurley 2011) provide overviews of the physical environmental conditions on the Scotian Slope. The Project Area is expected to fall within the range of the conditions described in the two SEAs therefore this section will only provide a brief overview. These met-ocean conditions are summarized in Table 9.1 below. Section 6.0 of Stantec (2012a)
also provides an overview of the potential effects of the environment on seismic programs. Climate change has not been considered in the discussion below due to the short term scope of this assessment which covers seismic activities in 2014 and 2015.

Table 9.1. Summary of climatological and oceanographic features of the Project Area.

<table>
<thead>
<tr>
<th>Physical and Climatological Summary</th>
</tr>
</thead>
<tbody>
<tr>
<td>Climate/Visibility</td>
</tr>
<tr>
<td>• Climate is strongly influenced by the warm Gulf Stream and the cold Labrador Current</td>
</tr>
<tr>
<td>• Daily Air Temperature Range: -1.4°C (February) to 17.8°C (August)</td>
</tr>
<tr>
<td>• Extreme Minimum Air Temperatures: -19.4°C (January) to 4.4°C (August)</td>
</tr>
<tr>
<td>• Extreme Maximum Air Temperatures: 12.8°C (February) to 29.6°C (July)</td>
</tr>
<tr>
<td>• Average Monthly Precipitation: 95.2 mm (July) to 147.0 mm (November)</td>
</tr>
<tr>
<td>• Extreme Daily Precipitation: 66.00 mm (April) to 166.1 mm (November)</td>
</tr>
<tr>
<td>• Average days per year with fog: 127 days (Sable Island).</td>
</tr>
</tbody>
</table>

| 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: 74 km/h (August) to 130 km/h (November) |
| • Maximum Wind Gust Speed: 100 km/h (August) to 130 km/h (November) |

| Wave Height                           |
| • Monthly mean (m): 1 – 1.5 in (July/August) to 3 – 4.5 (December) |
| • Monthly maximum (m): 3 – 4 (July) to 9 - 10 (December to March) |
| • 1 - Year return Hmax (m): 14.7 |
| • 100 - year return Hmax (m): 24 |

| Sea Ice / Icebergs                    |
| • Sea Ice is generally transported out of the Gulf of St. Lawrence through the Cabot Strait. |
| • Ice rarely can be transported from the Cabot Strait by northwesterly winds and ocean currents onto the Eastern Scotian Shelf, although this is not expected in the Project Area. |

Source: Stantec (2012a).

Hmax = maximum wave height in a recorded burst of raw data.

9.1 Fog and Reduced Visibility

Arctic air masses and tropical air masses from the Gulf of Mexico converge over the offshore area of Atlantic Canada. The surface climate of the Project Area depends on these airstreams and their fronts. Fog is often present on the Scotian Shelf and Slope, with approximately 35% of days reporting fog with a visibility less than 1 km. This increases to 65% of days in July as warm tropical air masses move north and cause large fog banks and stratiform clouds (Hurley 2011; Stantec 2012a). Periods with reduced visibility offshore Nova Scotia generally peak from May to August (Figure 9.1). Fog can affect seismic operations by limiting helicopter operations, visual
monitoring for marine mammals and sea turtles and also small boat operations that may be required for repairing streamers.

![Graph showing monthly hours with visibility <1 km from January to December](image)

**Figure 9.1.** Average Number of Hours per Month with Visibility <1 km Based on Data Collected on Sable Island (1971-2000; Government of Canada 2013).

### 9.2 Wind and Wave Heights

During April to September, wind direction is most frequently from the southwest with an average wind speed in September of 17.5 km/h while maximum gusts can reach 100 km/h in August and 130 km/h in November during severe storm events (Stantec 2012a). Weather conditions during the summer typically result in wave heights under 2 m, but they have exceeded 5 m in June (Hurley 2011).

The Atlantic hurricane season runs from June through November, which coincides with the timing of the Project. A total of 89 tropical storms entered the Maritimes marine area between 1951 and 2000. Forty-one of these storms were at hurricane strength (Environment Canada 2013a). Up to four tropical storms, hurricanes or post tropical storms can be expected to reach Canadian waters in a given year (Environment Canada 2013b).
9.3 Sea Ice

Sea ice typically forms in the western and northern Gulf of St. Lawrence during December and by the end of January starts to flow through the Cabot Strait. A mixture of drift ice and locally formed ice may extend as far south as Halifax (Stantec 2012a), although ice is not expected to reach the Project Area (Environment Canada 2013c). Ice around Sable Island last occurred in 1947 (Hill et al. 2002; Environment Canada 2013c).

9.4 Planning and Mitigation

Seismic programs are typically planned to occur during periods when environmental conditions (notably wind and wave) are most suitable for operations. The project planning process helps aid in providing for the safety of personnel, and protection of equipment, vessels and the natural environment. Potential safety issues associated with poor weather conditions will be assessed in detail through the review of BP and WesternGeco’s safety management systems and emergency response plans as part of the geophysical authorization process followed by the CNSOPB.

Typically, seismic vessels can continue operating in conditions up to Sea State 5 with wave height of 3 m or greater. Seismic vessels typically suspend surveys once wind and wave conditions reach specified levels because the ambient noise affects the data. Seismic operators also try to minimize the risk of damaging towed gear.

The Project’s temporal scope of April to November should avoid the more frequent extreme weather conditions typically encountered over the winter. The Project will be executed during the Atlantic hurricane season. BP’s geophysical contractors, WesternGeco, will be familiar with east coast operating conditions and written procedures will be in place under the Project Safety Plan for the continuous monitoring of actual and predicted weather conditions. The Emergency Response Plan will also identify specific actions to be taken in the event of extreme weather. These actions may include the suspension of operations, lowering the seismic gear to a greater depth to avoid potential impacts or damage by wave action, retrieval of gear and/or moving the vessels in advance of a storm’s approach to a safe location either within or outside of the Project Area.

Effects of the biological environment on the Project are unlikely although there are anecdotal accounts of sharks damaging streamers. As discussed in Section 2.3, only solid streamers will be used for the Project thus mitigating the potential for spills from shark bites.

It is expected that vessels and equipment would be based on appropriate environmental design criteria to ensure integrity of the vessels and safety and protection of workers and the natural environment (Stantec 2012a). In summary, with appropriate monitoring and mitigation measures, the residual effects of the environment on the Project are predicted to be not significant.
10.0 Cumulative Effects

Cumulative environmental effects assessments address potential significant adverse effects from past, present and reasonably foreseeable projects (Hegmann et al. 1999). A cumulative effects assessment attempts to ensure that the sum of potential effects from multiple activities on a VEC is evaluated; it is possible that a number of individually-assessed insignificant effects may additively become significant.

This section provides a qualitative assessment of cumulative effects from the Project in combination with other users and activities, with an emphasis on other seismic programs, military operations and increased vessel presence as stipulated in the Scoping Document. The primary geographical boundary for this assessment is the Study Area. However, wider spatial boundaries will be used where necessary to evaluate potential cumulative effects. Examples of this include DND Operations Areas and shipping in and out of ports such as Halifax (even though Halifax is outside the Study Area).

The Scoping Document requires BP to assess the “potential cumulative effects of their activity and other significant sources of sound in the marine environment, such as other seismic programs and military exercises, as well as the cumulative effects of increased vessel presence as a result of the project on the above listed VECs” (CNSOPB 2013). This assessment therefore focuses on existing and reasonably foreseeable projects, as opposed to past projects, which is the standard approach used for EAs subject to approval by the CNSOPB. Reasonable foreseeable projects include those which have been posted on the CNSOPB or CEAA Public Registries, and any other projects that have been publicly announced.

Other ocean users relevant to the Study Area are described in Section 7.3 of this EA. The SEAs for the Scotian Slope (Hurley 2011; Stantec 2012a,b) provide summaries of cumulative effects on Species of Special Status and Special Areas from the following activities:

- Commercial fishing;
- Vessel traffic (e.g., commercial shipping, cruise ships and tourism, scientific research surveys);
- Military operations;
- Offshore oil and gas;
- Offshore mining;
- Offshore renewable energy projects; and
- Subsea pipelines and cables.

At the time of submission of this EA, there were no existing or planned marine mining operations in the east coast offshore and no marine mining management regime. There are no reasonably foreseeable cable placement projects planned for the Study Area. The Maritime Link
transmission project between Cape Breton and Newfoundland is over 300 km away. Similarly, there are no existing proposals for offshore renewable energy projects (such as wave, wind and tidal) in the Study Area. Marine mining, offshore renewable energy and underwater cables are not considered further.

### 10.1 Commercial Fishing

Commercial fishing has been assessed in detail in Section 7.3.1. Commercial fishing activities, by their nature, cause mortality and disturbance to fish populations and may cause incidental mortalities or disturbance to seabirds, marine mammals, and sea turtles. With mitigation measures in place, it is judged that the Project is unlikely to cause any additional mortality to these VECs. There is some potential for cumulative effects on marine mammals and sea turtles from disturbance (e.g., fishing vessel sound, vessel presence). There will be directed attempts by fishing groups and BP to avoid each other’s active areas and times. As a result of these coordination measures, residual cumulative effects are judged to be not significant.

### 10.2 Vessel Traffic

Vessel traffic in the Study Area is discussed in Section 7.3.2 (Other Ocean Users VEC: Marine Shipping) of this EA. The primary ecological interactions related to marine navigation are the potential release of ship-source pollutants and discharges (including oil and ballast water), underwater sound (continuous, low-frequency) from vessels, and vessel interactions with cetaceans (DFO 2008). Collisions with ships may cause marine mammal or sea turtle mortality or serious injury, particularly for vessels exceeding 14 knots travel speed.

Birds may also strand on ocean-going vessels. Petrels in particular could become stranded on the Project vessels and other vessels transiting through the Study Area. The potential cumulative loss or injury to petrels is expected to be very low, affecting a negligible proportion of the petrel population of the Scotian Shelf and Scotian Slope. Significant adverse cumulative effects from injury or mortality of petrels are not anticipated.

With mitigation measures in place, it is judged that the Project is unlikely to cause mortality to these VECs (with the potential exception of small numbers of petrels). The Project Area is approximately 75 to 100 km seaward of the highest concentrations of marine traffic off Nova Scotia, and the number of vessels transiting through the Project Area is comparatively low (see Figure 7.23). Given these distances, it is unlikely that Species of Special Status would be affected by non-Project vessel sound. Cruise ship traffic may increase to Sable Island, but it is unknown at this time by how many vessels given the isolated location of the island, and challenging navigational conditions around the island. The seismic vessels used for the WATS and NATS surveys will be moving at a comparatively slow speed (4.5–5 knots), and will have observers and a PAM system in place, thus reducing the potential for ship collisions with marine mammals or other
vessels. It is judged that residual cumulative effects on Species of Special Status from increased vessel traffic as a result of the Project will be *not significant*.

### 10.3 Military Operations and Other Oil and Gas Projects

Military operations in and near the Study Area are described in Section 7.3.4. The proposed Project will not come into contact with the sea bottom, therefore, disturbance of unexploded munitions and shipwrecks are not expected to occur. DND will be consulted prior to the commencement of seismic operations to assist in avoiding military operations. In addition, there are no reasonably foreseeable DND operations in the Project Area including those that may use military sonar; therefore, residual cumulative effects are judged as *not significant*.

In addition to this Project, offshore oil and gas industry projects listed on the CNSOPB public registry (www.CNSOPB.ns.ca as viewed 6 December 2013) include:

- Sable Offshore Energy Project (ExxonMobil)
- Deep Panuke Project (Encana)
- Shelburne Geohazard Seismic Survey (Shell)
- Shelburne Basin Venture Exploration Drilling Project (Shell)

The Deep Panuke Project, located ~20 km north of the NATS East Area, has commenced production operations, and is not considered a “significant” source of sound in the marine environment. The NATS East Area is also adjacent to the existing Sable Offshore Energy Project’s Alma platform. The Alma platform is a small satellite production platform, and is not considered a “significant” source of sound in the marine environment. The seismic vessel used during the NATS survey will avoid the Alma platform and respect the 500 m safety exclusion zone.

The CNSOPB has issued four licences to BP and eight licences to Shell Canada Ltd. during the past two years for a total work expenditure bid of nearly two billion Canadian dollars. The issuance of 12 exploration licences in the Nova Scotia offshore (to two operators) may result in one or two seismic programs per year, and one to three exploration wells per year, the latter only likely commencing in 2015. Each project will require an EA, including an assessment of cumulative effects. Seismic programs will require mitigation such as the use of safety zones and ramp-up as set out in the Statement of Canadian Practice.

Shell proposes to conduct a geohazard survey program in 2014, which will consist of a multi-beam echo sounder (MBES) survey over a large portion of their licences to the west and

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7 This was the only new project listed in the CEAA Registry (as of 6 December 2013) that was located in or near the Nova Scotia offshore area.
adjacent to BP’s licences (Figure 10.1). There is some concern that operation of a MBES has recently been linked to a mass stranding of melon-headed whales (*Peponocephala electra*; Southall et al. 2013). During May-June 2008, ~100 melon-headed whales entered and stranded in the Loza Lagoon system in northwest Madagascar at the same time that a 12 kHz MBES survey was being conducted ~65 km of the coast. An independent scientific review panel reviewed all of the available information and concluded that the Kongsberg EM 120 MBES was the most plausible trigger of the stranding (Southall et al. 2013). Southall et al. (2013) noted that sounds from the MBES exceeded 120 dB re 1 µPa across a swath of 30–35 km, but that odontocetes would have heard the MBES sounds at farther distances (Southall et al. 2013). Given the location of the Shell survey area well offshore Nova Scotia away from coastal areas where marine mammals could strand, the spatial separation between BP and Shell activities, and that Shell will implement appropriate mitigation measures to minimize effects of sound emitted by the MBES8, no significant cumulative effects are expected on VECs, including marine mammal and sea turtle Species of Special Status.

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Figure 10.1. BP and Shell’s Licences on the Scotian Slope (Source: CNSOPB website http://www.cnsopb.ns.ca/sites/default/files/pdfs/web_map_slope_zoom.pdf).

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8 Note that multi-beam echosounders operate at much higher frequencies (e.g., 12 kHz, 30 kHz, 100 kHz, 300 kHz) than airgun arrays.
Shell has not announced any additional 3D seismic programs. Shell is proposing an exploration drilling program of up to seven wells from 2015 to 2019. The initial campaign will include drilling up to three wells commencing in Q2 2015. The drilling program project area extends from EL 2424 to EL 2426, overlapping the western portion of BP’s Project Area. A dynamically positioned (DP) drillship or semi-submersible rig will drill the wells, supported by two to three support vessels (Shell Canada Limited and Stantec Limited 2013). The drilling project will therefore add sound from the wellhead, thrusters and support vessels (and potentially from a vertical seismic profile) to the marine environment, and the presence of a drilling rig and support vessels to the western Scotian Slope.

There will be no overlap with Shell’s drilling project in 2014. There may be a temporal overlap in 2015. The rig will be in a fixed location for several months during the drilling of a particular well, and vessel traffic will be restricted to a transit every few days, therefore significant adverse cumulative effects from increased vessel traffic are not anticipated. Sound from the rig will only reach levels which could result in adverse effects on marine mammals and sea turtles within a localized area around the rig. It is conceivable that petrels may be stranded on the rig, however Shell will be expected by the CNSOPB to conduct searches for stranded birds, and to follow CWS protocols for their handling. Significant adverse cumulative effects are not anticipated.

10.4 Summary

BP’s Project Area is outside any Special Area with existing management designation (with the exception of small overlap with the Haddock Box); therefore, the Project is not expected to increase vessel presence in Special Areas. As discussed in this EA, potential adverse effects on key VECs such as marine mammal and sea turtle Species of Special Status may occur within a localized area from the sound source. In addition, seismic programs will use mitigation measures such as ramp-ups, delayed start-ups, and shutdowns of the airgun arrays. Thus, while some animals may detect sound from one or more geophysical or drilling programs and possibly from commercial or military vessels transiting through or near the Study Area, the current judgement is it that any cumulative disturbance effects will be minor to moderate, over a short-term duration of 1-12 months, and a geographic extent ranging from 101-1,000 km$^2$ to 1,001-10,000 km$^2$ and that residual effects will be not significant.
11.0 Monitoring and Observation Procedures, and Reporting

This section describes the monitoring approach and observation procedures for marine mammals, sea turtles and seabirds, and reporting requirements, as required in Section 8 of the Scoping Document (Appendix B).

11.1 Marine Mammals and Sea Turtles

11.1.1 Visual and Acoustic (PAM) Monitoring

BP developed a project specific marine mammal monitoring management plan and is conducted an associated workshop with the seismic planning team of contractors. Three marine mammal observers, each proficient at PAM will be on board each seismic survey vessel. Each vessel will have one lead MMO, one intermediate MMO, and one junior MMO. Lead MMOs have previous MMO experience on seismic surveys and have demonstrated leadership on previous projects. Intermediate MMOs have previous experience on seismic surveys and juniors are new to marine mammal observations on seismic survey vessels.

MMOs are ultimately responsible for marine mammal observations, data collection, and reporting throughout the monitoring program. MMOs will provide guidance to WesternGeco on the monitoring and mitigation measures established in the Canadian Statement of Practice and the project EA. It is important to remember that all MMOs on board are part of a team and aid each other when practical in order to complete the monitoring objectives.

MMOs with previous research experience related to beaked whales, either through direct field studies or through photo-identification and acoustic data analysis will be placed on the project and will offer guidance to other MMOs with less experience with beaked whale observation. The lead seismic vessel for the survey, the Western Neptune, will have one MMO with beaked whale experience.

Visual observations for marine mammals will be conducted by trained MMOs during daylight hours with good visibility using both the naked eye and binoculars of 8 to 12 times magnification. Observations are conducted from the bridge wings, where the complete safety zone (360°) can be viewed with minimal obstruction; however other suitable locations such as the helideck may be used. Distance to observed marine species is estimated by using known reference distances (distance astern of the seismic equipment, distance to other vessels if in a wide azimuth setting, etc.) or by using reticle binoculars. Species are identified based upon physical characteristics and behaviours. Identification is facilitated by consulting relevant field guides or by observer experience.

Upon making a visual detection, the MMO will determine whether the presence of the marine species immediately warrants a mitigation action. The MMO will maintain visual contact with the animal until the marine mammal can no longer be observed, whether because the animal has
dived or the distance at which the MMO could maintain visual contact has been exceeded. Mitigation actions will be implemented when appropriate and will be made direct to the WesternGeco seismic observers located in the instrument room by handheld radio or by the intra-vessel phone system. Notes on the detection, such as behaviour of the animal, distance to the animal from the seismic source, bearing to the animal, animal direction of travel, number of individuals, etc., as well as other notable events or observations are kept by the MMO throughout their monitoring shift in a notebook and later transcribed into an electronic log and associated data forms. Details on operations, vessel position, and weather conditions are also recorded during the monitoring shift.

MMOs will advise the appropriate vessel personnel of any occurrences of marine mammals and sea turtles observed within the designated safety zone of each seismic vessel. MMO duties will include watching for and identifying marine mammals and sea turtles; recording species, numbers, distances and responses (behaviour) to the seismic operations; recording seismic operation details; recording environmental conditions (e.g., sea state, visibility, water depth); initiating mitigation measures when appropriate (see Section 12); and reporting the results. Data will be entered in an electronic database that is error-checked.

PAM will be used to detect marine mammals during periods of poor visibility (e.g., darkness, fog) and during the pre-ramp up watch. If a marine mammal is detected acoustically during the pre-ramp up watch, ramp up will be delayed (see Section 12). In consideration that the 2014 acquisition survey will commence in the north of the WATS area, which coincides with the shelf break, and seasonally will be subject to frequent fog occurrence, PAM will be expected to be in use for extended periods during the first few months.

PAM will be implemented on each of the source vessels in order to monitor the area around each source. Communication protocols will also be established between vessels to combine PAM detection data from each of the vessels in order to provide an acoustic monitoring capability across the operational area.

Towed PAM provides an additional monitoring capability to detect the presence of marine mammals at sea and estimate their location relative to a hydrophone array being towed from a moving vessel. Marine mammal species are identified and located based on interpretation by the PAM Operator of the specific characteristics of the detected sounds.

A typical PAM system uses a towed hydrophone array section to detect marine mammal vocalization signals, which is connected via a tow and deck cable to a data processing and monitoring station comprising a computer with two monitors or two laptops (and headphones) with pre-loaded PAMGuard (or alternative) software that has been designed to detect marine mammal vocalizations. Acoustic monitoring is typically conducted from the instrument room, but other locations. Additional ‘repeater’ monitors may also be located on the vessel bridge to enable integration of acoustic and visual monitoring personnel resources. Hydrophone signals
are processed and displayed to enable the PAM Operator to estimate location of the detection and identify species where possible. Range estimates are obtained by analyzing the bearings to vocalizations and looking for concentrated areas of cross-bearings.

PAMGuard software on each vessel will be pre-set up to monitor for the full range of frequencies utilized by the species anticipated in the survey area. Two click detectors will be incorporated, one for low/mid frequency clicks produced by delphinids and sperm whales and one for high frequency clicks produced by delphinids, *Kogia*, phocoenids, and beaked whales. General classifiers for beaked whales, phocoenids, and *Kogia* will be included in the high frequency click detector. Click waveforms, spectrums, and Wigner plots are also available through the click detector for further analysis and potential identification/confirmation of cetacean group or in some cases species. Two tonal detectors or whistle and moan detectors will also be incorporated to the PAMGuard configuration. One whistle and moan detector will be configured to detect low frequency tonal calls from baleen whales and the second will be configured to detect low/mid frequency whistles. The detectors do often mark non-biological sources as clicks and/or tones, so it is important that an operator maintain focus while monitoring.

Information from both the click detector and whistle and moan detector will be used to provide details on bearing to the vocalizing cetacean. Bearings are plotted on the map module, which can then be used to estimate range. It should be noted that whilst PAM software offers some level of automatic detection, classification and localization capability, similar to visual monitoring methods, overall performance of a PAM system is also dependent on the ability and judgment of the Operator.

Confirmation of detections and estimation of location and classification will be made based on the expert judgment of the PAM Operator. Upon making an acoustic detection of marine mammal vocalizations, based upon the characteristics of the vocalization and mitigation criteria, the operator will determine whether the detection immediately warrants a mitigation action. The operator will continue to monitor for vocalizations to better assess range to vocalizing marine mammals until vocalizations are no longer detected aurally or via user interface display.

PAM detection data will be collected, as will screen images of the PAMGuard visualization modules. Archiving of audio recording data will be very limited in order to help maximize computing efficiency for real-time monitoring purposes. Notes on the detection, as well as other notable events or observations are kept by the operator throughout their monitoring shift. Details on operations, vessel position, and weather conditions are also recorded during the monitoring shift.

A PAM system’s frequency range is typically from 10s Hz up to over 100kHz in order to enable coverage of the marine mammals of interest expected to be present in the survey area. The effective ‘listening’ frequency range under operational conditions is determined by the presence and characteristics of ambient acoustic noise relative to animal vocalisations.
Deployment methods and the physical location of the PAM hydrophones relative to the source array will vary between vessels in order to reduce the risk of entanglement with other deployed equipment. The listening performance of the PAM system will be optimized for the given towing capabilities of each vessel during mobilisation in the field.

Any marine mammal incidents as a result of this survey program (e.g., ship strikes, entanglements, injuries, mortalities of any species) will be reported immediately to the Marine Animal Response Society (MARS: 1-866-567-6277) or via the Coast Guard Emergency VHF channel 16. The latter contact applies when beyond cell phone range. Photographs and information will be collected and submitted to MARS.

A marine mammal monitoring management plan will be prepared prior to Project start up, and submitted to the CNSOPB for review and comment.

11.1.2 Marine Mammal Observer and PAM Operator Training and Experience

BP is working collaboratively with the contracting partners engaged to provide both the seismic and MMO services to ensure experienced visual observers and PAM System are available. Lead MMOs will have relevant marine mammal observation experience, either through previous work on seismic survey vessels, academic research, or through ecotourism/walke watching and will provide guidance to individuals with less observer experience. Preference will be given to MMOs that have a background in marine biology, wildlife biology, biology, fisheries, or environmental management/science.

All PAM Operators will have completed a PAM training course and have previous experience as an operator on seismic survey vessels. Where possible, the operators will have completed the contractor’s internal three day training course, which includes theory and hands-on software and hardware training. Preference will be given to PAM operators will have a background in marine biology, wildlife biology, biology, fisheries, or environmental management/science. Individuals serving as a MMO will complete a PAM tutorial covering basic cetacean acoustics, detection software, and range estimation as a minimum.

11.2 Seabirds

11.2.1 Standardized Counts

Seabird surveys, i.e., standardized counts (as required by Environment Canada), will be conducted throughout the seismic program from the seismic vessels by MMOs/SBOs experienced in the identification of seabirds at sea and in the use of Environment Canada seabird survey protocols. Protocols modified and approved for use from ships at sea by Environment Canada as outlined in the Eastern Canada Seabirds at Sea (ECSAS) Standardized Protocol for Pelagic Seabird Surveys from Moving and Stationary Platforms will be utilized for all seabird counts (Gjerdrum et al. 2012).
These protocols will be included as part of observer orientation/training. A schedule of conducting seabird surveys (likely three times per day) at widely spaced intervals will be followed. Surveys can only be conducted when visibility is >300 m and adequate light conditions permit positive species identification.

Using the moving platform survey method, each survey will be 10 minutes in length along a transect area 300 m wide. The transect length depends on the speed the vessel maintains during the 10-minute survey period. Note that in previous discussions with CWS, a 10-minute count duration was deemed appropriate for surveying from seismic vessels given the periodic versus continuous nature of the seabird counts (B. Mactavish, LGL Limited, pers. comm., December 2013). Within the 300 m band, all birds on the water will be counted but only flying birds observed during snapshot counts will be included in the count. An instantaneous snapshot count will be taken every time the vessel travels 300 m. From these counts, bird densities can be derived for various species.

11.2.2 Monitoring for Stranded Birds

A MMO/SBO aboard each seismic vessel will routinely patrol the ship for stranded birds each day (typically early in the morning). Leach’s Storm-Petrel, a species prone to stranding on ships operating at night in northwest Atlantic waters, is the species most likely to strand. Similarly, designated and trained ship crew, will conduct daily searches for stranded birds aboard the picket and supply vessels. Any stranded birds will be handled and released under a CWS Migratory Bird Handling Permit using protocols developed by the CWS and Petro-Canada (Williams and Chardine, n.d.).

11.3 Routine Operational Reporting

BP will meet reporting requirements as outlined in Section 8 of the Scoping Document. Weekly reports will be submitted to the CNSOPB (and posted on its public registry) throughout the seismic programs, which include a summary of marine mammal, seabird, and sea turtle observations and any shut down or ramp up delay occurrences due to marine mammals or sea turtles. In addition, any shut downs due to a marine mammal or sea turtle detected within the safety zone will be reported to the CNSOPB within 24 hours of the occurrence. In all reports, species at risk will be identified.

A monitoring report detailing all observations (marine mammal, sea turtle, and seabird) will be submitted to the CNSOPB following completion of the WATS and NATS survey and this report will be posted on the CNSOPB public registry. Following the monitoring programs, copies of the marine mammal and sea turtle sightings data will be provided to DFO. Environment Canada will be provided with “raw” seabird count data. Data compiled on stranded seabirds will be submitted to CWS as part of the CWS Migratory Bird Handling Permit.
12.0 Assessment Summary

A detailed summary of all mitigation measures, commitments and/or follow-up monitoring is provided below as required in Section 11 of the Scoping Document (Appendix B). Mitigation and monitoring commitments were specifically developed through BP’s Management of Geophysical Operations Process (MOGO). This internal cross-disciplinary planning procedure considers health, safety and the environment. Table 12.3 at the end of this section includes a summary of effects assessment for Project activities made for each VEC, as well as a summary of mitigation measures.

12.1 Marine Mammals/Sea Turtles and Airgun Array Sound

BP is committed to the mitigation measures and monitoring requirements as outlined in the Statement of Canadian Practice with Respect to the Mitigation of Seismic Sound in the Marine Environment (i.e., Statement of Canadian Practice), as well as the additional requirements for marine mammals noted in the Scoping Document and those developed during the BP MOGO process. The proposed mitigation measures and monitoring commitments specific to marine mammals and sea turtles are reviewed below.

12.1.1 Ramp Up

As per the Statement (Section 7b), prior to the onset of seismic surveying, the airgun array will be gradually ramped up. The smallest airgun in the array will be activated first with the gradual activation of additional airguns over a minimum 30-minute period until the operational volume of the array is reached.

12.1.2 Line Changes

The Statement (Section 9) requires that airgun arrays are either shut down completely or reduced to a single airgun. BP will require that all airgun arrays are shut down during line changes to minimize the amount of airgun sound introduced into the water column. Note however, that during some line changes individual airguns may be activated for maintenance or other operational purposes. Airguns will not be activated in the Haddock Box. During the WATS and NATS surveys, line changes will be 5–5.5 hours and 2–3 hours in duration, respectively.

12.1.3 Selection of a Safety Zone for Shut Downs and Ramp Up Delays

The Statement of Canadian Practice (Section 6a) requires that a proponent “establish a safety zone which is a circle with a radius of at least 500 m as measured from the centre of the air
BP has undertaken acoustic modelling of the 5,085 in³ airgun array to assess sound levels and to assist in determining precautionary safety zones for its WATS and NATS surveys. BP’s objective is to meet Canadian regulatory requirements and to minimize the risk of exposing marine mammals and sea turtles to sound levels that may elicit hearing impairment.

Given the large differences in propagation characteristics in the shallower areas of the NATS survey area versus the deeper WATS survey area, modelling results have been considered separately for the purposes of establishing safety zones. The practice of accounting for regional differences in acoustic propagation when determining safety zones for marine mammals is regularly used for seismic surveys in the Canadian Beaufort Sea (see Moulton et al. 2009; Upun-LGL 2012).

Available information on airgun sound and hearing impairment (PTS and TTS) in marine mammals is reviewed in Section 1.6 of Appendix D. As summarized previously in Section 4.2.1.2, an expert committee convened by the U.S. NMFS has studied the issue of marine mammal sound exposure criteria and made some initial scientific recommendations for criteria to be used (Southall et al. 2007; see Appendix D for further details). In Canada, DFO has not formulated new policy directions in response to Southall et al. (2007). Southall et al. (2007) defined minimum exposure criteria for injury as the level at which a single exposure is estimated to cause onset of permanent hearing loss (or PTS). The committee recommended that cetaceans should not be exposed to RLs of ≥198 dB re 1 μPa²·s (SEL, M-weighted) or 230 dB re 1 μPa (peak SPL, flat or unweighted) from pulsed sound (either single or multiple pulses). Corresponding TTS criterion (used as the basis for establishing PTS criterion) for cetaceans as presented in Southall et al. (2007) is ≥183 dB re 1 μPa²·s (SEL, M-weighted) and 224 dB re 1 μPa (peak SPL, flat weighted).

Prior to Southall et al. (2007), the NMFS recommendation was that cetaceans should not be exposed to RLs from pulsed sounds of 180 dB rms in order to avoid TTS. As described in Appendix D, this criterion was established before there was any information about the minimum received levels of sounds necessary to cause auditory impairment in marine mammals and is likely precautionary for most cetaceans, including the low-frequency (right, blue, and fin whales) and mid-frequency (northern bottlenose whales and Sowerby’s whales) cetaceans considered Species of Special Status in this EA. NMFS is currently moving toward adoption of new procedures taking at least some of the Southall et al. recommendations into account (Scholik-Schlomer 2012; NMFS 2013). The new noise exposure criteria for marine mammals will account for available data considered in Southall et al. and subsequent scientific data on TTS, the expected offset between the TTS and PTS thresholds, differences in the acoustic frequencies to

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9 The Statement and its corresponding Background Paper do not provide the specific objective of establishing the safety zone or rationale for using 500 m. It is uncertain if DFO’s objective in the Statement in specifying a 500-m safety zone is to minimize the risk of auditory injury (i.e., Permanent Threshold Shift = PTS) or both PTS and Temporary Threshold Shift (TTS), or something else (see Moulton et al. 2009).
which different marine mammal groups are sensitive (e.g., M-weighting or generalized
frequency weightings for various groups of marine mammals, allowing for their functional
bandwidths), and other relevant factors.

Given that recommendations provided in Southall et al. (2007) considered best available
scientific data, the criteria for hearing impairment provided in that document was used as the
basis for establishing a safety zone for marine mammals. Details are provided below.

12.1.3.1 WATS Survey

Based on acoustic modelling results of the 5085 in³ array, SELs ≥198 dB re 1 μPa² · s (PTS
criterion for low- and mid-frequency cetaceans) are predicted to occur within 50 m of the airgun
array (unweighted and M-weighted) at all modelling sites in the WATS Survey Area (Table
12.1). RLS ≥183 dB SEL (TTS criterion for low- and mid-frequency cetaceans) from the airgun
array are predicted to occur at maximum horizontal distances of about 300 m and <50 m for
LFCs and MFCs, respectively, in the WATS survey area (Table 12.1). Based on these results, the
commitment to adhere to the Statement of Practice (Section 6a—requirement for a minimum
safety zone of 500 m from the centre of the airgun array), and the operational design of the
WATS vessel fleet, a 600 m safety zone will be used during the WATS survey. The larger and
hence, more precautionary 600 m safety zone was selected given that the distance between each
of the five seismic vessels is 1200 m (i.e., the midway point between two adjacent seismic
vessels is 600 m). Therefore, if a cetacean is detected amongst the fleet of seismic vessels, a
shutdown will be initiated (as appropriate—see Section 12.1.4) and/or a ramp up procedure will
be delayed (see Section 12.1.5). This should allow a marine mammal the opportunity to move
away from one airgun array and to avoid exposure to sound levels that may cause hearing
impairment from an airgun array towed by an adjacent seismic vessel in the WATS fleet.

Table 12.1. Maximum horizontal distance estimates (Rmax, m) from the airgun array to modelled sound
level thresholds (198 dB SEL, 190-180 dB SEL) at modelling sites within the WATS survey area. Distance
estimates are provided for April and August, without (unweighted) and with M-weighting applied for low-
frequency cetaceans (LFC) and mid-frequency cetaceans (MFC).

<table>
<thead>
<tr>
<th>Marine Mammal Group</th>
<th>SEL (Rmax)</th>
<th>Distance Estimate (m) in WATS Survey Area</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Site 1</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Apr</td>
</tr>
<tr>
<td>Unweighted</td>
<td>198</td>
<td>&lt; 50</td>
</tr>
<tr>
<td></td>
<td>190-180</td>
<td>71-316</td>
</tr>
<tr>
<td>LFC</td>
<td>198</td>
<td>&lt; 50</td>
</tr>
<tr>
<td></td>
<td>190-180</td>
<td>71-292</td>
</tr>
<tr>
<td>MFC</td>
<td>198</td>
<td>&lt; 50</td>
</tr>
<tr>
<td></td>
<td>190-180</td>
<td>&lt; 50</td>
</tr>
</tbody>
</table>

Note: See Tables 9-20 in Appendix A for modelling results for HFC and pinnipeds in water. These
results are not presented here given that the Statement of Practice requires shutdowns for species listed
as Endangered or Threatened on Schedule 1 of SARA—currently, there are no HFC or pinniped species listed on Schedule 1 of SARA that occur in the Study Area.

12.1.3.2 NATS Survey

It is anticipated that the 5085 in$^3$ airgun array will also be used during the NATS survey in 2015. Based on acoustic modelling results, SELs $\geq$198 dB re 1 $\mu$Pa$^2$·s (PTS criterion for low- and mid-frequency cetaceans) are predicted to occur within 50 m of the airgun array (unweighted and M-weighted) at all modelling sites in the NATS survey areas (Table 12.2). RLs $\geq$183 dB SEL (TTS criterion for low- and mid-frequency cetaceans) from the airgun array are predicted to occur at maximum horizontal distances of about 300 m and <50 m for LFCs and MFCs, respectively, based on modelling results for three of the four modelling sites in the NATS survey areas (Table 12.2). The exception is Site 3, which is located in shallow shelf waters (100 m water depth). At Site 3, RLs $\geq$183 dB SEL from the airgun array are predicted to occur at maximum horizontal distances of about 650 m and <50–100 m for LFCs and MFCs, respectively (Table 12.2).

Based on these results and the commitment to adhere to the Statement of Practice (Section 6a—requirement for a minimum safety zone of 500 m from the centre of the airgun array), a 700 m safety zone will be used during the NATS survey. The application of the larger safety zone throughout the NATS survey area is considered precautionary given that only 6.6% and 10.7% of NATS West and NATS East survey areas, respectively, have water depths <100 m. Most of the NATS survey areas have deeper waters where sound levels $\geq$183 dB SEL from a single airgun array pulse are predicted to occur within about 300 m of the airgun array.

Table 12.2. Maximum horizontal distance estimates (R$_{max}$, m) from the airgun array to modelled sound level thresholds (198 dB SEL, 190-180 dB SEL) at modelling sites within the NATS survey areas. Distance estimates are provided for April and August, without (unweighted) and with M-weighting applied for low-frequency cetaceans (LFC) and mid-frequency cetaceans (MFC).

<table>
<thead>
<tr>
<th>Marine Mammal Group</th>
<th>SEL (R$_{max}$)</th>
<th>Distance Estimate (m) in NATS Survey Areas</th>
</tr>
</thead>
<tbody>
<tr>
<td>Site 3</td>
<td>Site 4</td>
<td>Site 5</td>
</tr>
<tr>
<td></td>
<td>Apr</td>
<td>Aug</td>
</tr>
<tr>
<td>Unweighted</td>
<td>198</td>
<td>&lt;50</td>
</tr>
<tr>
<td></td>
<td>190-180</td>
<td>150-700</td>
</tr>
<tr>
<td>LFC</td>
<td>198</td>
<td>&lt;50</td>
</tr>
<tr>
<td></td>
<td>190-180</td>
<td>112-652</td>
</tr>
<tr>
<td>MFC</td>
<td>198</td>
<td>&lt;50</td>
</tr>
<tr>
<td></td>
<td>190-180</td>
<td>&lt;50-100</td>
</tr>
</tbody>
</table>

Note: See Tables 9-20 in Appendix A for modelling results for HFC and pinnipeds in water. These results are not presented here given that the Statement of Practice requires shutdowns for species listed as Endangered or Threatened on Schedule 1 of SARA—currently, there are no HFC or pinniped species listed on Schedule 1 of SARA that occur in the Study Area.
If array parameters change for the 2015 NATS seismic survey to an extent that requires re-modelling, BP will update the associated modelling and subsequently modify the safety zone. BP will also consider using new NMFS (or DFO) recommendations based on relevant science regarding hearing impairment in marine mammals should they become available prior to the 2015 NATS survey.

12.1.4 Delay of Ramp Up

A pre-ramp up visual watch of 30 minutes (minimum) will be conducted before the start of any airgun operations. In addition, PAM will be used to monitor for vocalizing marine mammals within the safety zone during this pre-ramp up period. [As noted in Section 10.1.1, PAM will also be used during periods when the full safety zone is not visible and also during other periods the airguns are active to supplement visual observations.]

As detailed above, safety zones of 600 m and 700 m will be used during the WATS and NATS surveys, respectively. If any marine mammal (cetaceans and seals) or sea turtle is detected within the safety zone during the pre-ramp up watch, the ramp-up will be delayed until the animal has been observed outside of the safety zone or 30 minutes has passed since the animal was last detected inside the safety zone. Similarly, if any marine mammal is acoustically detected within the safety zone during the pre-ramp up watch period, the ramp-up will be delayed until the animal has been detected outside of the safety zone or 30 minutes has passed since the animal was last detected inside the safety zone. If a beaked whale species is detected (visually or acoustically) within the safety zone during the pre-ramp up watch period, the ramp up will be delayed for 60 minutes or until the animal has been detected outside the safety zone (as per Section 6.1 of the Scoping Document). A longer pre-ramp up watch for beaked whales was requested by DFO in consideration of the longer dive times for beaked whales.

12.1.5 Shut Downs

Airguns will be temporarily shut down if a marine mammal or sea turtle species listed as Endangered or Threatened on Schedule 1 of SARA (i.e., right whale, blue whale, northern bottlenose whale, and leatherback sea turtle), is observed within the applicable safety zone (600 m for the WATS survey and 700 m for NATS survey). Airgun activity will not resume unless the marine mammal or sea turtle has been observed to leave the safety zone or 30 minutes has passed since initial detection. If the species observed within the safety zone is a beaked whale, airgun activity will not resume unless the animal is observed to leave the safety zone or 60 minutes has passed since initial detection. A longer delay time before ramp up is initiated is required for beaked whales given the longer dive times for beaked whales.
12.2 Special Areas

The primary mitigation measure to minimize effects on Special Areas assessed in the EA is spatial avoidance (see Figure 7.4). BP’s seismic surveying activities do not overlap with The Gully, which includes northern bottlenose whale Critical Habitat. The Project Area and WATS survey area are 45.7 km and 67.8 km from the Gully MPA, respectively. Similarly, disturbance effects on marine animals around Sable Island National Park Reserve will be minimized because of spatial avoidance and airguns will be shut down during line changes. BP will adhere to ExxonMobil Canada and the Encana Code of Practice for Sable Island.

The WATS survey area is 31.9 km from the Haddock Box—this minimizes airgun array sound in this Special Area. The northern boundary of the NATS West survey area borders the Haddock Box and although no seismic data acquisition will occur in the Haddock Box, seismic vessels will turn around in this Special Area. To minimize effects in the Haddock Box during the NATS survey, airguns will be shut down during line changes.

12.3 Lighting and Stranded Birds

Deck lighting will be minimized (especially upward and horizontal-projecting light) to the extent that it is safe and practical to reduce the likelihood of birds stranding on Project vessels. Daily searches of Project vessels will be conducted by trained personnel for stranded birds (as described in Section 10.2.2). Project personnel will be made aware of bird attraction to the lights on offshore structures. However, certain levels of lighting are required for safe work practices as seismic surveying is conducted around the clock.

Any seabirds (most likely Leach’s Storm-Petrel) that become stranded on a Project vessel will be released using the mitigation methods consistent with The Leach’s Storm-Petrel: General Information and Handling Instructions by U. Williams (Petro-Canada) and J. Chardine (CWS) (n.d.). It is understood by BP that a CWS Migratory Bird Handling Permit will be required and this will be obtained prior to survey start.

12.4 Fisheries Interactions

BP has started engagement with potentially affected fishing groups (see Appendix C) and will continue to communicate project information to ensure coordination of activities. Good communication between fishers and seismic surveyors can mitigate the potential for conflict by enabling temporal and spatial adjustment of operational activities as appropriate. During the consultation process, several fishing groups (see Appendix C) requested that during the WATS survey, seismic surveying start in the north and proceed southwards. The request was made to accommodate halibut and swordfishers that fish on the shelf break in summer. BP has committed to accommodate this request. In addition, BP will provide weekly updates on seismic survey activity (including location of seismic fleet and anticipated plans) to interested fishing groups.
and communities as requested during stakeholder engagement. A Notice to Mariners and Notice to Shipping will also be issued to advise of the timing and location of survey activities.

To further minimize the potential for interaction, multiple picket vessels (maximum of three) will be sailing in front of the seismic fleet and seismic vessels will be equipped with radar to ensure early identification of any potential conflict during operations. All seismic and support vessels will be equipped with a VMS. As well, two FLO(s) will be supporting the seismic fleet. One FLO will be stationed on the lead streamer vessel (R/V Western Neptune) and other will be assigned to the other streamer vessel (R/V Western Regent). The FLOs will rotate on schedule with the pool of FLOs onshore. The FLO(s) will provide dedicated marine radio contact for all fishing vessels in the vicinity of seismic operations to discuss interactions and resolve any problems that may arise at sea. The FLO(s) will inform the vessel's bridge personnel about local fishing activities. WesternGeco vessels will also monitor for fishing gear when enroute to and from the survey area. In the event that gear is damaged or lost due to contact with the seismic configuration, the compensation claims process will be activated as per the Compensation Guidelines Respecting Damages Relating to Offshore Petroleum Activity (C-NLOPB/CNSOPB 2002) and the Guideline for the Reporting and Investigation of Incidents (C-NLOPB/CNSOPB 2009).

12.5 Interactions with Other Ocean Users

To minimize potential effects on DFO research surveys and DND offshore exercises, the key mitigation is spatial and temporal avoidance, which can be achieved with good communication as demonstrated in previous seismic programs.

Both DFO and DND were consulted by the CNSOPB and BP during preparation of this EA. As the location of future military training operations and details of DFO’s research activities are still being finalized, DND and DFO will be consulted prior to the commencement of seismic operations to further clarify any potential issues. A Notice to Mariners and Notice to Shipping will also be issued to advise of the timing and location of survey activities. BP will provide weekly updates on seismic surveying activities to DFO and DND. Multiple (maximum of three) picket vessels will be sailing in front of the seismic configuration and seismic vessels will be equipped with radar to enable early identification of potential conflict during operations. During the WATS survey, all seismic and support vessels will be equipped with a VMS.

12.6 General Ship Operations and Seismic Gear

Project vessels will steer a straight course and maintain constant and typically low speed (4.5-5 knots) whenever possible. This minimizes the risk of ship collisions with marine mammals and sea turtles. In addition, picket vessels sailing ahead of the seismic fleet will watch for marine mammals and sea turtles. Passive acoustic monitoring (PAM) will also be conducted at nighttime.
and during periods of poor visibility to further minimize the risk of ship collisions with marine mammals.

To reduce the potential of sea turtles becoming entangled in towed seismic gear, turtle guards (Ketos Ecology 2009) will be deployed on tail buoys. Tail buoys will also be equipped with radar reflectors to permit easier detection by marine traffic. The vessel work boats are deployed several times a week for inspection and maintenance on the towed gear, which also includes observation for entanglement.

In response to a vessel collision with a marine mammal or sea turtle, BP will contact DFO and the CNSOPB. Vessel personnel will provide any photographs or documentation in regards to the noted incident. BP also commits to reporting any observed entanglements or dead marine species to DFO and CNSOPB noted during the survey. Immediate written notification shall be provided to the CNSOPB via the incident reporting email address incident(cnsopb.ns.ca in the event of a marine mammal strike or turtle entanglement/strike, and immediate verbal notification shall be provided to the Marine Animal Response Society at 1-866-567-6277 or via Coast Guard Emergency VHF channel 16.

12.7 Vessel Wastes, Discharges and Air Emissions

Grey and black water, bilge water, deck drainage, discharges from machinery spaces and hazardous and non-hazardous waste material will be managed in accordance with MARPOL, CNSOPB OWTG, and WG’s waste management plan. A licenced waste contractor will be used for any waste returned to shore. Vessels will adhere to MARPOL Annex VI, Regulations for the Prevention of Air Pollution from Ships.

12.8 Malfunctions and Accidental Events

Preventative measures and plans will be in place to avoid any fuel spillage or other accidental events during the seismic program. The seismic contractor will have Shipboard Oil Pollution Emergency Plans (SOPEP) that will be reviewed by BP. Plans and measures include: spill prevention plans, crew training, proper handling and storage requirements, vessel inspections, fuel transfer plan, use of TODO® fuel hoses, secondary containment and adherence to the safety management procedures including proper bunkering procedures. Project vessels will be equipped with spill kits as appropriate.

In the unlikely event of the accidental release of hydrocarbons during the Project, BP and its seismic contractor(s) will implement the measures outlined in its spill response plan which will be filed with the CNSOPB in support of the Geophysical Work Authorization application. In addition, BP will have emergency response plans in place for the Project and these will be bridged with the seismic contractor’s response plans prior to commencement of the seismic program. BP will provide a list of the sources and volumes of petroleum products expected to be
on board all vessels to be used in the Project to the CNSOPB (as stated in Section 6.3 of the Scoping Document) prior to program start.

In the event, project equipment or accidental spills of fuel occur, a report will immediately be filed with CNSOPB and the need for follow-up monitoring assessed.

12.9 Residual Effects of the Project

A summary of the residual effects of Project activities on the environment are shown in Table 12.3. With mitigation measures in place, Project activities are judged to have *no significant residual effects* on VECs.
Table 12.3. Summary of potential interactions, effects, key mitigations, significance criteria ratings, significance ratings and levels of confidence associated with the proposed Project. (NS is Not Significant)

<table>
<thead>
<tr>
<th>VEC/Interaction</th>
<th>Potential Effects</th>
<th>Key Mitigations</th>
<th>Effect Criteria and Ratings</th>
<th>Judged Significance Rating</th>
<th>Level of Confidence in Judgment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Species of Special Status</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cetaceans (Right, Blue, Northern Bottlenose, Fin, and Sowerby’s Beaked Whales) and Sea Turtles (Leatherback) x Airgun Array Sound</td>
<td>Hearing impairment</td>
<td>Compliance with Statement of Canadian Practice</td>
<td>Negligible to Minor</td>
<td>&lt;1 month</td>
<td>&lt;1 km² to 1-10 km²</td>
</tr>
<tr>
<td></td>
<td>Disturbance</td>
<td>Delay start-up of airguns if marine mammals or sea turtles are detected within safety zone (600 m and 700 m for WATS and NATS surveys, respectively). Unless marine mammal or sea turtle observed to leave safety zone, ramp up will be delayed minimum 30 minutes for all sightings with exception of beaked whales. If beaked whale detected, ramp up will be delayed 60 minutes. Ramp-up of airguns over 30 min-period. Shut down airguns during line changes, except for maintenance requirements. Shutdown of airgun arrays for SARA listed</td>
<td>Minor to Moderate</td>
<td>&lt;1 month to 1-12 months</td>
<td>101-1,000 km² to 1,001-10,000 km²</td>
</tr>
<tr>
<td>VEC/Interaction</td>
<td>Potential Effects</td>
<td>Key Mitigations</td>
<td>Effect Criteria and Ratings</td>
<td>Judged Significance Rating</td>
<td>Level of Confidence in Judgment</td>
</tr>
<tr>
<td>--------------------------</td>
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<td>----------------------------------------------------------------------------------------------------------</td>
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</tr>
<tr>
<td></td>
<td>(Endangered, Threatened). on Schedule 1 of the <em>Species at Risk Act (SARA)</em> marine mammals and sea turtles detected inside of safety zone. Unless marine mammal or sea turtle observed to leave safety zone, ramp up will be delayed minimum 30 minutes for all sightings with exception of beaked whales. If beaked whales are detected, ramp up will be delayed 60 minutes</td>
<td>Report to the CNSOPB within 24 hours. Use of qualified MMOs on each seismic vessel to monitor for marine mammals and sea turtles during daylight seismic operations Use of PAM during periods of poor visibility and pre-ramp up watch Avoid spatial overlap with critical habitat</td>
<td>Magnitude</td>
<td>Duration</td>
<td>Geographic Extent</td>
</tr>
<tr>
<td>Wolffishes/White Shark x Airgun</td>
<td>Subtle</td>
<td>Ramp-up of airguns over</td>
<td>Negligible</td>
<td>&lt;1 month</td>
<td>&lt;1 km²</td>
</tr>
<tr>
<td>VEC/Interaction</td>
<td>Potential Effects</td>
<td>Key Mitigations</td>
<td>Effect Criteria and Ratings</td>
<td>Judged Significance Rating</td>
<td>Level of Confidence in Judgment</td>
</tr>
<tr>
<td>----------------------------------------</td>
<td>-------------------------------------------</td>
<td>---------------------------------------------------------------------</td>
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<td>-------------------------------</td>
</tr>
<tr>
<td>Array Sound</td>
<td>Behavioural effects</td>
<td>30 min-period</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cetaceans/Sea Turtles x Vessel Presence</td>
<td>Injury or mortality due to collision with ship</td>
<td>Vessels to maintain constant course and speed</td>
<td>Negligible to Minor</td>
<td>&lt;1 month to 1-12 months</td>
<td>1-10 km²</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Monitoring by MMOs/PAM system and picket vessel crew</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Use of PAM during periods of poor visibility</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sea turtles x Seismic Gear</td>
<td>Injury or mortality due to entanglement</td>
<td>Use of turtle guards on tail buoys</td>
<td>Negligible to Minor</td>
<td>&lt;1 month to 1-12 months</td>
<td>1-10 km²</td>
</tr>
<tr>
<td>Roseate Tern/Red Knot/Savannah Sparrow x Vessel Lights</td>
<td>Injury or mortality due to stranding</td>
<td>Daily monitoring of vessels by trained personnel</td>
<td>Negligible to Minor</td>
<td>1-12 months</td>
<td>11-100 km²</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Handling and release protocols and permit</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Minimize lighting if safe</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td></td>
<td></td>
<td>Spatial avoidance of Critical Habitat</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Migratory Birds x Vessel Lights</td>
<td>Injury or mortality due to stranding</td>
<td>Daily monitoring of vessels by trained personnel</td>
<td>Negligible to Minor</td>
<td>1-12 months</td>
<td>11-100 km²</td>
</tr>
<tr>
<td>VEC/Interaction</td>
<td>Potential Effects</td>
<td>Key Mitigations</td>
<td>Effect Criteria and Ratings</td>
<td>Judged Significance Rating</td>
<td>Level of Confidence in Judgment</td>
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</tr>
<tr>
<td>Gully MPA, including Northern Bottlenose Whale Critical Habitat x Airgun Array Sound</td>
<td>Hearing impairment in cetaceans, Disturbance of cetaceans</td>
<td>Spatial avoidance of Gully MPA and Critical Habitat, Compliance with Statement of Canadian Practice, Shut down airguns during line changes</td>
<td>Negligible, Minor to Moderate</td>
<td>&lt; 1 month to 1-12 month</td>
<td>NS, NS</td>
</tr>
<tr>
<td>Gully MPA, including Northern Bottlenose Whale Critical Habitat x Vessel Presence</td>
<td>Injury or mortality due to ship collision with cetacean</td>
<td>Spatial avoidance of Gully MPA and Critical Habitat</td>
<td>Negligible</td>
<td></td>
<td>NS, NS</td>
</tr>
<tr>
<td>Sable Island National Park Reserve x Airgun Array Sound</td>
<td>Hearing impairment in seals, Disturbance of seals</td>
<td>Spatial avoidance of Sable Island, Compliance with Statement of Canadian Practice, Shut down airguns during line changes</td>
<td>Negligible, Negligible</td>
<td></td>
<td>NS, NS</td>
</tr>
<tr>
<td>Haddock Box x Airgun Array Sound</td>
<td>Subtle behavioural effects</td>
<td>Ramp-up of airguns over 30 min-period, No airgun activation within the Haddock Box, Compliance with Statement of Canadian</td>
<td>Negligible to Minor</td>
<td>&lt;1 month</td>
<td>NS</td>
</tr>
<tr>
<td>VEC/Interaction</td>
<td>Potential Effects</td>
<td>Key Mitigations</td>
<td>Effect Criteria and Ratings</td>
<td>Judged Significance Rating</td>
<td>Level of Confidence in Judgment</td>
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</tr>
</tbody>
</table>
| Scotian Slope/Shelf Break EBSA x Airgun Array Sound | Subtle invertebrate and fish behavioural effects | Ramp-up of airguns over 30 min-period  
Compliance with Statement of Canadian Practice. | Negligible  
<1 month  
101-1,000 km² | NS | High |
| Other Ocean Users | Behavioural effects potentially resulting in reduced catch rates | Temporal and spatial avoidance, to the extent possible (e.g., seismic surveying to be conducted from north to south to accommodate Atlantic halibut and swordfish fishers during 2014 WATS survey)  
Communication with fishers  
Upfront planning to avoid fishing vessels  
Request input from fishers/fishing groups through stakeholder engagement and ongoing communication.  
Proactive advisories and communications | Minor  
1-12 months  
101-1,000 km² | NS | Medium to High |
<table>
<thead>
<tr>
<th>VEC/Interaction</th>
<th>Potential Effects</th>
<th>Key Mitigations</th>
<th>Effect Criteria and Ratings</th>
<th>Judged Significance Rating</th>
<th>Level of Confidence in Judgment</th>
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<td></td>
<td>Magnitude</td>
<td>Duration</td>
<td>Geographic Extent</td>
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<td></td>
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<td></td>
<td>Minor</td>
<td>1-12 months</td>
<td>11-100 km²</td>
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<tr>
<td>Aboriginal FSC Fisheries &amp; Commercial Fisheries x Presence of Seismic Configuration</td>
<td>Interference with fishing vessels</td>
<td>Temporal and spatial avoidance (i.e., Project Area located away from major fishing activities)</td>
<td>Communication with fishers</td>
<td>Upfront planning to avoid fishing vessels</td>
<td>Request input from fishers/fishing groups through stakeholder engagement and ongoing communication.</td>
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</table>

- **VEC/Interaction**
  - Tangier 3-D Seismic Survey
  - Environmental Assessment

- **Potential Effects**
  - FLO(s)
  - Radio Contact
  - Picket Vessels
  - Radar and VMS

- **Key Mitigations**
  - Temporal and spatial avoidance (i.e., Project Area located away from major fishing activities)
  - Communication with fishers
  - Upfront planning to avoid fishing vessels
  - Request input from fishers/fishing groups through stakeholder engagement and ongoing communication.
  - Proactive advisories and communications
  - FLO(s)
  - Radio Contact
  - Picket Vessels

- **Effect Criteria and Ratings**
  - **Magnitude**
  - **Duration**
  - **Geographic Extent**
  - **Judged Significance Rating**
  - **Level of Confidence in Judgment**
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<tr>
<td></td>
<td></td>
<td>Radar and VMS</td>
<td>Negligible</td>
<td>NS</td>
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<td></td>
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<td>Compensation for gear damage</td>
<td>&lt;1 month</td>
<td>11-100 km²</td>
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<td>Marine Shipping x Presence of Seismic Configuration</td>
<td>Interference with shipping</td>
<td>Proactive advisories and communications</td>
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<td>Notice to Mariners</td>
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<td>Radar and VMS</td>
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<td>FLO(s)</td>
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<tr>
<td>DFO Scientific Research x Airgun Array Sound</td>
<td>Fish behavioural effects potentially affecting catch rates</td>
<td>Temporal and spatial avoidance (i.e., Project Area located away from survey activities)</td>
<td>Minor</td>
<td>&lt;1 month</td>
<td>101-1,000 km²</td>
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<td>Communication with DFO</td>
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<td>Proactive advisories and communications</td>
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<tr>
<td>DFO Scientific Research x Presence of Seismic Configuration</td>
<td>Interference with research vessels and equipment</td>
<td>Temporal and spatial avoidance (i.e., Project Area located away from survey/research activities)</td>
<td>Minor</td>
<td>&lt;1 month</td>
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<td>Communications and scheduling</td>
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<td>Upfront planning to avoid research vessels</td>
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<td>Radio Contact</td>
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<td>Picket Vessels</td>
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<td>Radar and VMS</td>
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<tr>
<td>DND Operations x Presence of Seismic Configuration</td>
<td>Interference with DND operations</td>
<td>Communications and scheduling</td>
<td>Negligible</td>
<td>&lt;1 month</td>
<td>11-100 km²</td>
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<td>Notice to Mariners</td>
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<tr>
<td>All VECs x Malfunctions and Accidental Events (considering small fuel release)</td>
<td>Contamination</td>
<td>Spill prevention plans</td>
<td>Negligible to Minor</td>
<td>&lt;1 month</td>
<td>&lt;1 km² to 1-10 km²</td>
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<td>SOPEP</td>
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<td>Crew training</td>
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<td>Proper handling and storage requirements</td>
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<td>Vessel inspections</td>
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<td>Fuel transfer plan (including use of certified TODO® fuel hoses)</td>
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<td>Use of solid streamers</td>
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<td>Adherence to the safety management procedures</td>
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<td>VEC/Interaction</td>
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<td>Spill kits onboard vessels</td>
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<td>Emergency Response Plan</td>
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13.0 Literature Cited


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