5.0 Effects Assessment

Two general types of effects are considered in this document:

1. Effects of the environment on the Project; and
2. Effects of the Project on the environment, particularly the biological environment.

Methods of effects assessment used here are comparable to those used in recent east coast offshore seismic (e.g., LGL 2007, 2010a) and drilling EAs (e.g., Buchanan et al. 2006; LGL 2006a,b). These documents conform to the (now repealed) *Canadian Environmental Assessment Act* (*CEAA*) of 1992 and its associated Responsible Authority's Guide and the CEA Agency Operational Policy Statement (OPS-EPO/5-2000; CEA Agency 2000). Cumulative effects are incorporated within the procedures in accordance with *CEAA* (CEA Agency 1994) as adapted from Barnes and Davey (1999).

5.1 Scoping

The C-NLOPB provided a final Scoping Document (dated January 28, 2014) for the Project which outlined the factors to be considered in the assessment. In addition, various stakeholders were contacted for input (see Section 5.2 below). The Scoping Document was also sent to the Canada Nova Scotia Offshore Petroleum Board (CNSOPB) and the Government of France given that the Study Area extends slightly into the waters of both Nova Scotia and St. Pierre et Miquelon. Another aspect of scoping for the effects assessment involved reviewing relevant and recent EAs and SEAs that were conducted in Newfoundland and Labrador waters including (but not limited to) the ConocoPhillips Laurentian Sub-basin seismic EA (LGL 2009b), the ConocoPhillips Laurentian Sub-basin exploratory drilling EA (Buchanan et al. 2006), the Husky Oil Lewis Hill exploratory drilling EA (LGL 2003b), and the Southern Newfoundland SEA (LGL 2010a). Reviews of present state of knowledge on the effects of seismic as well as the physical and biological setting of the Study Area were also conducted.

5.2 Consultations

5.2.1 MKI Consultation Policy and Approach

MKI's policy for consultation on marine seismic projects is to consult (primarily through in-person meetings) with relevant agencies, stakeholders and rights-holders (e.g., beneficiaries) during the pre-survey and survey stages. MKI will initiate meetings and respond to requests for meetings with the interested groups throughout this period. After the survey is complete MKI will conduct follow-up discussions. The same approach would be followed before, during and after any survey work for 2014-2018. In summary, each year MKI will meet as follows:

- Before the survey is permitted: to provide Project information, gather information about area fisheries, determine issues or concerns, discuss communications and mitigations;
- After the survey is permitted, during the survey activities: to report on the progress of the survey, to determine if any survey-related issues have come up, and to discuss potential solutions; and

- After the survey is complete: to provide an up-date on the Project, hear if there were any issues, and to present results of the MMO and FLO reports.

The in-person meetings include the direct participation of MKI's Project Manager and Environmental Manager, and other issue-specific personnel support as needed.

5.2.2 Program Consultations

The program consultations were organized and coordinated by Nexus Coastal Resource Management. In addition to Nexus personnel, representatives of MKI and LGL also attended some of the consultation meetings. All face-to-face meetings were held at various locations on the Avalon and Burin Peninsulas. Initial and subsequent contact and face-to-face meetings were conducted between 18 December 2013 and 31 January 2014.

During the face-to-face meetings, PowerPoint presentations with details about the proponents and the proposed Project were given. The presentations included provisional maps of the proposed 2014 survey lines and the Project and Study Areas as well as several maps showing fish-harvesting locations (key species) in relation to those lines. Nexus/MKI recorded information about commercial fish harvesting details, including Traditional Environmental/Ecological Knowledge (TEK) related to the Project, and noted any issues, concerns and advice about mitigations (particularly avoiding concurrent fisheries) and communications. Questions were invited at all times. Information packages were provided either before or at the meetings (including additional copies for wider distribution), as were coordinates for locating the full Project Description through the C-NLOPB Registry. Some agencies and groups did not request in-person meetings but they were provided information packages and invited to comment. Appendix 1 contains a table that provides details of the consultations, including stakeholder group name, names of contacts within that group, details of the engagement, comments/concerns/requests, and responses to these. Where possible, particular sections of the EA are referred to in the responses.

Stakeholder groups that were engaged include the following (in the order they appear in Appendix 1):

- Environment Canada;
- Fish, Food and Allied Workers Union (FFAW) and One Ocean;
- Fisheries and oceans Canada (DFO);
- Nature Newfoundland and Labrador (NNL);
- Newfoundland and Labrador Department of Fisheries and Aquaculture;
- Association of Seafood Producers (ASP);
- Ocean Choice International (OCI);
- Transport Canada;
- Aquaforte Town Council;
- Argentia Management Authority;
- Bay Bulls Town Council;
- Burin Harbour Authority;
- Burin Town Council;
- Wave Energy Research Centre;

- Ferryland Harbour Authority;
- Ferryland Town Council;
- Fortune Harbour Authority;
- Fortune Town Council;
- Grand Bank Harbour Authority;
- Grand bank Town Council;
- Marystown Shipyard;
- Marystown Town Council;
- Placentia Harbour Authority;
- Placentia Town Council;
- Riverhead Harbour Authority;
- St. Bride's Community Council;
- City of St. John's;
- St. John's Port Authority; and
- St. Mary's Harbour Authority.

As has been the case for other seismic project assessments in the Newfoundland and Labrador sector, the most consistent issue raised during the consultations related to potential conflict with the commercial fisheries, specifically ensuring that the survey does not interfere with or otherwise impact harvesting success (Section 4.3 describes the important fisheries in the Study and Project Areas). Consequently, fish harvester groups and agencies were a key focus of the consultations.

Other topics of discussion included potential effects on marine biota, employment opportunities, and the importance of ongoing communication between the Operator and potentially affected groups.

Both the CNSOPB and the Government of France will be contacted by MKI prior to the onset of any seismic surveying.

5.2.3 Follow-Up

As described above, MKI will conduct follow-up discussions with all interested groups during and after the survey. This would include reporting on the progress of the survey, monitoring the effectiveness of the mitigations, determining if any survey-related issues had arisen, and presenting monitoring results.

5.3 Valued Environmental Components

The Valued Environmental Component (VEC) approach was used to focus the assessment on those biological resources of most potential concern and value to society.

VECs include the following groups:

- rare or threatened species or habitats (as defined by the *SARA* and COSEWIC);
- species or habitats that are either unique to an area or valued for their aesthetic properties;
- marine species that are harvested by people (e.g., commercial fishery target species); and
- marine species with some potential to be affected by the Project.

The VECs were identified based on the scoping exercise as described in Section 5.1. The VECs and the associated rationale for their inclusion are as follows:

- **Fish and Fish Habitat** with emphasis on principal commercial species in the Study Area including snow crab (invertebrate species), yellowtail flounder (flatfish without swim bladder), and Atlantic cod (groundfish with swim bladder), as well as *SARA* species (e.g., wolffishes). It is recognized that there are many other fish species, commercial or prey species, that could be considered but it is LGL's professional opinion that this suite of species captures all of the relevant issues concerning the potential effects of seismic surveys on important invertebrate and fish populations of the Study Area.

- **Fisheries** (primarily commercial harvesting) were the most referenced VEC of concern during consultations. While they are directly linked to the Fish and Fish Habitat VEC above in that an impact on fish could affect fishery success for that species, the greater concern expressed was interference with fishing, either through the sound produced by the array (scaring fish from fishing gear) or interference with fixed fishing gear (caused by the ships or the seismic streamer). All fisheries are considered where relevant (i.e., commercial, subsistence/ ceremonial, recreational). The commercial fishery is a universally acknowledged important element in the society, culture, economic and aesthetic environment of Newfoundland and Labrador. Also included in this VEC are research surveys conducted by both DFO and industry. This VEC is of prime concern from both a public and scientific perspective, at local, national and international scales.

- **Seabirds** with emphasis on those species most sensitive to seismic activities (e.g., deep divers such as murres) or vessel stranding (e.g., petrels). Newfoundland and Labrador waters support some of the largest seabird colonies in the world and the Study Area hosts large populations during all seasons. They are important socially, culturally, economically, aesthetically, ecologically and scientifically. This VEC is of prime concern from both a public and scientific perspective, at local, national and international scales.

- **Marine Mammals** with emphasis on those species potentially most sensitive to low frequency sound (e.g., baleen whales) and *SARA* species (e.g., blue whale). Whales and seals are key elements in the social and biological environments of Newfoundland and Labrador. The economic and aesthetic importance of whales is evidenced by the large number of tour boats that feature whale watching as part of a growing tourist industry. This VEC is also of concern from both a public and scientific perspective, at local, national and international scales.

- **Sea Turtles**, although uncommon in the Study Area, are mostly *threatened* and *endangered* on a global scale. The leatherback sea turtle that forages in eastern Canadian waters has *endangered* status under *SARA*. While they are of little or no economic, social or cultural importance to Newfoundland and Labrador, their *endangered* status warrants their inclusion as a VEC.

- **Species at Risk** are those designated as *endangered* or *threatened* on Schedule 1 of *SARA*. In addition, species listed as *special concern* have been considered here as well. All species at risk in Newfoundland and Labrador offshore waters are captured in the VECs listed above. However, because of their special status, they are also discussed separately.

- **Sensitive Areas** are areas considered to be unique due to their ecological and/or conservation sensitivities. Examples of sensitive areas in the Study Area include Ecologically and Biologically Significant Areas (EBSAs) and coral conservation areas.

5.4 Boundaries

For the purposes of this EA, the following boundaries are defined.

5.4.1 Temporal

The temporal boundaries of the Project are 1 May to 30 November, 2014-2018.

5.4.2 Spatial

5.4.2.1 Project Area

The 'Project Area' is defined as the area within the C-NLOPB jurisdiction where seismic data could be acquired and all vessel movements with deployed equipment will occur (see Figure 1.1). The coordinates of the Project Area (WGS84, unprojected geographic coordinates) are presented in Table 5.1.

Table 5.1 Coordinates of the Project Area Extents (WGS84, unprojected geographic coordinates).

Project Area Extent	WGS84 (Decimal Degrees)	
	Latitude (°N)	Longitude (°W)
Northwest	45.914	-57.631
Northeast	45.979	-40.960
Southwest	41.546	-55.727
Southeast	38.657	-47.274

5.4.2.2 Affected Area

The 'Affected Area' varies according to the specific vertical and horizontal distributions and sensitivities of the VECs of interest and is defined as that area within which effects (physical or important behavioural ones) have been reported to occur.

5.4.2.3 Study Area

The 'Study Area' is an area larger than the Project Area that encompasses any potential effects (including those from accidental events) reported in the literature.

5.4.2.4 Regional Area

The 'Regional Area' is an area larger than the Study Area and is used when considering cumulative effects.

5.5 Effects Assessment Procedures

The systematic assessment of the potential effects of the Project involved three major steps:

1. preparation of interaction matrices (i.e., interactions of Project activities and the environment);
2. identification and evaluation of potential effects, including description of mitigation measures and residual effects; and
3. preparation of residual effects summary tables, including evaluation of cumulative effects.

5.5.1 Identification and Evaluation of Effects

Interaction matrices identifying all possible Project activities that could interact with any of the VECs were prepared. The interaction matrices are used to identify potential interactions only and they do not make any assumptions about the potential effects of the interactions.

Interactions were then evaluated for their potential to cause effects. In instances where the potential for an effect of an interaction was deemed impossible or extremely remote, these interactions were not considered further. This approach allows the assessment to focus on key issues and the more substantive environmental effects.

An interaction was considered to be a potential effect if it could change the abundance or distribution of VECs, or change the prey species or habitats used by VECs. The potential for an effect was assessed by considering:

- the location and timing of the interaction;
- the literature on similar interactions and associated effects (seismic EAs for offshore Nova Scotia and Newfoundland and Labrador);

- consultation with other experts, when necessary; and
- results of similar effects assessments, especially monitoring studies done in other areas.

When data were insufficient to allow precise effects evaluations, predictions were made based on professional judgement. In such cases, the uncertainty is documented in the EA. Effects were evaluated for the proposed seismic survey program, and included the consideration of mitigation measures that are either mandatory or have become standard operating procedure in the industry.

5.5.2 Classifying Anticipated Environmental Effects

The concept of classifying environmental effects simply means determining whether they are negative or positive. The following includes some of the key factors that are considered for determining negative environmental effects, most of which are included in the CEA Agency guidelines (CEA Agency 1994):

- negative effects on the health of biota;
- loss of rare or *endangered* species;
- reductions in biological diversity;
- loss or avoidance of productive habitat;
- fragmentation of habitat or interruption of movement corridors and migration routes;
- transformation of natural landscapes;
- discharge of persistent and/or toxic chemicals;
- toxicity effects on human health;
- loss of, or detrimental change in, current use of lands and resources for traditional purposes;
- foreclosure of future resource use or production; and
- negative effects on human health or well-being, including economic well-being, such as fishing income.

5.5.3 Mitigation

Where needed, mitigation measures appropriate for each effect predicted in the matrix were identified (see Section 5.7), and the effects of various Project activities were then evaluated assuming that appropriate mitigation measures are applied. Residual effects predictions were made taking into consideration these mitigations.

5.5.4 Evaluation Criteria for Assessing Environmental Effects

Several criteria were taken into account when evaluating the nature and extent of environmental effects. These criteria include (CEA Agency 1994):

- magnitude;
- geographic extent;
- duration;

- frequency;
- reversibility; and
- ecological, socio-cultural and economic context.

5.5.4.1 Magnitude

Magnitude describes the nature and extent of the residual environmental effect for each activity.

Ratings for this criterion are defined as:

0 *Negligible* - An interaction that may create a measureable effect on individuals but would never approach the value of the 'low' rating.

1 *Low* - Affects >0 to 10% of individuals in the affected area (e.g., geographic extent). Effects may include acute mortality, sublethal effects or exclusion due to disturbance.

2 *Medium* - Affects >10 to 25% of individuals in the affected area (e.g., geographic extent). Effects may include acute mortality, sublethal effects or exclusion due to disturbance.

3 *High* - Affects >25% of individuals in the affected area (e.g., geographic extent). Effects may include acute mortality, sublethal effects or exclusion due to disturbance.

Definitions of magnitude used in this EA have been used previously in numerous offshore oil-related environmental assessments under CEAA. These include assessments of the Chevron Labrador Shelf seismic EA (LGL 2010b), Labrador Shelf infill-extension EA (Canning and Pitt 2007), the White Rose Oilfield Comprehensive Study (Husky 2000), the Husky Jeanne d'Arc Basin exploration drilling EAs and update (LGL 2002, 2005a, 2006b), the Husky Jeanne d'Arc Basin 3-D seismic EA and update (LGL 2005b; Moulton et al. 2006c), the StatoilHydro Jeanne d'Arc Basin area seismic and geohazard program EA (LGL 2008), and the ConocoPhillips Laurentian Sub-Basin exploration drilling EA and supplement (Buchanan et al. 2006; LGL 2009a), and seismic EA (LGL 2009b).

5.5.4.2 Geographic Extent

Geographic extent refers to the specific area (km^2) of the residual environmental effect caused by the Project activity. Geographic extent will likely vary depending on the activity and the relevant VEC.

Ratings for this criterion are defined as:

1 = <1 km^2
2 = 1-10 km^2
3 = >10-100 km^2
4 = >100-1,000 km^2
5 = >1,000-10,000 km^2
6 = >10,000 km^2

5.5.4.3 Duration

Duration describes how long a residual effect will occur.

Ratings for this criterion are defined as:

1 = <1 month
2 = 1 – 12 months
3 = 13 – 36 months
4 = 37 – 72 months
5 = >72 months

Short duration can be considered 12 months or less, medium duration 13 to 36 months, and long duration >36 months.

5.5.4.4 Frequency

Frequency describes how often a residual effect will occur.

Ratings for this criterion are defined as:

1 = <11 events/yr
2 = 11-50 events/yr
3 = 51-100 events/yr
4 = 101-200 events/yr
5 = >200 events/yr
6 = continuous

5.5.4.5 Reversibility

Reversibility refers to the capability of a VEC population to return to either its pre-Project or an improved condition, after the Project has ended.

Ratings for this criterion are defined as:

R = reversible
I = irreversible

5.5.4.6 Ecological, Socio-cultural and Economic Context

The ecological, socio-cultural and economic context refers to the pre-Project status of the Study Area (i.e., potential affected area) in terms of existing environmental effects. The Study Area is not considered to be strongly affected by human activities.

Ratings for this criterion are defined as:

1 = Environment not negatively affected by human activity (i.e., relatively pristine area)
2 = Evidence of existing negative effects on the environment

5.5.5 Cumulative Effects

Projects and activities considered in the cumulative effects assessment include other human activities in Newfoundland and Labrador offshore waters, with emphasis on the Grand Banks Regional Area.

- Within-Project cumulative impacts. For the most part, and unless otherwise indicated, within-Project cumulative effects are fully integrated within this assessment;
- Existing and *in progress* offshore oil developments in Newfoundland and Labrador: Hibernia (GBS platform), Terra Nova FPSO, White Rose FPSO and associated extension, and the Hebron GBS;
- Other offshore oil exploration activity (particularly seismic surveys and exploratory drilling as outlined on the C-NLOPB website). There is some potential for several 2D/3D/4D, geohazard and VSP surveys in any given year;
- Fisheries (domestic and foreign commercial, recreational, aboriginal/subsistence);
- Marine transportation (tankers, cargo ships, supply vessels, naval vessels, fishing vessel transits, etc.); and
- Hunting activities (marine birds and seals).

5.5.6 Integrated Residual Environmental Effects

Upon completion of the evaluation, the residual environmental effects are assigned a rating of significance for:

- each project activity or accident scenario;
- the cumulative effects of activities within the Project; and
- the cumulative effects of combined projects in the Regional Area.

The last of these points considers all residual environmental effects, including project and other-project cumulative environmental effects. As such, this represents an integrated residual environmental effects evaluation.

The analysis and prediction of the significance of residual environmental effects, including cumulative environmental effects, encompasses the following:

- determination of the significance of residual environmental effects;
- establishment of the level of confidence for prediction; and
- evaluation of the scientific certainty and probability of occurrence of the residual impact prediction.

Ratings for level of confidence associated with each prediction are presented in the table of residual environmental effects. In the case of a significant predictive rating, ratings for probability of occurrence and determination of scientific certainty are also included in the table of residual environmental effects. The guidelines used to determine these ratings are discussed in the following sections.

5.5.6.1 Significance Rating

Significant residual environmental effects are those that are considered to be of sufficient magnitude, duration, frequency, geographic extent, and/or reversibility to cause a change in the VEC that will alter its status or integrity beyond an acceptable level. Establishment of the criterion is based on professional judgment but is transparent and repeatable. In this EA, a significant residual effect is defined as:

> *Having either a high magnitude regardless of duration and geographic extent ratings, or a medium magnitude for more than one year over a geographic extent greater than 100 km*^{2}

A residual effect can be considered *significant* (S), *not significant* (NS), or *positive* (P).

5.5.6.2 Level of Confidence

The significance of the residual environmental effects is based on a review of relevant literature, consultation with experts, and professional judgement. In some instances, making predictions of potential residual environmental effects are difficult due to the limitations of available data (i.e., technical boundaries). Ratings are therefore provided to qualitatively indicate the level of confidence for each prediction. The level of confidence is considered low (1), medium (2) or high (3).

5.5.6.3 Probability of Occurrence

The probability of occurrence of a *significant* residual effect, based on professional judgement, is considered low (1), medium (2) or high (3).

5.5.6.4 Scientific Certainty

The scientific certainty of a *significant* residual effect, based on scientific information, statistical analysis and/or professional judgement, is considered low (1), medium (2) or high (3).

5.5.7 Follow-up Monitoring

Since any effects of the Project on the environment will be relatively short-term and transitory, there is no need to conduct follow-up monitoring. However, there will be some monitoring (described below in Section 5.6 on Mitigations) during the course of the Project, and if these observations indicate evidence of an anticipated effect on a VEC or an accidental release of fuel, then the need for follow-up monitoring and other actions will be assessed in consultation with the C-NLOPB.

5.6 Mitigation Measures

The effects assessments that follow in this chapter (see Sections 5.8) consider the potential effects of the Southern Grand Banks seismic program in light of the specific mitigation measures that will be applied for this Project in this environment. The purpose of these measures is to eliminate or reduce the potential impacts that might affect the area VECs (as identified in Section 5.4). MKI recognizes that the careful and thorough implementation of, and adherence to, these measures will be critical for ensuring that the Project does not result in unacceptable environmental consequences.

This section details the various measures that will be established and applied for this Project. Many of these are specially tailored to this program, while others are founded in regulations, guidelines, or "best environmental practices". Collectively, they are based on or take guidance from several sources, including:

- Discussions and advice received during consultations for this Project (Section 5.2 and Appendix 1), and for other relevant EAs;
- The C-NLOPB Scoping Documents, and the Environmental Planning, Mitigation and Reporting guidance in Appendix 2 of the Board's *Geophysical, Geological, Environmental and Geotechnical Program Guidelines* (C-NLOPB 2012);
- DFO's *Statement of Practice with respect to the Mitigation of Seismic Sound in the Marine Environment;*
- National and international acts, regulations or conventions, such as the *Fisheries Act* and Regulations, *International Convention for the Prevention of Pollution from Ships* (MARPOL), and International Maritime Organization (IMO) standards;
- Other standards and guidance, such as the One Ocean *Protocol for Seismic Survey Programs in Newfoundland and Labrador* (2013), and the Joint Nature Conservation Committee (JNCC) *Guidelines for minimising the risk of injury and disturbance to marine mammals from seismic surveys* (2010);
- Industry best practices; and
- Expert judgement/experience from past surveys.

The mitigations that follow are organized under the following principal categories: (1) Survey Layout and Location; (2) Communications and Liaison; (3) Fisheries Avoidance; (4) Fishing Gear Damage Program; (5) Marine Mammal/Wildlife Protection; and (6) Pollution Prevention and Emergency Response. Several of the specific mitigation plans listed under these categories mitigate potential effects on more than one VEC (e.g., seismic array ramp-up/soft start can warn away marine mammals and fish). Therefore, the relevant VECs are noted for each of the measures in parentheses following the section heading.

These measures will be adhered to in each survey year, with adjustments as necessary based on monitoring and follow-up.

5.6.1 Survey Layout and Location (Fish, Fisheries, Marine Mammals/Sea Turtles, Seabirds, Cumulative Effects)

The layout of MKI 2D seismic surveys, with very long and widely spaced lines, means that in most areas (fishing grounds and wildlife habitat) there will be only one-time exposures to Project activities. With the seismic ship travelling at ~8–9 km hour, for any given location, the survey will be 10–20 km away within a few hours and will not return there, except for the crossing points, which will likely be separated by several days or even weeks in timing. Typically, only parts of a few of the lines would pass over any key fishing ground in any program year. The layout of 3D seismic surveys includes more narrowly spaced lines meaning that exposures at any location within the survey area will occur more frequently.

5.6.2 Communications and Liaison (Fisheries, Effects of the Environment on the Project, Other Marine Users)

Consultations and discussions for this Project have indicated that frequent, timely and effective communications with fishing industry organizations/participants must be a central part of the fisheries mitigations for the survey. This will work, (1) to ensure that the seismic program does not operate in the area of active fisheries, and (2) to allow the survey to plan its acquisition and proceed in the most efficient way possible in light of concurrent fishing locations.

5.6.2.1 Information Exchange

Detailed and up-to-date information about the fisheries likely to be active in specific parts of the Project Area at specific times.

Maps of past fish harvesting activities (see Section 4.3 of this EA) are a valuable planning tool, but exact times and locations change somewhat from year to year. To be accurate, the information flow about current fishing activities will need to be a continuing process that is updated as fishing seasons open and close, and as quotas are taken. This information will be accessed through continuing information exchanges with the relevant fishing organizations on a regular basis, including through the mechanisms described below, such as the FFAW Petroleum Information Liaison person, the FLOs, direct contacts with representatives of the Newfoundland fisheries organizations, and with DFO (for fisheries survey/research information). Operational details of these communications will be finalized with the relevant organizations as the fishing season information and plans are known.

5.6.2.2 Weekly Status Meetings

MKI will hold weekly update meetings with FFAW and other invited fishery groups throughout the survey. Status maps will be provided at these face-to-face meetings where the past week's acquisition will be reviewed and the expected plan for the upcoming week will be shown and discussed. Minutes of the meeting will be agreed to, and maps and information will be forwarded to other interested parties including, but not limited to, the C-NLOPB.

5.6.2.3 Fisheries Liaison Officers (FLOs)

The survey will place FLOs on board the seismic ship and support vessel to communicate with fishing vessels at sea, and relay information to shore as needed (at least two FLOs – one FFAW representative on the seismic vessel and an Inuit representative on the support vessel). The FLOs are the primary at-sea liaison between the commercial fishing industry and the seismic survey program. In past seismic surveys, FLOs have been very effective for "real time" communications, and to assist the vessel in planning activities in light of current fisheries and fishing gear locations.

As described in the document One Ocean Protocol for Seismic Survey Programs in Newfoundland and Labrador (One Ocean 2013), "the FLO is tasked with identifying potential at-sea conflicts between fishing and petroleum operations". His/her duties include radio contact with fishing boats in the area, informing fishers nearby about the seismic program (including providing coordinates of planned survey lines), helping to identify fishing plans (when in area, when leaving) and any fishing gear in and near the seismic survey program area so it can be avoided, advising on best course of action to avoid gear and/or other fishing activities, providing information about changes in relevant fisheries, and sending daily reports. The FLO roles and duties, based on past practice and the One Ocean Protocol document (Section 4.6, FLO Operational Responsibilities, Protocols and Communications *in* One Ocean 2013), will include the following:

- while stationed on the seismic vessel and support vessel, observe activities which may affect the fishing industry and petroleum operations;
- initiate and maintain radio contact with fishing boats in the area and ensure all communication with fishing vessels is conducted via the FLO;
- inform fishers nearby about the seismic survey program and provide coordinates and relevant spatial and temporal details;
- help identify/locate any fishing gear in and near the seismic survey program area so it can be avoided;
- determine gear type, layout, fishing plans (when in area, when leaving);
- advise bridge about best course of action to avoid gear and/or fishing activities;
- serve as initial contact if damaged gear is encountered, verify damage, help identify owners and file an incident report;
- regularly discuss/convey fisheries related aspects including changes in relevant fisheries, status of species quotas and closures with the onboard Client Representative;
- report to and confer with the onboard Client Representative regarding operational situations;
- attend regular operations briefings;
- attend safety meetings and participate in all relevant Health Safety and Environment (HSE) initiatives and procedures as requested;
- complete and submit a daily report (electronic/hardcopy) including all observations, communications and meetings attended to the onboard Client Representative; and
- other duties as identified and approved through consultation with the Operator and Service Provider.

The One Ocean Protocol document (One Ocean 2013) also notes that the FFAW/One Ocean Petroleum Industry Liaison (see below) usually prepares a Summary Report on fishing activity for the FLO, including Vessel Monitoring System (VMS) data (see below) before departure on the seismic ship, and continues to provide data to the FLO while on board the seismic vessel on an as-needed basis throughout the program. (see www.oneocean.ca/pdf/2013%20Seismic%20Protocol%20Document.pdf.)

The FLO would also assist if there are any gear damage incidents, as detailed below (Fishing Gear Damage Program).

5.6.2.4 Single Point of Contact (SPOC)

The role of the shore-based SPOC (as noted in the C-NLOPB Guidelines [C-NLOPB 2012]) is to facilitate communication between the Project and other marine users, particularly those involved in the fisheries. It has become a standard and effective mitigation for seismic surveys over many years. Typical services provided are as follow:

- documenting the locations of known vessels for seismic survey operators; provide current information about the locations of seismic activities and fishing activities;
- regularly update survey vessels on expected locations of fishing activities in their operating areas;
- assisting with updates to the seismic vessels about changes in relevant fisheries, the progress of species quotas and closures;
- maintaining additional contact with fishers known to be in active survey areas, directly or through the FLOs, the FFAW, other fishing organizations (such as the Torngat Co-op), and One Ocean;
- providing information directly to fishers when requested via email or a toll-free phone line maintained for this purpose, based on the best-available data provided to them by the survey;
- attempting to identify (from CFV id numbers, etc.) any gear located in the water or involved in an incident, as requested by the survey operator;
- providing survey information to fisheries groups and organizations as required; and
- providing initial contacts (via email and/or the toll free phone number) for any gear damage or loss claims, for the survey's fishing gear compensation program.

SPOC contact information will be broadcast in the Coast Guard Notices to Shipping and communicated to fishers through their organizations. The SPOC will also have duties if there are any gear damage incidents, as detailed below (Fishing Gear Damage Program).

5.6.2.5 FFAW/One Ocean Petroleum Industry Liaison Contacts

As an initiative of One Ocean (whose mission is to be the medium for information exchange regarding industry operational activities between the fishing and petroleum industries in Newfoundland and Labrador), an arrangement was undertaken for the employment of a Petroleum Industry Liaison (PIL) at the FFAW. The principle objective of the PIL is to ensure the views and concerns of fish harvesters are considered by the offshore petroleum industry and regulators during the development, review and execution of exploration, development and production activities. As such, the PIL is the main contact for petroleum related activities at the FFAW. MKI will utilize the PIL as the key contact for communications between the Project and FFAW-represented fishing interests.

5.6.2.6 VMS Data

MKI will use VMS data (as available) to understand and help avoid fishing locations and monitor other area marine activities, for logistics and safety. The One Ocean Protocol notes that "One Ocean and Fisheries and Oceans Canada (DFO) have an arrangement to provide Vessel Monitoring System (VMS) information to petroleum company members of One Ocean. The VMS program at DFO Newfoundland Region provides a satellite based, near real time, positional tracking system of fishing vessels within the Canadian Exclusive Economic Zone (EEZ), as well as foreign and domestic vessels in the northwest Atlantic Fisheries Organization (NAFO) Regulatory Area outside the 200 nautical mile limit. The ability to access current fisheries data (location of activity) is an important component in the development of operational plans for offshore petroleum related activities. The VMS data generated by DFO consists of coordinates only and does not divulge information of a confidential or sensitive nature." MKI has requested (through One Ocean) that the Project have access to these data.

5.6.2.7 Notices to Shipping

As a standard procedure and requirement, MKI will file and update NotShips with Canadian Coast Guard Radio/ECAREG advising marine interests of the seismic survey's general operating area for the period covered by the Notice. The Notices will include contact information (email and toll-free phone number) for the survey's Fishing Gear Damage program (see below).

5.6.2.8 Survey Start-Up Sessions (Project Ships' Crews)

MKI places a strong emphasis on informing the at-sea Project personnel on each ship before the survey begins, through several presentation modules, about the environmental issues and concerns in the area in which they will be working, MKI's environmental commitments and regulatory requirements, safety, emergency response, the duties and authority of the MMOs and the FLOs, and the cultural importance and legal status of Aboriginal interests in the area. These sessions will include showing the Canadian Association of Petroleum Producers "Fishery Liaison Officer Video" about the importance of FLO participation in offshore Newfoundland and Labrador exploration activities, as recommended in the One Ocean Protocol. The FLOs, MMOs and MKI Project Manager will be present at these meetings.

5.6.2.9 Communications Follow-Up

As stated in the Consultations section (Section 5.2; Appendix 1), MKI will continue to consult with fisheries (and other) groups before and during the survey (with the active participation of MKI Managers) and will also conduct follow-up discussions with all interested groups after the survey. This would include reporting on the progress of the survey, monitoring the effectiveness of the mitigations and whether any survey-related issues had come up, and (after survey) to present monitoring results.

5.6.2.10 Other Notifications/Communication

MKI will also follow several procedures/vehicles to facilitate excellent communications for the survey, including the following:

- MKI will employ the latest technology in at-sea communications with and between the survey ships (VHF, HF, Satellite telephone and internet, VMS).
- MKI will provide information (the NotShip text) to the CBC Fisheries Broadcast.

Further details of the communications plans will be developed during MKI's continuing discussions with fisheries representatives.

5.6.3 Fisheries Avoidance (Fisheries)

5.6.3.1 Avoidance of Commercial Fishing Areas

To the best of its ability, MKI will avoid active fishing areas during the seismic survey. Specifically, MKI will monitor the location of fishing activities and make best efforts to plan its work away from those grounds when fishing is active there. The communications protocols and methods described above will be the key means for MKI to have the information to plan around and away from fish harvesting. Continuing contact between the Project and fishing group representatives, the on-board FLOs, the SPOC, DFO and the FFAW PIL will be essential for this process.

MKI understands that fish harvesters are not required to move their vessels or gear from the seismic survey program area and will not be told to do so. This information will be clearly communicated at the start-up meetings (described above).

5.6.3.2 No Gear Deployment Enroute to Survey Area

MKI will not deploy its array or streamer (s) in Newfoundland and Labrador waters during transits to the survey area. In addition, the FLOs will advise the vessel en-route to the area to ensure fishing gear is avoided by the ships during transits.

5.6.3.3 Avoidance of Fisheries Science Surveys

As with the commercial fishery, those involved in DFO and joint DFO/Industry research surveys will need to exchange detailed locational information with those involved in the seismic surveying. For previous seismic surveys off Newfoundland and Labrador, a temporal and spatial separation plan has been implemented (on DFO advice) to ensure that seismic operations did not interfere with the research survey. The procedures, which MKI will follow, involve adequate "quiet time" before the research vessel arrived at its survey location. The avoidance protocol includes a 30 km (16 nm) spatial separation and a 7 day pre-research survey temporal separation.

5.6.3.4 Use of Scout Vessel

If there is a possibility of the survey program working in areas adjacent to active fishing, MKI will use a vessel (the program support vessel or an additional smaller vessel) to scout ahead, usually along the planned route of a survey line, to make sure there are no fishing boats or gear in the area. Information about any sightings or radio communications will be relayed back to the survey ship and the FLOs.

5.6.3.5 Monitoring and Follow-up

As described above, MKI in discussions with relevant groups and mechanisms (such as the FLOs), will continue to monitor the effectiveness of the mitigations during the survey, and consider the results before subsequent year programs.

5.6.4 Fishing Gear Damage Program (Fisheries)

5.6.4.1 Fishing Gear Damage or Loss Compensation Program

A compensation Program will be made available by MKI which is consistent with C-NLOPB guidelines and past practices. This program covers any damage to fishing gear (or vessels) caused by the survey vessels or survey gear, and includes the value of any harvest lost as a direct result of an incident. The Notices to Shipping filed by the vessels for survey work and for transits to and from the survey area will also inform fishers that they may contact the SPOC toll free by telephone or email if they believe that they have sustained survey-related gear damage. This information will also be communicated through other means (e.g., the Newsletter, contact through fisheries organizations).

The SPOC will follow through with any claim received, in communication with MKI, the FLOs and the relevant fisheries organization. For responding to a claim, MKI will follow procedures (which have been employed successfully in the past by other Operators) similar to those outlined in the One Ocean Protocol document.

5.6.4.2 Damage or Loss Incident Response

The One Ocean Protocol (Sections 4.8 and 4.9 in One Ocean 2013) describes responses to a gear conflict to be followed on board a Project ship. MKI will have such procedures in place and will respond to them and any subsequent compensation claim. More specifically, in case of an observed or reported incident, one of the FLOs will follow the following procedures:

- if personnel on board the seismic and/or scout vessel observe fishing gear (abandoned, adrift or active) it should be communicated to the FLO. Gear should not be touched/retrieved by project personnel as it is illegal for anyone but the gear owner to move the gear;
- if the support vessel makes the observation, personnel should record exact positions and name or Canadian Fishing Vessel (CFV) number on the gear (buoy/highflyer) and report it to the FLO;
- the FLO will communicate with fishing vessels in the vicinity in an attempt to identify the gear owner;

- if the CFV number is known, the FLO or the SPOC may be able to identify and contact the owner;
- if identification and contact with the gear owner is successful, the FLO will attempt to determine the plans/schedule of the gear owner with respect to the gear and will encourage the owner to communicate with the FLO at sea;
- if it is not possible to contact the gear owner, the survey ship should attempt to work in another area and return to the location at a later time;
- the FLO will record the information in the daily report and submit it to the on-board Client representative;
- if there is any indication a Project vessel or its equipment made contact with fishing gear it should be communicated to the FLO immediately;
- the FLO will contact the on-board Client Representative and vessel Master as soon as possible after discovery of the incident;
- the FLO will take all reasonable action to prevent any further or continuing damage;
- if possible, photograph the gear or gear debris in the water and after recovery;
- if necessary, secure and retain any of the gear debris;
- record the incident in the Daily Report;
- file a Fishing Gear Incident Report and give it to the on-board MKI Client Representative; and
- any contact with fishing gear must be reported immediately even if no damage to the gear has occurred.

Appendix F of the One Ocean Protocol document (One Ocean 2013) contains an incident reporting form which meets the requirements of the C-NLOPB Guidelines in assessing a claim. MKI understands that all such incidents must be reported to the C-NLOPB, which maintains a 24-hour answering service at 709-682-4426 for this purpose (709-778-1400 during working hours). Reports on contacts with fishing gear will include the exact time and location of initial contact, loss of contact and a description of any identifying markings on the gear. Incidents will be reported to MKI (Project Manager and Environmental Manager) by their onboard Client Representative; MKI will then report it to the C-NLOPB following the Board’s incident reporting guidelines and/or any other requirements.

5.6.5 Marine Mammal / Wildlife Protection (Marine Mammals, Sea Turtles, Seabirds, Fish)

The following marine mammal and sea turtle related measures are based on the Statement of Canadian Practice which is also contained in the C-NLOPB Guidelines.

5.6.5.1 Use of a Safety Zone

The survey (MMOs) will establish a circular safety zone with a radius of at least 500 m as measured from the center of the air source array. It will be used at all times the safety zone is visible when the array is operating and before operations during the pre-start up watch.

5.6.5.2 Pre-Start Up Watch

A qualified MMO will continuously observe the safety zone for a minimum period of 30 minutes before array start up and maintain a regular watch of the safety zone at all other times the array is active. The array ramp up can only start (or restarting if the array has been inactive for more than 30 minutes) if the full extent of the safety zone is visible and no cetacean, sea turtle or other marine mammal listed as endangered or threatened on Schedule 1 of *SARA* has been seen for at least 30 minutes.

5.6.5.3 Ramp-Up/Soft Start

If array activation is permitted (based on the pre-watch) a gradual ramp-up (slow increase in power) of the air source array may take place over a minimum of 20 minutes beginning with the activation of a single source element of the air source array, preferably the smallest source element in terms of energy output, and a gradual activation of additional source elements of the air source array will follow until the operating level is reached.

5.6.5.4 Shut-down of Array

The air source array will be shut down immediately if any of the following is observed by the MMO in the safety zone:

a) a marine mammal or sea turtle listed as endangered or threatened on Schedule 1 of *SARA*; or
b) any other marine mammal or sea turtle that has been identified in an EA process as a species for which there could be significant adverse effects.

5.6.5.5 Line Changes and Maintenance Shut-Downs

When seismic surveying (data collection) ceases during line changes, for maintenance or for other operational reasons, the air source array(s) will be

a) shut down completely; or
b) reduced to a single source element.

If the air source array(s) is reduced to a single source element, visual monitoring of the safety zone and shut-down requirements will be maintained, and ramp up will be required when seismic surveying resumes. The 30 minute pre-start up watch will not be required.

5.6.5.6 Operations in Low Visibility

If the full extent of the safety zone is not visible, and the array has been inactive for more than 30 minutes, pre-watch, ramp up and acquisition will not commence until visibility conditions allow.

5.6.5.7 Seabird Strandings

Any seabirds (most likely Leach's Storm-Petrel) that become stranded on the vessels 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 MKI that a CWS *Migratory Bird Handling Permit* will be required. MKI will request the ships to minimize lighting on board to the extent that it does not affect safety.

5.6.5.8 Wildlife Data Collection

Marine mammal/sea turtle observations will be made during ramp-ups and during data acquisition periods, and at other times on an opportunistic basis. This will include observations about marine mammal responses and behaviour to the ships and/or the array. Seabird surveys, i.e., standardized counts, will be conducted throughout the seismic program from the seismic vessel by MMOs experienced in the identification of seabirds at sea. 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 (Gjerdrum et al. 2012). A schedule of conducting seabird surveys (e.g., 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. Data will be collected by a qualified environmental observer(s) (MMO) and FLOs.

5.6.5.9 Reporting

A monitoring report will be submitted to the C-NLOPB by 31 January of the year following completion of the surveys as per the C-NLOPB *Guidelines*. In the unlikely event that marine mammals, turtles or birds are injured or killed by Project equipment or accidental spills of fuel, a report will immediately be filed with C-NLOPB and the need for follow-up monitoring assessed.

5.6.6 Pollution Prevention / Emergency Response (Fisheries, Marine Mammals, Sea Turtles, Seabirds, Fish, Cumulative Effects)

The following sections describe the various pollution prevention/emergency response mitigations.

5.6.6.1 Waste Management

As described in Section 2.0 of this EA, wastes produced from the vessels, including hazardous and non-hazardous waste material, will be managed in accordance with MARPOL and with the vessel-specific waste management plans. PGS has a garbage management plan in place for the *Sanco Spirit*, and there is a waste management plan in place for the *Blain M*. A waste log will be kept onboard the *Sanco Spirit*. All solid wastes will be sorted by type, compacted where practicable, and stored on board before disposal to an appropriate certified reception facility. Non-toxic combustible material and waste oil from the vessels will be burned on-board in approved incinerators. The shipboard incinerators will have been examined and tested in accordance with the requirements for shipboard incinerators IMO Res. MEPC 76(40) for disposing of ships-generated waste appended to the Guideline for the implementation of Annex V of MARPOL 73/78. Sufficient and adequate facilities will be available on vessels to store solid wastes generated. The contracted vessels policies and procedures will be reviewed against the MKI waste management plan, which will be filed with the C-NLOPB. Only ports with licensed waste contractors will be used for any waste returned from offshore.

5.6.6.2 Discharge Prevention and Management

Vessel discharges will not exceed those of standard vessel operations and will adhere to all applicable regulations. The main discharges include grey water (wastewater from washing, bathing, laundry, and food preparation), black water (human wastes), bilge water, deck drainage and discharges from machinery spaces. All discharges will comply with requirements in the International Convention for the Prevention of Pollution of Ships, 1973, as modified by Protocol of 1978 (MARPOL 73/78) and its annexes. Ground galley food waste can be discharged when a vessel is more than 3 miles offshore. Non-ground galley food waste can be discharged when a vessel is more than 12 miles offshore.

5.6.6.3 Air Emission Control

The vessels will have an International Air Pollution Prevention Certificate issued under the provisions of the Protocol of 1997 as amended by resolution MEPC.176(58) in 2008, to amend the International Convention for the Prevention of Pollution from Ships, 1973, as modified by the Protocol of 1978 related thereto (hereinafter referred to as the Convention). Atmospheric emissions will be those associated with standard operations for marine vessels in general, including the seismic vessel and support vessel. Vessels will only use diesel and gasoil with a sulphur content of no more than 1% (weight) following the International Convention for the Prevention of Pollution from Ships (MARPOL) Annex VI, for the North American Emission Control Area, which was implemented in Canada in August 2012 (see http://www.tc.gc.ca/eng/marinesafety/bulletins-2012-03-eng.htm).

5.6.6.4 Response to Accidental Events

In the unlikely event of the accidental release of hydrocarbons during the Project, MKI will implement the measures outlined in the Shipboard Oil Pollution Emergency Plans (SOPEPs) which will be filed with the C-NLOPB. In addition, MKI has an emergency response plan in place which bridges the emergency plans of all project entities and vessels to the local facilities and the Halifax Search and Rescue Region. The MKI representative onboard will represent MKI in all offshore Quality, Health, Safety & Environment (QHSE) activities. The Vessel Supervisor will represent MKI onshore from an office in St. John’s.

The SOPEPs are designed to assist the ships’ personnel in dealing with an unexpected discharge of oil. The primary purpose is to set in motion the necessary actions to stop or minimize the discharge of oil and to mitigate its effects. Effective planning ensures that the necessary actions are taken in a structured, logical and timely manner. The primary objectives of this Plan are to prevent oil pollution, to stop or minimize oil outflow when damage to the ship occurs, to stop or minimize oil outflow when an operational spill occurs, and to help contain/clean-up a spill.

The ships also carry Spill Kits which typically contain such equipment as:

- air operated pump;
- polypropylene scoops;
- swabs, shovels, brooms with handle;
- bags with absorbent;
- absorbent sheets;
- absorbent bond;
- guard bond;
- plastic drums;
- plastic garbage bin;
- plastic bags;
- rubber gloves and boots; and
- chemical protective suits.

In the event of the spill, the two ships would work and use their gear together to respond to and contain the released hydrocarbons.

5.6.6.5 Use of Solid Core Streamer

MKI will use a solid core streamer, manufactured by PGS; this eliminates the risk of leakage associated with cables filled with floatation fluid.

The following summarizes these mitigations organized by potential effect on VECs (Table 5.2).

Table 5.2 Summary of Mitigations Measures by Potential Effect.

Potential Effects	Primary Mitigations
Interference with fishing vessels/mobile and fixed gear fisheries	• Upfront communications, liaison and planning to avoid fishing activity • Continuing communications throughout the program • FLOs • SPOC • Advisories and communications • VMS data • Avoidance • Start-up meetings on ships
Fishing gear damage	• Upfront communications, liaison and planning to avoid fishing gear • Use of support vessel • SPOC • Advisories and communications • FLOs • Compensation program • Reporting and documentation • Start-up meetings on ships
Interference with shipping	• Advisories and at-sea communications • FLOs (fishing vessels) • Use of support vessel • SPOC (fishing vessels) • VMS data
Interference with DFO/FFAW research program	• Communications and scheduling • Avoidance
Temporary or permanent hearing damage/disturbance to marine animals	• Pre-watch of safety zone • Delay start-up if marine mammals or sea turtles are within 500 m • Ramp-up of airguns • Shutdown of airgun arrays for *endangered* or *threatened* marine mammals and sea turtles within 500 m • Use of qualified MMO(s) to monitor for marine mammals and sea turtles during daylight seismic operations
Temporary or permanent hearing damage/ disturbance to Species at Risk or other key habitats	• Pre-watch of safety zone • Delay start-up if marine mammals or sea turtles are within 500 m • Ramp-up of airguns • Shutdown of airgun arrays for *endangered* or *threatened* marine mammals and sea turtles within 500 m • Use of qualified MMO(s) to monitor for marine mammals and sea turtles during daylight seismic operations. [No critical habitat has been identified in or near the Study Area.]
Injury (mortality) to stranded seabirds	• Daily monitoring of vessel • Handling and release protocols • Minimize lighting if safe
Seabird oiling	• Adherence to MARPOL • Spill contingency and response plans • Use of solid streamer

5.7 Effects of the Environment on the Project

The physical environment is summarized in Section 3.0 of this EA and the reader is referred to this section to assist in determining the effects of the environment on the Project. Furthermore, safety issues are assessed in detail during the permitting and program application processes established by the C-NLOPB as the regulatory authority in this matter. Nonetheless, effects on the Project are important to consider, at least on a high level, because they may sometimes cause effects on the environment. For example, accidental spills may be more likely to occur during rough weather.

Given the Project time window of May to November for seismic operations and the requirement of a seismic survey to avoid periods and locations of sea ice, sea ice should have little or no effect on the Project (see Section 3.4.2). Icebergs in the spring and early summer may cause some survey delays if tracks have to be altered to avoid them (see Section 3.4.3). Within the Project time frame, icebergs may cause some detours in May and June, when ~36% of the yearly total of icebergs are expected to occur based on monthly iceberg distribution data (LGL 2010a).

Most environmental constraints on seismic surveys on the Grand Banks are those imposed by wind and wave. If the Beaufort wind scale is six or greater, there is generally too much noise for seismic data to be of use. A Beaufort wind scale of six is equivalent to wind speeds of 22-27 knots (11.3-13.9 m/s), and is associated with wave heights ranging from 2.4-4.0 m. In the Study Area, these conditions are typically reached at a consistent level in the late autumn and winter months. Certainly, if the sea state exceeds 3.0 m or winds exceed 40 kt (20.6 m/s), then continuation/termination of seismic surveying will be evaluated. The absolute operating limits for seismic vessels are 3.5 m combined sea significant wave height and 45 kt (23.2 m/s) winds. Based on multi-year data at grid point 0500 in the Laurentian Sub-Basin, these wave limits may be approached about 9% of the time in May, 4% in June, 2% in July, 4% in August, 10% in September, 21% in October, and 36% in November (see Figure 2.25 in Oceans 2014). Similar percentages for exceedance of significant wave height were observed at grid points 08026 (Figure 2.26 in Oceans 2014), 10537 (Figure 2.27 in Oceans 2014), and 11154 (Figure 2.28 in Oceans 2014). In addition, based on multi-year data at all grid points, wind speeds of 23.2 m/s are likely to occur less than 1% of the time during the Project time frame (see Figures 2.10 to 2.13 in Oceans 2014).

Poor visibility (see Section 3.2.3.2) can constrain helicopter operations. It also may hinder sightings of other vessels and fishing gear. These constraints are alleviated somewhat by MKI's experience in northwest Atlantic operations, state of the art forecasting, use of radar and FLOs to detect fishing vessels and gear.

As a prediction of the effects of the environment on the Project, some operators have used an estimate of 25% weather-related down time for the project planning purposes. If 25% is used as a guideline, then conditions in November might be considered a significant effect on Project logistics and economics by some proponents although this is likely to be variable depending upon the operator.

The Project scheduling avoids most of the continuous extreme weather conditions and MKI will be thoroughly familiar with East Coast operating conditions. Seismic vessels typically suspend surveys once wind and wave conditions reach certain levels because the ambient noise affects the data. They also do not want to damage towed gear which would cause costly delays.

Environmental effects on other Project vessels (e.g., support and service vessels) are likely less than on the seismic vessel which is constrained by safety of towed gear and data quality issues.

Effects of the biological environment on the Project are unlikely although there are anecdotal accounts of sharks attacking and damaging streamers.

The Department of National Defense (DND) records indicate that there are three shipwrecks present within the Study Area: (1) the HMCS Valleyfield [46.04°N, 52.40°W]; (2) the USS Pollux [45.88°N, 55.48°W]; and (3) the U-656 Submarine [45.24°N, 53.25°W]. The fourth shipwreck mentioned by DND in its comments on the draft scoping document, the U-658 Submarine [50.00°N, 46.53°W], does not occur within the Study Area. These vessels contained munitions at the time of sinking and these munitions may continue to pose an explosive hazard. Additionally, the Sydney Shallow Disposal Site (46.31°N, 58.65°W) is located within 50-100 km of the northwest corner of the Study Area. The Sydney Shallow Disposal Site was used to dispose excess munitions following WWII and the area surrounding the point will likely contain discarded military munitions.

It is understood that the proposed seismic activities to be conducted will have no interaction with the sea floor; therefore the associated unexploded ordinate (UXO) risk is negligible. Nonetheless, due to the inherent dangers associated UXO and the fact that the northwest Atlantic Ocean was exposed to many naval engagements during WWII, any suspected UXO encountered during the course of the operations will be left alone, geo-referenced, and immediately reported to the Coast Guard.

Effects of the environment on the Project are predicted to be *not significant* for the reasons discussed above.

5.8 Effects of the Project Activities on the Environment

This effects assessment is organized so that issues generic to any type of ship activity in the Study Area such as fisheries vessels, DFO research vessels, military ships, marine transporters, or the proposed seismic surveys are discussed first. A detailed effects assessment then follows, which focuses on the effects of noise (primarily on marine mammals, fish and fisheries) and the towed seismic streamer (primarily on fishing gear), which is the major distinction between the effects of seismic surveys versus those of other marine vessels. The applicable mitigation measures (detailed in Section 5.6) are also noted for the relevant activity. The detailed assessment includes the generic effects in the ratings and predictions tables but does not discuss these generic issues in any detail.

5.8.1 Generic Activities - Air Quality

The atmospheric emissions from Project activities will be those from the Project vessels engines and generators, and vessel incinerators, all of which will be within the range of emissions from typical marine vessels on the east coast such as fishing, research, or offshore supply vessels. As such, there will be no particular or unique health or safety concerns associated with project emissions.

Given that the Project will use low sulphur content (no more than 1%) fuel (following Canadian 2012 ECA regulations) and that it will add negligible atmospheric emissions (relative to total northwest Atlantic ship traffic) to a windy oceanic environment, there will be no measureable adverse effect on air quality or human health in the Project Area.

5.8.2 Generic Activities - Marine Use

Project-related traffic will include one seismic survey vessel and one support vessel. The seismic and support vessels will operate within the Project Area (see Figure 1.1), except when transiting to or from the survey area. The seismic and/or support vessel may operate occasionally to and from the Project Area for re-provisioning, re-fuelling, and crew changes.

Other ships operating in the area could include freighters, tankers, fishing vessels, research vessels, naval vessels, and private yachts. The Department of National Defence (DND) has indicated that it will likely be operating in the vicinity of the Study Area during the Project timeframe. DND will be kept informed of the dates and locations of seismic activities. Mitigations (detailed in Section 5.6) will minimize potential conflicts and any adverse effects with other vessels; these include:

- At sea communications (VHF, HF, Satellite, radar etc.);
- Utilization of FLOs for advice and coordination in regard to avoiding fishing vessels and fishing gear;
- Support vessel to alert other vessels of towed gear in water;
- Posting of advisories with the Canadian Coast Guard and the CBC Fisheries Broadcast;
- Compensation program in the event any project vessels damage fishing gear; and
- Single Point of Contact (SPOC).

MKI will also coordinate with DFO, St. John's, to avoid any potential conflicts with research vessels that may be operating in the area. Given the expected vessel density conditions and mitigations described above, there should be *negligible* adverse effects on other marine users of the Project Area.

5.8.3 Generic Activities - Waste Handling

Project waste will be generated by about 50 personnel. Waste will include:

- Gray/black water;
- Galley waste; and
- Solid waste.

As described in Section 5.6, vessel discharges will not exceed those of standard vessel operations and will adhere as a minimum to all applicable regulations and applicable international standards. The main discharges include grey water (wastewater from washing, bathing, laundry, and food preparation), black water (human wastes), bilge water, deck drainage and discharges from machinery spaces. Wastes produced from the seismic and support vessels, including hazardous and non-hazardous waste material, will be managed in accordance with MARPOL and with the vessel specific waste management plans.

Waste produced by the Project will handled and treated appropriately and therefore have *negligible* effect on the environment in the Project Area.

5.8.4 Fish and Fish Habitat VEC

Despite the probability of interaction between Project activities and the 'fish habitat' component of the Fish and Fish Habitat VEC (i.e., water and sediment quality, phytoplankton, zooplankton, and benthos) (Table 5.3), residual effects are predicted to be *negligible* and thus *not significant*. The seismic program will not result in any direct physical disturbance of the bottom substrate. Also, the probability of an accidental event (i.e., hydrocarbon release) of sufficient magnitude to cause a significant effect on fish habitat is low. Therefore, other than in Table 5.3, no further reference to the 'fish habitat' component of the Fish and Fish Habitat VEC is made in this assessment section. Ichthyoplankton, invertebrate eggs and larvae, and macro-benthos are considered part of the 'fish' component of the Fish and Fish Habitat VEC.

The following sections discuss the Project activities that will interact with the Fish and Fish Habitat VEC, including assessment of the potential effects of these interactions.

5.8.4.1 Underwater Sound

Exposure to anthropogenic underwater sounds has the potential to cause physical (i.e., pathological and physiological) and behavioural effects on marine invertebrates and fishes. Studies that conclude that there are physical and physiological 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. Comprehensive literature reviews related to auditory capabilities of fishes and marine invertebrates and the potential effects of exposure to seismic airgun noise on them are contained in Appendices 2 and 3. The following sections related to the Fish and Fish Habitat VEC contain summaries of the information contained in the two appendices.

Sound Detection

Sensory systems, like those that allow for hearing, provide information about an animal's physical, biological, and social environments in both air and water. Extensive work has been done to understand the structures, mechanisms, and functions of animal sensory systems in aquatic environments (Atema et al. 1988; Kapoor and Hara 2001; Collin and Marshall 2003).

Underwater sound has both a pressure component and a particle displacement component. While all marine invertebrates and fishes appear to have the capability of detecting the particle displacement component of underwater sound, only certain fish species appear to be sensitive to the pressure component (Breithaupt 2002; Casper and Mann 2006; Popper and Fay 2010).

Table 5.3 Potential Interactions of the Project Activities and the Fish and Fish Habitat VEC.

Valued Environmental Component: Fish and Fish Habitat							
Project Activities	Non-Biological Environment	Feeding		Reproduction		Adult Stage	
	Water or Sediment Quality	Plankton	Benthos	Eggs and Larvae	Juveniles [a]	Pelagic Fish	Groundfish
Underwater Sound							
Airguns		X	X	X	X	X	X
Seismic Vessel						X	
Support Vessel						X	
Supply Vessel						X	
Echo Sounder						X	
Helicopter[b]							
Vessel Presence							
Seismic Vessel and Gear							
Support Vessel							
Supply Vessel							
Vessel Lights		X				X	
Helicopter Presence							
Sanitary/Domestic Wastes	X	X		X		X	
Atmospheric Emissions	X	X		X		X	
Accidental Releases	X	X		X		X	
Garbage [c]							
Shore Facilities [d]							
Other Projects and Activities							
Oil and Gas Activities	X	X	X	X	X	X	X
Fisheries	X	X	X	X	X	X	X
Marine Transportation	X	X	X	X	X	X	X

[a] Juveniles are young fish that have left the plankton and are often found closely associated with substrates.
[b] A crew change may occur via helicopter if the seismic program is longer than 5 to 6 weeks.
[c] Not applicable as garbage will be brought ashore.
[d] There will not be any new onshore facilities; existing infrastructure will be used.

Invertebrates

The sound detection abilities of marine invertebrates are the subject of ongoing debate. Aquatic invertebrates, with the exception of aquatic insects, do not possess the equivalent physical structures present in fish and marine mammals that can be stimulated by the pressure component of sound. It appears that marine invertebrates respond to vibrations (i.e., particle displacement) rather than pressure (Breithaupt 2002). Statocysts, organs of balance containing mineral grains that stimulate sensory cells as the animal moves, apparently function as a vibration detector for at least some species of marine invertebrates (Popper and Fay 1999). The statocyst is a gravity receptor and allows the swimming animal to maintain a suitable orientation.

Among the marine invertebrates, decapod crustaceans and cephalopods have been the most intensively studied in terms of sound detection and the effects of exposure to sound. Crustaceans appear to be most sensitive to low frequency sounds (i.e., <1,000 Hz) (Budelmann 1992; Popper et al. 2001). Both cephalopods (Packard et al. 1990) and crustaceans (Heuch and Karlsen 1997) have been shown to possess acute infrasound (i.e., <20 Hz) sensitivity. Some studies suggest that there are invertebrate species, such as the American lobster (*Homarus americanus*), that may also be sensitive to frequencies >1,000 Hz (Pye and Watson III 2004).

A recent study concluded that planktonic coral larvae can detect and respond to sound, the first description of an auditory response in the invertebrate phylum Cnidaria (Vermeij et al. 2010). Eggleston et al. (2013) have presented results of laboratory and field experiments that suggest oyster larvae use underwater sound to optimize settlement. Similarly, in a study by Stocks et al. (2012), it was found that marine invertebrate larvae of several species responded to sound and, in some cases, appeared to distinguish between different sound frequencies.

Fishes

Marine fishes are known to vary widely in their abilities to detect sound. Although hearing capability data only exist for fewer than 100 of the 27,000 fish species (Hastings and Popper 2005), current data suggest that most species of fish detect sounds with frequencies <1,500 Hz (Popper and Fay 2010). Some marine fishes, such as shads and menhaden, can detect sound at frequencies >180 kHz (Mann et al. 1997, 1998, 2001). These fishes have highly specialized otophysic connections (e.g., Weberian apparatus) between pressure receptive organs, such as the swim bladder, and the inner ear. There are other fishes (e.g., Atlantic salmon (*Salmo salar*) and European eel (*Anguilla anguilla*) that are acutely sensitive to infrasound (Sand and Karlsen 2000). Reviews of fish sound-detection mechanisms and capabilities are presented in Fay and Popper (2000) and Ladich and Popper (2004).

All fishes have hearing (inner ear) and skin-based mechanosensory systems (lateral lines). Amoser and Ladich (2005) hypothesized that, as species within a particular family of fish may live under different ambient sound conditions, the hearing abilities of the individual species are likely to have adapted to the dominant conditions of their specific environments. The ability of fish to hear a range of biotic and abiotic sounds may affect their survival rate, with better adapted fish having an advantage over those that cannot detect prevailing sounds (Amoser and Ladich 2005).

Fish ears are able to respond to changes in pressure and particle displacement in the water (van Bergeijk 1964; Schuijf 1981; Kalmijn 1988, 1989; Shellert and Popper 1992; Hawkins 1993; Fay 2005). Two major pathways have been identified for sound transmittance: (1) the otoliths, calcium carbonate masses in the inner ear that act as accelerometers when exposed to the particle displacement component of sound, which cause shearing forces that stimulate sensory hair cells; and (2) the swim bladder, which expands and contracts in a sound field, re-radiating the sound's signal within the fish and in turn stimulating the inner ear (Popper and Fay 1993).

Researchers have noted that fish without an air-filled cavity (swim bladder), or with a reduced swim bladder or limited connectivity between the swim bladder and inner ear, are limited to detecting particle displacement and not pressure, and therefore have relatively poor hearing abilities (Casper and Mann 2006). These species have commonly been known as 'hearing generalists' (Popper and Fay 1999), although a recent reconsideration suggests that this classification is oversimplified (Popper and Fay 2010). Rather, there is a range of hearing capabilities across species that is more like a continuum, presumably based on the relative contributions of pressure to the overall hearing capabilities of a species

(Popper and Fay 2010). Results of direct study of fish sensitivity to particle displacement have been reported in numerous recently published papers (e.g., Horodysky et al. 2008; Wysocki et al. 2009; Kojima et al. 2010).

Sound Production

Many invertebrates and fishes produce sounds. It is believed that these sounds are used for communication in a wide range of behavioural and environmental contexts. The behaviours most often associated with acoustic communication include territorial behaviour, mate searching, courtship and aggression. Sound production provides a means of long distance communication as well as communication when underwater visibility is poor (Zelick et al. 1999).

Invertebrate groups with species capable of producing sound include barnacles, amphipods, shrimps, crabs, and lobsters (Au and Banks 1998; Tolstoganova 2002; Pye and Watson III 2004; Henninger and Watson III 2005; Buscaino et al. 2011). Invertebrates typically produce sound by scraping or rubbing various parts of their bodies together.

More than 700 fish species are known to produce sounds (Myrberg 1981, Kaatz 2002 *in* Anderson et al. 2008). Fishes produce sounds mainly by using modified muscles attached to their swim bladders (i.e., drumming) or rubbing body parts together (i.e., stridulating). Examples of 'soniferous' fishes include Atlantic cod (Finstad and Nordeide 2004; Rowe and Hutchings 2004), toadfishes (Locascio and Mann 2008; Vasconcelos and Ladich 2008), and basses (Albers 2008; Johnston et al. 2008).

Effects of Exposure to Airgun Sound

Most airgun sound energy is associated with frequencies <500 Hz, although there is also some energy at higher frequencies.

<u>Physical Effects</u>

For the purposes of this EA, physical effects include both pathological and physiological effects.

Invertebrates

To date, experimentation intended to investigate the physical effects of exposure to seismic airgun sound on marine invertebrates has been limited to crustaceans and cephalopods. Both egg/larvae and juvenile/adult stages have been used in the limited number of studies.

Dungeness crab (*Cancer magister*) larvae and snow crab (*Chionoecetes opilio*) fertilized eggs have both been studies with respect to the effects of exposure to airgun sound. In their field study, Pearson et al. (1994) did not find any statistically significant differences in immediate survival, long-term survival, or time to moult between the treatment and control Dungeness crab larvae, even when exposure occurred within one metre of the sound source. Christian et al. (2003, 2004) found a significant difference in development rate between treatment and control fertilized eggs containing embryos. The egg mass exposed to seismic sound had a higher proportion of less-developed eggs than did the unexposed mass.

It should be noted that both egg masses came from a single female and any measure of natural variability was unattainable. In another field study involving snow crab, neither acute nor chronic lethal or sub-lethal injury to crab embryos was apparent after egg-bearing females were exposed to seismic sound emitted during a commercial seismic survey (DFO 2004a,b). In a recent study, wild New Zealand scallop larvae were exposed to recorded seismic sound and results suggested developmental delays and body abnormalities due to cumulative exposure (de Soto et al. 2013)

Adult American lobster (*Homarus americanus*), snow crab, and blue mussels (*Mytilus edulis*) have also been used as subjects during the study of the potential effects of exposure to airgun sound on marine invertebrates. Payne et al. (2007) exposed adult lobsters in a laboratory-based study and observed for both acute and chronic physical effects. No pathological effects were seen but significant differences in levels of serum protein, enzymes and calcium were observed. During histological analysis four months after exposure, Payne et al. (2007) noted the presence of glycogen deposits in the hepatopancreas of some exposed animals, perhaps due to stress or disturbance of cellular processes. Christian et al. (2003, 2004) did not observe any physical effects in adult snow crab exposed to seismic airgun sound. Physical differences between treatment and control female snow crabs were observed during a study in the Gulf of St. Lawrence but due to study design, these differences could not be linked to the airgun sound (DFO 2004a,b).

McCauley et al. (2000a,b) exposed caged cephalopods to sound from a single 20 in^3 airgun with maximum SPLs of >200 dB re 1 $\mu Pa_{0\text{-}p}$. Statocysts were removed and preserved, but at the time of publication, results of the statocyst analyses were not available. No squid or cuttlefish mortalities were reported as a result of these exposures.

See Appendix 3 for more details related to the study of the physical effects of exposure to airgun sound on marine invertebrates.

Fishes

Several review papers on the effects of anthropogenic sources of underwater sound on fishes have been published recently (Popper 2009; Popper and Hastings 2009a,b; Slabbekoorn et al. 2010, Fay and Popper 2012). These papers consider various sources of anthropogenic sound, including seismic airguns. As with marine invertebrates, both egg/larvae and juvenile/adult stages have been used in the study of physical effects of exposure to airgun sound on fishes.

Fertilized capelin (*Mallotus villosus*) eggs and monkfish (*Lophius americanus*) larvae were exposed to seismic airgun sound in the laboratory and subsequently examined and monitored for possible effects of the exposure (Payne et al. 2009). No statistical differences in mortality/morbidity between treatment and control subjects were found at one to four days post-exposure in any of the trials for either the capelin eggs or the monkfish larvae.

In uncontrolled experiments, Kostyuchenko (1973) exposed the eggs of numerous fish species (anchovy, red mullet, crucian carp, blue runner) to various sound sources, including seismic airguns. With the seismic airgun discharge as close as 0.5 m from the eggs, over 75% of them survived the exposure. Egg survival rate increased to over 90% when the subjects were 10 m from the airgun sound source.

Eggs, yolk sac larvae, post-yolk sac larvae, post-larvae, and fry of various commercially important fish species (cod, saithe, herring, turbot, and plaice) were exposed to received SPLs ranging from 220 to 242 dB re 1 μPa (unspecified measure type) (Booman et al. 1996). These received levels corresponded to exposure distances ranging from 0.75 to 6 m. The authors reported some cases of injury and mortality but most of these occurred as a result of exposures at very close range.

Saetre and Ona (1996) applied a "worst-case scenario" mathematical model to investigate the effects of seismic sound on fish eggs and larvae. They concluded that mortality rates caused by exposure to seismic airgun sound are so low compared to the natural mortality that the impact of seismic surveying on recruitment to a fish stock must be regarded as insignificant.

Evidence for airgun sound-related damage to adult fish ears has resulted from studies using caged pink snapper (*Pagrus auratus*) (McCauley et al. 2000a,b, 2003). In some individual fish, the sensory epithelium of the inner ear sustained extensive damage as indicated by ablated hair cells. Damage was more extensive in fish examined 58 days post-exposure compared to those examined 18 hours post-exposure. There was no evidence of repair or replacement of damaged sensory cells up to 58 days post-exposure. McCauley et al. (2000a,b, 2003) included the following *caveats* in the study reports: (1) fish were caged and unable to swim away from the seismic source, (2) only one species of fish was examined, (3) the impact on the ultimate survival of the fish is unclear, and (4) airgun exposure specifics required to cause the observed damage were not obtained.

In a study examining the effects of exposure to seismic airgun sound on anadromous fishes, Thomsen (2002) exposed rainbow trout and Atlantic salmon held in aquaculture enclosures to recordings of sounds from a small airgun array. No fish mortality was observed during or immediately after exposure.

See Appendix 2 for more details related to the study of the physical effects of exposure to airgun sound on marine fishes.

Behavioural Effects

Considering the lack of scientific evidence for physical effects of exposure to airgun sound on non-captive marine invertebrates and fishes, much of the current research is investigating the behavioural effects of exposure to airgun sound on these biota.

Invertebrates

Christian et al. (2003) investigated the behavioural effects of exposure to airgun sound on snow crabs using both telemetry and underwater video. None of the animals tagged with ultrasonic transmitters left the immediate area after exposure to the airgun sound. Underwater video was used to monitor caged animals placed on the ocean bottom and then exposed to airgun sound from a distance of 50 m. The snow crab did not exhibit any overt startle response during the exposure period.

In their study of the effects of exposure to airgun sound on adult American lobsters, Payne et al. (2007) noted a trend of increased food consumption by the animals exposed to seismic sound.

McCauley et al. (2000a,b) provided the first evidence of the behavioural response of southern calamari squid *Sepioteuthis australis* exposed to seismic survey sound. McCauley et al. (2000a, b) reported on the exposure of caged cephalopods (50 squid and two cuttlefish) to sound from a single 20 in^3 airgun. The cephalopods were exposed to both stationary and mobile sound sources. Some of the squid fired their ink sacs apparently in response to the first shot of one of the trials and then moved quickly away from the airgun. In addition to the above-described startle responses, some squid also moved towards the water surface as the airgun approached. McCauley et al. (2000a,b) reported that the startle and avoidance responses occurred at a received SPL of 174 dB re 1 μPa_{rms}. They also exposed squid to a ramped approach-depart airgun signal whereby the received SPL was gradually increased over time. No strong startle response (i.e., ink discharge) was observed, but alarm responses, including increased swimming speed and movement to the surface, were observed once the received SPL reached a level in the 156 to 161 dB re 1 μPa_{rms} range.

Although not demonstrated in the invertebrate literature, masking can be considered a potential effect of anthropogenic underwater sound on marine invertebrates. Some invertebrates are known to produce sounds (Au and Banks 1998; Tolstoganova 2002; Latha et al. 2005). The functionality and biological relevance of these sounds are not understood (Jeffs et al. 2003, 2005; Lovell et al. 2006; Radford et al. 2007). If some of the sounds are of biological significance to some invertebrates, then masking of those sounds or sounds produced by predators could potentially have adverse effects on marine invertebrates. However, even if masking does occur in some invertebrates, the pulsed nature of airgun sound is expected to result in less masking effect than would occur with continuous sound.

Invertebrate Fisheries

Christian et al. (2003) investigated the pre- and post-exposure catchability of snow crabs during a commercial fishery. Catch-per-unit-effort did not decrease after the crabs were exposed to seismic survey sound. Note that there was considerable variability in set duration due to poor weather conditions. Anecdotal information from Newfoundland suggested that catch rates of snow crabs showed a reduction immediately following a pass by a seismic survey vessel (G. Chidley, Newfoundland fisherman, pers. comm.). Additional anecdotal information from Newfoundland indicated that a school of shrimp observed via a fishing vessel sounder shifted downwards and away from a nearby seismic airgun sound source (H. Thorne, Newfoundland fisherman, pers. comm.). These observed behaviours were temporary.

Andriguetto-Filho et al. (2005) evaluated the impact of seismic survey sound on artisanal shrimp fisheries off Brazil. Results of that study did not indicate any significant impact on shrimp catches.

Parry and Gason (2006) statistically analyzed data related to rock lobster (*Jasus edwardsii*) commercial catches and seismic surveying in Australian waters from 1978 to 2004. They found no evidence that lobster catch rates were affected by seismic surveys. They also noted that due to natural variability and fishing pressure, a large effect on lobster would be required to make any link to seismic surveys.

See Appendix 3 for more details related to the study of the behavioural effects of exposure to airgun sound on marine invertebrates.

Fishes

Pearson et al. (1992) investigated the behavioural effects of seismic airgun sound on the behaviour of captive rockfishes (*Sebastes* spp.). The authors reported that rockfishes reacted to the airgun sounds by exhibiting varying degrees of startle (classic C-turn response) and alarm (e.g., darting movements, flash school expansion, fast swimming) responses, depending on the species of rockfish and the received sound pressure level. Skalski et al. (1992) also studied the potential behavioural effects of exposure to seismic airgun sound on the rockfishes. During long-term stationary seismic airgun discharge, there was an overall downward shift in fish distribution. It should be noted that this experimental approach was quite different from an actual seismic survey, in that duration of exposure was much longer.

Caged fish exposed to airgun sound in a study by McCauley et al. (2000a,b) exhibited startle and alarm responses. The occurrence of both startle response and alarm responses decreased over time. Other observations included downward distributional shift, increase in swimming speed, and the formation of denser aggregations. Fish behaviour appeared to return to pre-exposure state shortly after the exposures ended.

Hassel et al. (2003, 2004) studied the potential effects of exposure to airgun sound on the behavior of captive lesser sandeel, *Ammodytes marinus*. During seismic airgun discharge, many fish exhibited startle responses, followed by flight from the immediate area. The frequency of occurrence of startle response seemed to increase as the operating seismic array moved closer to the fish. The sandeels stopped exhibiting the startle response once the airgun discharge ceased. During airgun discharge, the sandeels tended to remain higher in the water column and not bury themselves in the soft substrate.

Other studies of fish behavioural effects of exposure to airgun sound have been conducted (Chapman and Hawkins 1969; Dalen and Knutsen 1986; La Bella et al. 1996; Santulli et al. 1999; Wardle et al. 2001; Thomsen 2002; Slotte et al. 2004; Boeger et al. 2006; Jorgenson and Gyselman 2009). Generally, these studies reported results similar to those described above; temporary startle/alarm responses and distributional shifts.

The following section reviews fishery-related studies of fish behavioural effects due to exposure to airgun sound.

Finfish Fisheries

Early experimentation on the effects of seismic airgun sound on catchability of fishes was conducted in the Barents Sea by Engås et al. (1993, 1996). They investigated the effects of exposure to seismic airgun sound on distributions, abundances, and catch rates of cod and haddock using acoustic mapping and experimental fishing with trawls and longlines. They concluded that there were indications of distributional change during and immediately following the seismic airgun discharge. The authors indicated that trawl catches of both cod and haddock declined after the seismic operations. While longline catches of haddock also showed decline after seismic airgun discharge, those for cod increased.

Dalen and Knutsen (1986), Løkkeborg (1991), and Løkkeborg and Soldal (1993) also examined the effects of seismic airgun sound on demersal fish catches. Løkkeborg (1991) examined the effects on cod catches. Catch rate decreases ranging from 55 to 80% were observed within the seismic survey area. This apparent effect persisted for at least 24 hours within about 10 km of the survey area. The effect of exposure to seismic sound on commercial demersal fishes was again studied in 2009 using gillnet and longline fishery methods off the coast of Norway (Løkkeborg et al. 2012). Study results indicated that fishes did react to airgun sound based on observed changes in catch rates during seismic shooting. Gillnet catches increased during the seismic shooting, perhaps as a result of increased fish activity, while longline catches showed an overall decrease.

Skalski et al. (1992) examined the potential effects of airgun sound on the catchability of rockfishes. The catch-per-unit-effort (CPUE) for rockfish declined, on average, by 52% when the airguns were operating. Skalski et al. (1992) concluded that the reduction in catch resulted from a change in behaviour of the fishes. For example, the fish schools descended towards the bottom during airgun discharge. Although lateral fish dispersal was not observed, the authors hypothesized that it could have occurred at a different location with a different bottom type. Skalski et al. (1992) did not continue fishing after cessation of airgun discharge. They speculated that CPUE would quickly return to normal in the experimental area because fish behaviour appeared to normalize within minutes of cessation of airgun discharge. However, in an area where exposure to airgun sound might have caused the fish to laterally disperse, the authors suggested that a lower CPUE might persist for a longer period.

See Appendix 2 for more details related to the study of the behavioural effects of exposure to airgun sound on marine fishes.

Effects of Exposure to Marine Vessel Sound

Numerous papers about the behavioural responses of fishes to marine vessel sound have been published in the primary literature. They consider the responses of small pelagic fishes (e.g., Misund et al. 1996; Vabo et al. 2002; Jørgensen et al. 2004; Skaret et al. 2005; Ona et al. 2007; Sand et al. 2008), large pelagic fishes (Sarà et al. 2007), and groundfishes (Engås et al. 1998; Handegard et al. 2003; De Robertis et al. 2008). Generally, most of the papers indicate that fishes typically exhibit some level of reaction to the sound of approaching marine vessels, the degree of reaction being dependent on a variety of factors including the activity of the fish at the time of exposure (e.g., reproduction, feeding, and migration), characteristics of the vessel sound, and water depth.

Sound Exposure Effects Assessment

The assessment in this and subsequent sections is structured such that the reader should first refer to the interaction table (e.g., Table 5.3) to determine if there are any interactions with Project activities, secondly to the assessment table (e.g., Table 5.4) which contains ratings for magnitude, geographic extent, and duration, and thirdly to the significance predictions table (e.g., Table 5.5).

It is impossible to assess in detail the potential effects of every type of sound on every species in the Study Area. The best approach, and common practice in EA, is to provide focus by selecting (1) the strongest sound source (i.e., airgun array), and (2) several species that are locally important and representative of the different types of sensitivities, and (3) species or groups that offer a relevant literature base. Snow crab and Atlantic cod best serve this purpose.

The most notable animal-related criteria in the assessment include (1) distance between airgun array and animal under normal conditions (e.g., post-larval snow crabs remain on bottom, post-larval cod occur in the water column, and larvae of both snow crab and cod are planktonic in upper water column), (2) motility of the animal (e.g., post-larval snow crabs are much less motile than post-larval cod, and larvae of both are essentially passive drifters), (3) absence or presence of a swim bladder (i.e., auditory sensitivity) (snow crabs without swim bladder and cod with swim bladder), and (4) reproductive strategy (snow crabs carry fertilized eggs at the bottom until larval hatch, and cod eggs are planktonic).

Potential impacts on other marine invertebrate and fish species are inferred from the assessment using snow crab and Atlantic cod.

As already indicated in this section, many data gaps remain despite the increase in research on the effects of exposure to airgun sound on marine invertebrates and fishes. Available experimental data suggest that there may be physical impacts on the fertilized eggs of snow crab and on the egg, larval, juvenile and adult stages of cod at very close range. Considering the typical source levels associated with commercial seismic airgun arrays, proximate occurrence to the source would result in exposure to very high sound levels. While egg and larval stages are not able to actively escape such an exposure scenario, juvenile and adult cod would most likely avoid it. Developing embryos, juvenile and adult snow crab are benthic and generally far enough from the sound source to receive energy levels well below levels that may have effects. In the case of eggs and larvae, it is likely that the numbers negatively affected by exposure to seismic sound would be within the range of those succumbing to natural mortality. Atlantic cod do have swim bladders and are therefore generally more sensitive to underwater sounds than fishes without swim bladders. Spatial and temporal avoidance of critical life history times (e.g., spawning aggregations) to the extent possible as well as ramp-up should mitigate the effects of exposure to airgun sound. Snow crab, sensitive to the particle displacement component of sound only, will be at least 75-100 m from the airguns and will not likely be affected by any particle displacement resulting from airgun discharge.

Limited data regarding physiological impacts on fish and invertebrates indicate that these impacts are both short-term and most obvious after exposure at close range.

The physical effects on marine invertebrates and fishes of exposure to sound with frequencies >500 Hz are *negligible*, based on the available information from the scientific literature. The behavioural effects on marine invertebrates and fishes of exposure to sound with frequencies >500 Hz appear to be temporary.

Table 5.4 provides the details of the assessment of the effects of exposure to Project-related sound on the Fish and Fish Habitat VEC. As indicated in Table 5.4, sound produced as a result of MKI's proposed Project (airgun array sound being the worst-case scenario) is predicted to have *low* magnitude residual effects on the various life stages of the Fish and Fish Habitat VEC for a duration of *<1 month* to *1 to 12 months* over an area of *<1* to *11-100 km*^{2}. Based on these criteria ratings, the *reversible* residual effects of Project-related sound on the Fish and Fish Habitat VEC are predicted to be *not significant* (Table 5.5). The level of confidence associated with this prediction is *medium* to *high* (Table 5.5).

5.8.4.2 Other Project Activities

Vessel Lights

There are potential interactions between vessel lights and certain components of the Fish and Fish Habitat VEC (see Table 5.3). However, other than the relatively neutral effect of attraction of certain species/life stages to the upper water column at night, there will be *negligible* effects of vessel lights on this VEC (see Table 5.4). Therefore, the residual effects of vessel lights associated with MKI's proposed Project on the Fish and Fish Habitat VEC are predicted to be *not significant* (see Table 5.5). The level of confidence associated with this prediction is *high* (Table 5.5).

Sanitary/Domestic Waste

There are potential interactions between sanitary/domestic waste and certain components of the Fish and Fish Habitat VEC (Table 5.3). After application of mitigation measures, including treatment of the waste, the residual effects of sanitary/domestic waste on the Fish and Fish Habitat VEC are predicted to be *negligible* to *low* in magnitude for a duration of *<1* to *1-12 months* over an area of *<1 km*^{2} (see Table 5.4). Based on these criteria ratings, the *reversible* residual effects of *infrequent* exposure to sanitary/domestic waste associated with MKI's proposed Project on the Fish and Fish Habitat VEC are predicted to be *not significant* (see Table 5.5). The level of confidence associated with this prediction is *high* (Table 5.5).

Atmospheric Emissions

There are potential interactions between atmospheric emissions and certain components of the Fish and Fish Habitat VEC that occur very near surface (Table 5.3). Considering that the amount of atmospheric emissions produced during the proposed seismic program will rapidly disperse to undetectable levels, the residual effects of exposure to them on the Fish and Fish Habitat VEC are predicted to be *negligible* in magnitude for a duration of *<1* to *1-12 months* over an area of *<1 km*^{2} (see Table 5.4). Therefore, the *reversible* residual effects of *continuous* atmospheric emissions associated with MKI's proposed Project on the Fish and Fish Habitat VEC are predicted to be *not significant* (see Table 5.5). The level of confidence associated with this prediction is *high* (Table 5.5).

Table 5.4 Assessment of Effects on the Fish and Fish Habitat VEC.

Valued Environmental Component: Fish and Fish Habitat								
Project Activity	Potential Positive (P) or Negative (N) Environmental Effect	Mitigation	Evaluation Criteria for Assessing Environmental Effects					
			Magnitude	Geographic Extent	Frequency	Duration	Reversibility	Ecological/ Socio-Cultural and Economic Context
Underwater Sound								
Airguns	Physical effects (N); Disturbance (N)	Ramp-up of array; Spatial & temporal avoidance[a]	1	1-3	6	1-2	R	2
Seismic Vessel	Disturbance (N)	Spatial & temporal avoidance[a]	0-1	1	6	1-2	R	2
Support Vessel	Disturbance (N)	Spatial & temporal avoidance[a]	0-1	1	6	1	R	2
Supply Vessel	Disturbance (N)	Spatial & temporal avoidance[a]	0-1	1	6	1-2	R	2
Echo Sounder	Disturbance (N)	Spatial & temporal avoidance[a]	0	1	6	1	R	2
Vessel Lights	Neutral effect	-	0	-	-	-	-	-
Sanitary/ Domestic Waste	Pathological effects (N); Contamination (N)	Treatment	0-1	1	1	1-2	R	2
Atmospheric Emissions	Pathological effects (N); Contamination (N)	Equipment maintenance	0	1	6	1-2	R	2
Accidental Releases	Pathological effects (N); Contamination (N)	Solid streamer[b]; spill response	0-1	1-2	1	1	R	2

Key:

Magnitude:
0 = Negligible, essentially no effect
1 = Low
2 = Medium
3 = High

Frequency:
1 = <11 events/yr
2 = 11-50 events/yr
3 = 51-100 events/yr
4 = 101-200 events/yr
5 = >200 events/yr
6 = continuous

Reversibility:
R = Reversible
I = Irreversible
(refers to population)

Duration:
1 = <1 month
2 = 1-12 months
3 = 13-36 months
4 = 37-72 months
5 = >72 months

Geographic Extent:
1 = <1 km^2
2 = 1-10 km^2
3 = 11-100 km^2
4 = 101-1,000 km^2
5 = 1,001-10,000 km^2
6 = >10,000 km^2

Ecological/Socio-cultural and Economic Context:
1 = Relatively pristine area or area not negatively affected by human activity
2 = Evidence of existing negative effects

[a] Avoidance of sensitive areas and times,to the extent possible.
[b] Solid or isopar filled streamers may be used during surveys, depending on the seismic contractor.

Table 5.5 Significance of Potential Residual Environmental Effects of Project Activities on the Fish and Fish Habitat VEC.

Valued Environmental Component: Fish and Fish Habitat				
Project Activity	Significance Rating	Level of Confidence	Likelihood [a]	
	Significance of Predicted Residual Environmental Effects		Probability of Occurrence	Scientific Certainty
Underwater Sound				
Airguns	NS	2-3	-	-
Seismic Vessel	NS	2-3	-	-
Support Vessel	NS	2-3	-	-
SupplyVessel	NS	2-3	-	-
Echo Sounder	NS	2-3	-	-
Vessel Lights	NS	3	-	-
Sanitary/Domestic Wastes	NS	3	-	-
Atmospheric Emissions	NS	3	-	-
Accidental Releases	NS	2-3	-	-

Key:

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

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

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

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

Scientific Certainty: based on scientific information and statistical analysis or professional judgment:
1 = Low Level of Confidence
2 = Medium Level of Confidence
3 = High Level of Confidence

[a] Considered only in the case where 'significant negative effect' is predicted.

Accidental Releases

Planktonic invertebrate and fish eggs and larvae are less resistant to effects of contaminants than are adults because they are not physiologically equipped to detoxify them or to actively avoid them. In addition, many eggs and larvae develop at or near the surface where hydrocarbon exposure may be the greatest (Rice 1985). Generally, fish eggs appear to be highly sensitive at certain stages and then become less sensitive just prior to larval hatching (Kühnhold 1978; Rice 1985). Larval sensitivity varies with yolk sac stage and feeding conditions (Rice et al. 1986). Eggs and larvae exposed to high concentrations of hydrocarbons generally exhibit morphological malformations, genetic damage, and reduced growth. Damage to embryos may not be apparent until the larvae hatch. The natural mortality rate in fish eggs and larvae is extremely high and very large numbers would have to be destroyed by anthropogenic sources before effects would be detected in an adult population (Rice 1985).

There is an extensive body of literature regarding the effects of exposure to hydrocarbons on juvenile and adult fish. Although some of the literature describes field observations, most refer to laboratory studies. Reviews of the effects of hydrocarbons on fish have been prepared by Rice et al. (1986), Armstrong et al. (1995), Payne et al. (2003), and numerous other authors. If exposed to hydrocarbons in high enough concentrations, fish may suffer effects ranging from direct physical effects (e.g., coating of gills and suffocation) to more subtle physiological and behavioural effects. Actual effects depend on a variety of factors such as the amount and type of hydrocarbon, environmental conditions, species and life stage, lifestyle, fish condition, degree of confinement of experimental subjects, and others.

As indicated in Table 5.3, there are potential interactions of accidental releases and components of the Fish and Fish Habitat VEC that occur near surface. The effects of hydrocarbon spills on marine invertebrates and fish have been discussed and assessed in numerous recent environmental assessments of proposed offshore drilling programs and assessments have concluded that the residual effects of accidental hydrocarbon releases on the Fish and Fish Habitat VEC are predicted to be *not significant*. With proper mitigations in place, the residual effects of an accidental release associated with MKI's proposed seismic program on the Fish and Fish habitat VEC would be *negligible* to *low* in magnitude for a duration of *<1 month* over an area of *<1* to *1-10 km^2* (see Table 5.4). Based on these criteria ratings and consideration that the probability of accidental hydrocarbon releases during the proposed seismic program are low, the *reversible* residual effects of accidental releases associated with the proposed program on the Fish and Fish Habitat VEC are predicted to be *not significant* (see Table 5.5). The level of confidence associated with this prediction is *medium* to *high* (Table 5.5).

5.8.5 Fisheries VEC

The potential interactions of Project activities and the Fisheries VEC are indicated in Table 5.6. Traditional fisheries, recreational fisheries, DFO and joint DFO/Industry Research Surveys were included in the assessment of the Fisheries VEC.

The seismic survey vessel and Project-related support vessel traffic will be present within NAFO Divisions 3L, 3M, 3N, 3O, 3Ps and 4Vs. Behavioural changes in commercial species in relation to catchability, and conflict with harvesting activities and fishing gear were raised as potential issues during the consultations and issues scoping for the current and recent EAs (see reviewed EAs in Section 5.1). Seismic streamers and vessels can conflict with and damage fishing gear, particularly fixed gear (e.g., snow crab pots or gillnets). Such conflicts have occurred in Atlantic Canada in the past when seismic vessels were operating in heavily fished areas. There is also a potential for interference from seismic activities with DFO and DFO/Industry research surveys if both are being conducted in a same general area at the same time. An accidental release of petroleum hydrocarbons may result in tainting (or perceived tainting) thus affecting product quality and marketing.

The chief means of mitigating potential impacts on fishery activities is to avoid active fishing areas, particularly fixed gear zones. For the commercial fisheries, gear damage compensation provides a means of final mitigation of impacts, in case a conflict does occur with fishing gear (i.e., accidental contact of gear with the survey air source array, streamers or seismic vessel).

Table 5.6 Potential Interactions of Project Activities and the Fisheries VEC.

Valued Environmental Component: Fisheries			
Project Activities	**Mobile Invertebrates and Fishes (fixed [e.g., gillnet] and mobile gear [e.g., trawls])**	**Sedentary Benthic Invertebrates (fixed gear [e.g., crab pots])**	**Research Surveys (mobile gear-trawls; fixed gear-crab pots)**
Underwater Sound			
Airguns	X	X	X
Seismic Vessel	X	X	X
Support Vessel	X	X	X
Supply Vessel	X	X	X
Echosounder	X		
Helicopter[a]			
Vessel Presence			
Seismic Vessel and Gear	X	X	X
Support Vessel	X	X	X
Supply Vessel	X	X	X
Vessel Lights			
Helicopter Presence [a]			
Sanitary/Domestic Wastes	X	X	X
Atmospheric Emissions			
Accidental Releases	X	X	X
Garbage [b]			
Shore Facilities [c]			
Other Projects and Activities			
Oil and Gas Activities	X	X	X
Marine Transportation	X	X	X

[a] No helicopter use is planned for 2014 but helicopters may be used during 2015-2018.
[b] Not applicable as garbage will be brought ashore.
[c] There will not be any new onshore facilities. Existing infrastructure will be used.

The document *Geophysical, Geological, Environmental and Geotechnical Program Guidelines* (C-NLOPB 2012) provides guidance aimed at minimizing any impacts of petroleum industry surveys on commercial fish harvesters and other marine users. The mitigations described below are also relevant to DFO and joint DFO/Industry research surveys. Development of the guidelines was based on best practices applied during previous surveys in Atlantic Canada, as well as guidelines from other national jurisdictions.

The relevant guidelines state the following (in Appendix 2 of C-NLOPB (2012) - Environmental Planning, Mitigation and Reporting – II. Interaction with Other Ocean Users):

VSP Programs and Wellsite Surveys

a) The operator should implement operational arrangements to ensure that the operator and/or its survey contractor and the local fishing interests are informed of each other's planned activities. Communication throughout survey operations with fishing interests in the area should be maintained.

b) *The operator should publish a Canadian Coast Guard "Notice to Mariners" and a "Notice to Fishers" via the CBC Radio program Fisheries Broadcast.*

c) *Operators should implement a gear and/or vessel damage compensation program, to promptly settle claims for loss and/or damage that may be caused by survey operations. The scope of the compensation program should include replacement costs for lost or damaged gear and any additional financial loss that is demonstrated to be associated with the incident. The operator should report on the details of any compensation awarded under such a program (i.e., to the C-NLOPB).*

d) *Procedures must be in place on the survey vessel(s) to ensure that any incidents of contact with fishing gear are clearly detected and documented (e.g., time, location of contact, loss of contact, and description of any identifying markings observed on affected gear). As per Section 5.2 of these Guidelines, any incident should be reported immediately to the 24-hour answering service at (709) 778-1400 or to the C-NLOPB Duty Officer.*

2D, 3D and 4D Seismic Programs

In addition to the measures indicated above, the following mitigation measures should also be implemented:

a) *Surveys should be scheduled, to the extent possible, to reduce potential for impact or interference with Department of Fisheries and Ocean (DFO) science surveys. Spatial and temporal logistics should be determined with DFO to reduce overlap of seismic operations with research survey areas, and to allow an adequate temporal buffer between seismic survey operations and DFO research activities.*

b) *Seismic activities should be scheduled to avoid heavily fished areas, to the extent possible. The operator should implement operational arrangements to ensure that the operator and/or its survey contractor and local fishing interests are informed of each other's planned activities. Communication throughout survey operations with fishing interests in the area should be maintained. The use of a 'Fisheries Liaison Officer' (FLO) onboard the seismic vessel is considered best practice in this respect.*

c) *Where more than one survey operation is active in a region, the operator(s) should arrange for a 'Single Point of Contact' for marine users that may be used to facilitate communication.*

The following sections assess the potential effects of Project activities on the Fisheries VEC.

5.8.5.1 Underwater Sound

As indicated in the description of commercial fisheries in Section 4.3, there has been substantial harvesting within NAFO Units 3L, 3N, 3O, 3Ps and 4Vs in the Study Area between 2005 and 2010.

Snow crab, yellowtail flounder and redfish accounted for most of the commercial harvest within the Study Area during that period. The potential for impacts on fish harvesting will, depend on the location and timing of the surveying activities in relation to these fishing areas, and the type of fishing gear used in any given season. If the survey work is situated away from these fishing areas or occur at different times, the likelihood of any impacts on commercial harvesting will be greatly reduced.

The DFO and joint DFO/Industry research surveys are also conducted using fishing gear. As such, the issues related to potential interference with DFO and joint DFO/Industry research surveys are much the same as for commercial fish harvesting (i.e., potential effects on catch rates and conflicts with research vessel operations).

Potential effects on marine fish behaviour are assessed in Section 5.8.4. While adult fish could be injured by airgun sound if they are within a few metres of a sound source, this is unlikely since fish are likely to disperse during array ramp-up or vessel approach. Therefore, the most likely type of effect will be behavioural. Seismic surveys could cause reduced trawl and longline catches during and following a survey if the fish exhibit behavioural changes (e.g., horizontal and vertical dispersion). There are various research studies on this subject as discussed in Section 5.8.4. While some of the behavioural effects studies report decreases in catch rates near the seismic survey area, there is some disagreement on the duration and geographical extent of the effect.

Mitigation

Mitigations are detailed in a previous section. The primary measures intended to minimize the effects of Project activities on the harvesting success component of the Fisheries VEC include:

- Avoidance in time and space of concentrated fishing areas to the greatest extent possible;
- Good communications; and
- Deployment of Fisheries Liaison Officers (FLOs), for 2D/3D seismic programs.

The relevant guidelines state the following with respect to planning seismic surveys (in Appendix 2 of C-NLOPB (2012) - Environmental Planning, Mitigation and Reporting – I. Statement of Canadian Practice with Respect to the Mitigation of Seismic Sound in the Marine Environment):

Mitigation Measures

a) Use the minimum amount of energy necessary to achieve operational objectives;
b) Minimize the proportion of the energy that propagates horizontally; and
c) Minimize the amount of energy at frequencies above those necessary for the purpose of the survey.

Avoidance

The potential effects of seismic sound on fishery catch success can be mitigated by avoiding heavily fished areas when these fisheries are active (particularly the snow crab, yellowtail flounder and redfish areas) to the greatest extent possible. As described in this report, most of the domestic fishing in the past has been concentrated in well-defined areas within the Study Area, namely between the 100 and 1,000 m isobaths along the slope of the southern Grand Banks. During any seismic survey, the location of current fishing activities will be monitored by the ship and the FLO (see below), and fishing boats will be contacted by radio as required. Survey personnel (through the Single Point of Contact [SPOC], described below) will also continue to be updated about fisheries near the active survey area. The mapping of fishing activities contained in this EA report will also be an important source of fisheries information for the survey operators.

Communications

During the fisheries consultations for this and other surveys, fisheries representatives noted that good communication is one of the best ways to minimize interference between the seismic operations and fishing activities. Communication will be maintained (both directly at sea and through the survey SPOC) to facilitate information exchange, which includes such groups as DFO managers, independent fishers, representatives of fisheries organizations such as the FFAW, and managers of other key corporate fisheries in the area.

Relevant information about the seismic survey operations will also be transmitted using established communications mechanisms, such as the *Notices to Shipping* (Continuous Marine Broadcast and NavTex), the CBC (Newfoundland) Radio's *Fisheries Broadcast*, by the FFAW in the FFAW *Union Forum* (as suggested during previous consultations), and by direct communication between the seismic survey vessels and fishing vessels via marine radio at sea. This includes seismic survey vessel transit before and after the survey itself.

Fisheries Liaison Officer (FLO)

As a specific means of facilitating at-sea communications, and informing the 2D/3D survey vessel operators about local fisheries, when necessary MKI will have an on-board fisheries industry liaison officer serving as a "fisheries representative." The FLO will remain on the relevant survey vessel for the entire program. This will provide 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. This person will inform the vessel's bridge personnel about any local fishing activities.

Assessment of the Effects of Seismic Survey Sound

Since commercial catches are quota-based, the overlap between fishing activity and seismic activity is unknown at the moment, but will be determined prior to the commencement of the seismic surveys. The best way to prevent overlap between the DFO and joint DFO/Industry research surveys is to exchange detailed locational information and establish a mutually-agreed temporal and spatial separation plan, as was implemented with DFO Newfoundland and Labrador in past seasons. With application of the mitigations discussed above, effects of seismic survey sound on the Fisheries VEC are predicted to be a *negligible* to *low* magnitude during *<1* to *1-12 months* over an area of *<1* to *11-100* km^2 (Table 5.7). Based on these criteria ratings, the *reversible* residual effects of seismic survey sound on the Fisheries

VEC are predicted to be *not significant* (Table 5.8). The level of confidence associated with this prediction is *medium* to *high* (Table 5.8).

Table 5.7 Assessment of Effects on the Fisheries VEC.

Valued Environmental Component: Fisheries								
Project Activity	**Potential Positive (P) or Negative (N) Environmental Effect**	**Mitigation**[a]	**Evaluation Criteria for Assessing Environmental Effects**					
			Magnitude	**Geographic Extent**	**Frequency**	**Duration**	**Reversibility**	**Ecological/ Socio-Cultural and Economic Context**
Underwater Sound								
Airguns	Disturbance (N); Effect on catch rate (N)	Spatial & temporal avoidance[b]; communication	0-1	3	6	1-2	R	2
Seismic Vessel	Disturbance (N); Effect on catch rate (N)	Spatial & temporal avoidance[b]; communication	0	1	6	1-2	R	2
Support Vessel	Disturbance (N); Effect on catch rate (N)	Spatial & temporal avoidance[b]; communication	0	1	1	1-2	R	2
Supply Vessel	Disturbance (N); Effect on catch rate (N)	Spatial & temporal avoidance[b]; communication	0	1	6	1-2	R	2
Echosounder	Disturbance (N); Effect on catch rate (N)	Spatial & temporal avoidance[b]; communication	0	1	6	1-2	R	2
Vessel Presence								
Seismic Vessel and Gear	Conflict with gear (N)[c]	FLO; communication	0-1	1-3	6	1-2	R	2
Support Vessel	Conflict with gear (N)[c]	FLO; communication	0-1	1-3	1	1-2	R	2
Supply Vessel	Conflict with gear (N)[c]	FLO; communication	0-1	1-3	6	1-2	R	2
Sanitary/Domestic Waste	Taint (N); Perceived taint (N)	Treatment	0-1	1	1	1-2	R	2
Accidental Releases	Taint (N); Perceived taint (N)	Solid streamer[d]; spill response	0-1	1-2	1	1	R	2

Key:

Magnitude:
0 = Negligible, essentially no effect
1 = Low
2 = Medium
3 = High

Frequency:
1 = < 11 events/yr
2 = 11-50 events/yr
3 = 51-100 events/yr
4 = 101-200 events/yr
5 = > 200 events/yr
6 = continuous

Reversibility:
R = Reversible
I = Irreversible
(refers to population)

Duration:
1 = < 1 month
2 = 1-12 months
3 = 13-36 months
4 = 37-72 months
5 = > 72 months

Geographic Extent:
1 = < 1 km^2
2 = 1-10-km^2
3 = 11-100-km^2
4 = 101-1,000-km^2
5 = 1,001-10,000-km^2
6 = > 10,000-km^2

Ecological/Socio-cultural and Economic Context:
1 = Relatively pristine area or area not affected by human activity
2 = Evidence of existing effects

[a] Use of FLO for 2D/3D seismic programs
[b] To the extent possible.
[c] This is considered negligible since, if a conflict occurs, compensation will eliminate any economic impact.
[d] A solid streamer will be used for all seismic surveys.

Table 5.8 Significance of Potential Residual Environmental Effects on the Fisheries VEC.

Valued Environmental Component: Fisheries				
Project Activity	Residual Environmental Effect Rating	Level of Confidence	Likelihood [a]	
	Significance of Predicted Residual Environmental Effects		Probability of Occurrence	Scientific Certainty
Underwater Sound				
Airguns – hearing/physical effects	NS	2-3	-	-
Airguns – behavioural effects	NS	2-3	-	-
Seismic Vessel	NS	3	-	-
Support Vessel	NS	3	-	-
Supply Vessel	NS	3	-	-
Echosounder	NS	3	-	-
Vessel Presence				
Seismic Vessel and Gear	NS	3	-	-
Support Vessel	NS	3	-	-
Supply Vessel	NS	3	-	-
Sanitary/Domestic Wastes	NS	3	-	-
Accidental Releases	NS	2-3	-	-

Key:

Significance is defined as either a high magnitude, or a medium magnitude with duration greater than 1 year and a geographic extent >100 km^2

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

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

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

Scientific Certainty: based on scientific information and statistical analysis or professional judgment:
1 = Low Level of Confidence
2 = Medium Level of Confidence
3 = High Level of Confidence

[a] Considered only in the case where 'significant negative effect' is predicted.

5.8.5.2 Vessel Presence (including towed seismic equipment)

Commercial fish harvesting activities occur throughout the May to November period being assessed. Of these, the fixed gear (e.g., pot fishery for snow crab, and to a lesser extent the gillnet fishery) poses the highest potential for conflict, particularly if it is deployed concurrently with seismic survey operations. During 2D/3D seismic surveying, operations will be conducted continuously for 60 to 150 days. In 2014, the seismic survey is anticipated to require 120 to 150 days. Because of the length of the streamers being towed behind it, the maneuverability of a seismic vessel is restricted and other vessels must give way. As already noted in the EA, the turning radius required between each track line extends the assessment area beyond the actual survey project area (but stays within the Project Area). When gear conflict events occur, that damage gear or result in gear loss due to the survey, they will be assessed and compensation will be paid for losses attributable to the seismic survey.

Mitigation

Mitigations measures intended to minimize the conflict effects of Project activities on the fishing gear component of the Fishery VEC include:

- Avoidance to the extent possible;
- Communications;
- Fisheries Liaison Officers for 2D/3D seismic programs;
- Single Point of Contact; and
- Fishing Gear Compensation.

<u>Avoidance</u>

As discussed above, potential impacts on fishing gear will be mitigated by avoiding active fixed gear fishing areas during the seismic survey to the extent possible. If gear is deployed in a survey area, the diligence of the FLO, good at-sea communications and mapping of current fishing locations have usually proven effective at preventing such conflicts.

The principal mitigation will also be avoidance, based on route selection aimed at deviating around fixed gear fishing areas. Since the patterns of fishing vary by month, a final route, taking into account the avoidance of active areas, will be chosen shortly before the survey work begins. As noted above, a route analysis for this purpose will be prepared and discussions with fishing interests undertaken before the transits.

In addition to avoidance based on route analysis and selection, the onshore SPOC and the at-sea FLO will advise the vessel en-route to ensure fishing gear is avoided. In the case the avoidance mitigative measure fails, a gear damage program will be in place to compensate fishers whose gear is damaged or lost.

As with the commercial fishery, those involved in DFO and joint DFO/Industry research surveys will need to exchange detailed locational information with those involved in the seismic surveying. In 2002 when the plan was first implemented in the eastern Newfoundland Region, positional information was exchanged between DFO and the seismic survey company. A temporal and spatial separation plan was then agreed to with DFO and implemented by the seismic vessel to ensure that seismic operations did not interfere with the research survey. This included adequate "quiet time" before the research vessel arrived at its survey location. The avoidance protocol includes a 30 km (16 nm) spatial separation and a seven day pre-research survey temporal separation.

Communications

During the fisheries consultations for this and other surveys, fisheries representatives noted that good communication is one of the best ways to minimize interference with fishing activities. Communications will be maintained (directly at sea, and through the SPOC) to facilitate information exchange with fisheries participants. This includes such groups as DFO managers, independent fishers, representatives of fisheries organizations such as the FFAW, and managers of other key corporate fisheries in the area.

Relevant information about the survey operations will also be publicized using established communications mechanisms, such as the *Notices to Shipping* (Continuous Marine Broadcast and NavTex), the CBC (Newfoundland) Radio's *Fisheries Broadcast*, by the FFAW in the FFAW *Union Forum* (as suggested during previous consultations), and by direct communication between the survey vessel and fishing vessels via marine radio at sea. This will also include information about transit routes.

Fisheries Liaison Officer (FLO)

As described above, the on-board fisheries industry FLO will provide a dedicated marine radio contact for all fishing vessels near 2D/3D project operations to help identify gear locations, assess potential interactions and provide guidance to those on the bridge, including during transit to and from St. John’s.

Single Point of Contact (SPOC)

The SPOC has become a standard and effective mitigation for all seismic surveys operating in this sector. MKI’s Environment Advisor/Lead or designate will serve as the survey's SPOC with the fishing industry, as described in the C-NLOPB Guidelines. The SPOC will endeavor to update vessel personnel (e.g. the FLO) about known fishing activities in the area, and will relay relevant information from DFO and fishing companies.

Fishing Gear Compensation

MKI has developed a fishing gear damage compensation policy consistent with C-NLOPB guidelines that will be filed with the Board in support of the *Authorization to Conduct a Geophysical Program* application. In case of accidental damage to fishing gear or vessels, MKI will implement gear damage compensation contingency plans to provide appropriate and timely compensation to any affected fishery participants. The Notices to Shipping, filed by the vessels for surveys and for transits to and from the survey sites, will also inform fishers that they may contact the SPOC if they believe that they have sustained survey-related gear damage. MKI will follow the protocols outlined by One Ocean (One Ocean 2013) for documenting any incidents.

Assessment of the Effects of Vessel and Seismic Equipment Presence

With application of the mitigations discussed above, effects of vessel presence, including all gear being towed by the seismic vessel, on the Fisheries VEC are predicted to be a *negligible* to *low* magnitude during *<1* to *1-12 months* over an area of *<1* to *11-100* km^2 (see Table 5.7). Based on these criteria ratings, the *reversible* residual effects of vessel presence during the seismic program on the Fisheries VEC are predicted to be *not significant* (see Table 5.8). The level of confidence associated with this prediction is *high* (see Table 5.8).

5.8.5.3 Other Project Activities

Sanitary/Domestic Wastes

Impacts related to physical effects on fish and invertebrates, including those potentially resulting from releases of sanitary/domestic wastes, are not discussed any further in this section because earlier assessment of the Fish and Fish Habitat VEC predicted that the residual effects of the wastes on that VEC would be *negligible* and hence *not significant*.

Accidental Releases

In the event of an accidental release of hydrocarbons (e.g., streamer breakage, fuel spill), there is some possibility of the perception of tainting of invertebrate and fish resources in the proximity of a release, even if there is no actual tainting. Perception alone can have economic effects if the invertebrates and fish lose marketability. Preventative measures/protocols, rapid response plans and good communications are essential mitigations to minimize the effects of any accidental hydrocarbon release. In the event of a release, the length of time that fish are exposed is a determining factor in whether or not their health is substantially affected or if there is actual or perceived tissue tainting. Streamer floatation fluid can be expected to dissipate relatively rapidly. Any effect on access to fishing grounds would be of relatively short duration. In the unlikely event of a substantial hydrocarbon release, the need of compensation for commercial fishers will be determined through the C-NLOPB's guidelines.

With application of the mitigations discussed above, the effect of accidental hydrocarbon releases on the Fisheries VEC is predicted have a *negligible* to *low* magnitude during *<1 month* over an area of *<1* to 1-*10* km^2 (see Table 5.7). Based on these criteria ratings, the *reversible* residual effects of accidental releases on the Fisheries VEC during the seismic program are predicted to be *not significant* (see Table 5.8). The level of confidence associated with this prediction is *medium* to *high* (see Table 5.8).

5.8.6 Seabird VEC

Potential interactions between project activities and seabirds are shown in Table 5.9. Seabirds interact with all project activities to varying degrees.

Table 5.9 Potential Interactions between Project Activities and the Seabird VEC.

Project Activities	Valued Environmental Component: Seabirds
Underwater Sound	
Airguns	X
Seismic Vessel	X
Support Vessel	X
Supply Vessel	X
Echosounder	X
Helicopter [a]	X
Vessel Presence	
Seismic Vessel and Gear	X
Support Vessel	X
Supply Vessel	X
Vessel Lights	X
Helicopter Presence [a]	X
Sanitary/Domestic Wastes	X
Atmospheric Emissions	X
Accidental Releases	X
Garbage [b]	
Shore Facilities [c]	
OTHER PROJECTS AND ACTIVITIES	
Oil and Gas Activities	X
Fisheries	X
Marine Transportation	X

[a] No helicopter use is planned for 2014 but helicopters may be used during 2015-2018.
[b] Not applicable as garbage will be brought ashore.
[c] There will not be any new onshore facilities. Existing infrastructure will be used.

These interactions are discussed below. Table 5.10 presents a summary of the assessment of residual effects associated with each of the interactions, and Table 5.11 summarizes the *significance* of the residual effects associated with each interaction.

5.8.6.1 Underwater Sound

The effects of underwater sound on birds have not been well studied. Birds have good hearing abilities in air (Fay 1988), but much of what is believed about their hearing ability under water is inferred from mammals. Hearing thresholds (the minimum sound pressure levels at which a sound can be detected) in birds are probably higher in water than in air, as is the case with humans (Dooling and Therrien 2012). In addition, the frequency of best hearing in birds is probably lower in water than air, as it is with humans. However, the feathers that cover birds' ears may affect hearing. The muscles attached to the feather shafts contract during dives, forming a waterproof seal that probably prevents water from entering the auditory meatus.

Stemp (1985) made observations on the reactions of birds to seismic exploration programs in southern Davis Strait over three summer periods. No mortality or effects on distribution were detected in 1982, the only year when an airgun-based program was conducted. John Parsons (*in* Stemp 1985) reported that shearwaters off Sable Island, Nova Scotia, did not respond to underwater explosive charges 30 m away, even though the birds' heads were underwater. Evans et al. (1993) made observations from operating seismic vessels in the Irish Sea. They noted that when seabirds were near the seismic boats, "there was no observable difference in their behaviour, birds neither being attracted nor repelled by seismic testing".

Observations of free-ranging moulting Long-tailed Ducks (*Clangula hyemalis*) in the Beaufort Sea showed little effect on the ducks' movements or diving behaviour (Lacroix et al. 2003). However, the study did not monitor potential physical effects on the ducks. The authors suggested caution in interpretation of the data because they were limited in their ability to detect subtle disturbance effects and recommended studies on other species to fully understand the effects of seismic testing. This lack of overt response may be at least partly related to the fact that received levels of underwater sound from airguns are greatly reduced at and immediately below the surface as compared with levels deeper in the water (Greene and Richardson 1988).

Most species of seabirds that are expected to occur in the Study Area typically feed at the surface or at less than one metre below the surface of the ocean (see Table 4.9 in Section 4.4.4). This includes Northern Fulmar and shearwaters, storm-petrels, phalaropes, jaegers and skuas, gulls, and terns. These species are under the surface for a few seconds during each dive so would have minimal opportunity to receive underwater sound. Northern Gannet plunge dives deeper, to a depth of 10 m. A gannet is under the surface for only a few seconds during each dive so it would have minimal exposure to underwater sound. Great Shearwater, Sooty Shearwater, and Manx Shearwater feed mainly at the surface but also chase prey briefly beneath the surface down to a depth of two to ten metres (Brown et al. 1978, 1981).

Diving seabirds are more likely to be affected than are birds that remain at or near the surface of the water. The auks, or alcids, are one group of birds that spends considerable time under water at various depths to hunt for food and require a significant length of time to secure food (see Table 4.9 in Section 4.4.4). This group includes Dovekie, Common Murre, Thick-billed Murre, Razorbill, Black Guillemot, and Atlantic Puffin. From a resting position on the water, they dive under the surface in search of small fish and invertebrates. Alcids use their wings to propel their bodies rapidly through the water. All are capable of reaching considerable depths and spending considerable time under water (Gaston and Jones 1998). An average duration of dive times for the five species of alcids is 25 to 40 seconds reaching an average depth of 20 to 60 m, but murres are capable of diving to 120 m and have been recorded underwater for up to 202 seconds (Gaston and Jones 1998).

The sound created by airguns is focused downward below the surface of the water. Above the water, the sound is greatly reduced and should have little or no effect on birds that have their heads above water or are in flight. It is possible birds on the water at close range would be startled by the sound, however, the presence of the ship and associated gear dragging in the water should have already warned the bird of unnatural visual and auditory stimuli.

The effects of underwater sounds on auks are unknown. Sounds are probably not important to auks in securing food. However, all six species are quite vocal at breeding sites indicating that auditory capabilities are important in at least that part of their life cycle. The 'laughing call' of the Thick-billed Murre is shown to cover a frequency range of 1.0 to 4.0 kHz (Gaston and Jones 1998).

There are no specific data on the levels of low-frequency underwater sound that are harmful to seabirds, or that cause temporary hearing impairment (TTS). TTS is known to occur in birds exposed to strong, prolonged sounds in air (Saunders and Dooling 1974). Whether TTS could occur in waterbirds that are exposed relatively briefly to intermittent pulses of airgun sound close to an operating airgun array is unknown. TTS is, by definition, only temporary. Indeed, the auditory systems of birds, unlike mammals, have some capability to recover even from exposure to sounds that are strong enough to cause direct auditory injury (Corwin and Cotanche 1988). The ramp-up period for the airguns may mitigate the potential for physical harm by dispersing some birds from the immediate program area.

The few supporting data on the actual effects of exposure to underwater sound on seabirds indicate that the residual effect would have a *negligible* to *low* magnitude during *<1 month* to *1-12 months* over an area of *<1* km^2 to *1-10* km^2 (Table 5.10). Based on these criteria ratings, the residual effects of exposure to underwater sound produced by the Project on seabirds are predicted to be *not significant* (Table 5.11). The level of confidence associated with this prediction is *high* (Table 5.11).

5.8.6.2 Vessel Presence

The seismic and support vessels could potentially affect birds through discharges, lights, noise and their physical presence. The potential effects of discharges, lights, and noise from vessels are discussed below. Potential effects related to the physical presence of structures are likely minimal. Some seabirds will be attracted to the vessels. Seabirds sitting on the water in the path of these vessels can readily move out of the way.

The residual effects of Project vessel presence on the seabird VEC will have a *negligible* magnitude during *<1 month* to *1-12 months* over an area of *<1* km^2 to *1-10* km^2 (Table 5.10). Based on these criteria ratings, the residual effects of Project vessel presence on seabirds are predicted to be *not significant* (Table 5.11). The level of confidence associated with this prediction is *high* (Table 5.11).

Table 5.10 Assessment of Effects of Project Activities on the Seabird VEC.

Valued Environmental Component: Seabirds								
Project Activity	Potential Positive (P) or Negative (N) Environmental Effect	Mitigation	Evaluation Criteria for Assessing Environmental Effects					
			Magnitude	Geographic Extent	Frequency	Duration	Reversibility	Ecological/ Socio-Cultural and Economic Context
Underwater Sound								
Airguns	Disturbance (N)		0-1	1-2	6	1-2	R	1
Airguns	Physical Effects (N)	Ramp-up	0-1	1	6	1-2	R	1
Seismic Vessel	Disturbance (N)		0-1	1	6	1-2	R	1
Support Vessel	Disturbance (N)		0	1	6	1-2	R	1
Supply Vessel	Disturbance (N)		0	1	6	1-2	R	1
Echosounder	Disturbance (N)		0-1	1	6	1-2	R	1
Helicopter	Disturbance (N)	Maintain high altitude	0-1	1	1	1	R	1
Vessel Presence								
Seismic Vessel and Gear	Disturbance (N)	Stranding protocol	0	1-2	6	1-2	R	1
Support Vessel	Disturbance (N)	Stranding protocol	0	1-2	6	1-2	R	1
Supply Vessel	Disturbance (N)	Stranding protocol	0	1-2	6	1-2	R	1
Vessel Lights	Attraction (N)	Search/rescue strandings; Reduce lighting (if possible)	1	1-2	2-3	1-2	R	1
Helicopter Presence	Disturbance (N)	Maintain high altitude	0-1	1	1	1	R	1
Sanitary/Domestic Waste	Increased Food (N/P)	Treatment / containment	0-1	1	1	1-2	R	1
Atmospheric Emissions	Air Contaminants (N)	Low sulphur fuel (1%)	0	1	6	1-2	R	1
Accidental Releases	Mortality (N)	Solid streamer[a]; Spill Response	1	1-2	1	1	R	1

[a] Ramp-up will be delayed if any marine mammal or sea turtle is sighted within the 500 m safety zone.
[b] The airgun arrays will be shutdown if an *endangered* (or *threatened*) marine mammal or sea turtle is sighted within 500 m of the array.
[c] A solid streamer will be used for all seismic surveys.

Key:

Magnitude:
0 = Negligible, essentially no effect
1 = Low
2 = Medium
3 = High

Frequency:
1 = <11 events/yr
2 = 11-50 events/yr
3 = 51-100 events/yr
4 = 101-200 events/yr
5 = >200 events/yr
6 = continuous

Reversibility:
R = Reversible
I = Irreversible
(refers to population)

Duration:
1 = <1 month
2 = 1-12 months
3 = 13-36 months
4 = 37-72 months
5 = >72 months

Geographic Extent:
1 = <1 km^2
2 = 1-10 km^2
3 = 11-100 km^2
4 = 101-1,000 km^2
5 = 1,001-10,000 km^2
6 = >10,000 km^2

Ecological/Socio-cultural and Economic Context:
1 = Relatively pristine area or area not negatively affected by human activity
2 = Evidence of existing negative effects

Table 5.11 Significance of Potential Residual Environmental Effects of Project Activities on the Seabird VEC.

Valued Environmental Component: Seabirds				
Project Activity	**Residual Environmental Effect Rating**	**Level of Confidence**	**Likelihood [a]**	
	Significance of Predicted Residual Environmental Effects		**Probability of Occurrence**	**Scientific Certainty**
Underwater Sound				
Airguns – hearing/physical effects	NS	3	-	-
Airguns – behavioural effects	NS	3	-	-
Seismic Vessel	NS	3	-	-
Support Vessel	NS	3	-	-
Supply Vessel	NS	3	-	-
Echosounder	NS	3	-	-
Helicopter	NS	3	-	-
Vessel Presence				
Seismic Vessel and Gear	NS	3	-	-
Support Vessel	NS	3	-	-
Supply Vessel	NS	3	-	-
Vessel Lights	NS	3	-	-
Helicopter Presence	NS	3	-	-
Sanitary/Domestic Wastes	NS	3	-	-
Atmospheric Emissions	NS	3	-	-
Accidental Releases	NS	2	-	-

Key:

Significance is defined as either a high magnitude, or a medium magnitude with duration greater than 1 year and a geographic extent >100 km^2

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

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

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

Scientific Certainty: based on scientific information and statistical analysis or professional judgment:
- 1= Low
- 2= Medium
- 3= High

[a] Considered only in the case where 'significant negative effect' is predicted.

5.8.6.3 Vessel Lights

Nocturnally-active seabirds can be attracted to artificial lighting at night. This includes lights at coastal lighthouses and lights on vessels at sea (Montevecchi et al. 1999). Seabirds as well as migrating landbirds have been attracted to lights on offshore oil and gas platforms, especially during foggy or overcast conditions (Montevecchi 2006). Several studies of seabird attraction to artificial lighting on offshore and coastal structures and vessels have been conducted (see Husky 2012 for a review). The birds may become injured by flying directly into, and striking, the source of light or the ship infrastructure (Dick and Donaldson 1978; Telfer et al. 1987; Black 2005; Russell 2005; Poot et al. 2008; Rodríguez and Rodríguez 2009). However, most mortality occurs because these birds enter and become trapped in the partially enclosed areas of ships. On seismic vessels, stranded birds are often found on streamer and airgun decks, where they are unable to find their way out (LGL, unpubl. data). They fly about until exhausted and drop to the deck, after which they succumb to dehydration, starvation, exhaustion, or hypothermia. The latter occurs as a result of falling into the drip trays under winches used to deploy streamers or airgun hoses. There they come into contact with water and hydraulic fluid or streamer fluid. 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).

Attraction to artificial lighting and attendant grounding appears to be widespread among procellariiform seabird species (i.e., petrels, shearwaters, prions, storm-petrels, and diving-petrels [Pelecanoididae] but not albatrosses Diomedeidae), having been observed in more than 20 species (Imber 1975; Reed et al. 1985; Telfer et al. 1987; Le Corre et al. 2002; Black 2005; Montevecchi 2006; Abgrall et al. 2008a; Rodríguez and Rodríguez 2009; Miles et al. 2010; Howell 2012). Leach's Storm-Petrel is the seabird most often attracted to lights at night in Newfoundland and Labrador waters.

Large colonies of nesting Leach's Storm-Petrels occur in coastal south Newfoundland not too distant from the Study Area (see Figure 4.43 and Table 4.8 in Section 4.4) and large numbers of storm-petrels forage offshore. Storm-Petrels (Leach's and/or Wilson's) are present off south Newfoundland primarily from about April to November. The period of greatest risk of attraction to offshore lights is thought to be September when adults and newly fledged chicks are dispersing from nesting colonies and moving to offshore wintering grounds (Williams and Chardine n.d.). Young-of-the-year birds appear to be more susceptible to light attraction than are adults, but the extent of storm-petrel susceptibility is unclear. Leach's Storm-Petrel and other birds have regularly stranded on previous seismic and controlled source electromagnetic surveys in Newfoundland waters (Moulton et al. 2005, 2006a; Lang et al. 2006; Lang and Moulton 2008; Abgrall et al. 2008a). During seismic monitoring programs conducted in Atlantic Canada between 2003 and 2012, LGL MMOs recovered 877 Leach's Storm Petrels (B. Mactavish, LGL, unpub. Data, March 2013). The maximum number of stranded petrels recovered by LGL MMOs in a single night was 46. A detailed review of the issue is contained in the White Rose Extension Project EA (Husky 2012).

Monitoring and mitigation measures to rescue stranded storm-petrels and other birds on board the seismic vessel will be the responsibility of the MMO. The MMO will check all open decks daily for stranded birds, and ask ship crew to notify them of any stranded birds that they find. Procedures developed by the CWS and Petro-Canada (now Suncor) will be used to handle the birds and gently release them (Williams and Chardine, n.d.). Other vessels working on the project will be made aware of the potential problem of storm-petrels and other species stranding on their vessels. Each vessel will have a copy of the manual developed by CWS and Petro-Canada (now Suncor) on proper procedure and handling of stranded storm-petrels (Williams and Chardine, n.d.). MKI acknowledges that a Federal *Migratory Bird Salvage Permit* will be required. Deck lighting will be minimized (if it is safe and practical to do so) to reduce the likelihood of stranding. A report documenting each stranded bird, including the date, position, and the general condition of the feathers when found, and if releasable, the condition upon release, will be completed and delivered to the CWS by the end of the calendar year.

The residual effects of Project vessel lights on the seabird VEC will have a *low* magnitude during *<1 month* to *1-12 months* over an area of *<1 km*^{2} to *1-10 km*^{2} (see Table 5.10). Based on these criteria ratings, the residual effects of Project vessel lights on seabirds are predicted to be *not significant* (see Table 5.11). The level of confidence associated with this prediction is *high* (see Table 5.11).

5.8.6.4 Helicopter Presence

Helicopter flights are not planned for the 2014 program, but may occur during the 2015-2018 programs. However, even if flights do occur, they will be infrequent and of short duration. Although seabirds are expected to flush or dive in response to the sounds from helicopter flights to and from the seismic vessel, physical damage to seabirds is not expected as they will avoid the area near the helicopter. Any effects will be transitory. Helicopter flights will be operated at a minimum altitude of 300-450 m (~1,000-1,500 ft) when in transit to minimize any potential effects on seabirds.

The residual effects of helicopter presence on the seabird VEC will have a *negligible* to *low* magnitude during <1 month over an area of *<1 km*^{2} (see Table 5.10). Based on these criteria ratings, the residual effects of helicopter presence on seabirds are predicted to be *not significant* (see Table 5.11). The level of confidence associated with this prediction is *high* (see Table 5.11).

5.8.6.5 Sanitary and Domestic Waste

Sanitary waste generated by the vessels will be macerated before subsurface discharge, following requirements described in Section 5.6. While it is possible that seabirds (mostly gulls) may be attracted to the sewage particles, the small amount discharged below surface over a limited period of time will be unlikely to increase the far-offshore gull populations. Thus, any increase in gull predation on Leach’s Storm-Petrels, as suggested by Stenhouse and Montevecchi (1999b), is likely to be minimal. The number of smaller seabirds (e.g., storm-petrels) predated will likely be low.

The residual effects of Project sanitary and domestic waste on the seabird VEC will have a *negligible* to *low* magnitude during *<1 month* to *1-12 months* over an area of *<1 km*^{2} (Table 5.10). Based on these criteria ratings, the residual effects of sanitary and domestic waste on seabirds are predicted to be *not significant* (see Table 5.11). The level of confidence associated with this prediction is *high* (see Table 5.11).

5.8.6.6 Atmospheric Emissions

Although atmospheric emissions could theoretically affect the health of some resident marine seabirds, the effects will be negligible because emissions of potentially harmful materials will be small (especially using low 1% sulphur fuel) and rapidly disperse to undetectable levels due to their volatility, temperature of emission, and the exposed and often windy nature of the offshore. Therefore, the residual effects of atmospheric emissions on seabirds are predicted to be *not significant* (see Table 5.11). The level of confidence associated with this prediction is *high* (see Table 5.11).

5.8.6.7 Accidental Releases

The primary accidental event associated with the seismic program that could have environmental consequences of concern is the unintentional release of fuel from Project vessels. Solid streamers will be used during the 2014 2D seismic survey, thus eliminating the risk of streamer leakage. It is expected that solid streamers also will be used during the subsequent 2D and 3D seismic surveys (2015-2018), but details have not been finalized yet. Consequently, spills from broken liquid-filled streamers are not expected.

All fuel handling and reporting procedures on board will be consistent with MKI's policy, and handling and reporting procedures. A fuel spill may occur from the seismic ship and/or the support vessel—both vessels will use marine gas oil. Marine gas oil is a light fuel that persists in the environment for much shorter periods than does crude oil or heavy fuel oils such as Bunker C. In cold water, only about 50% of the spilled gas oil would remain on the water surface after 12 hours (Smith and McIntyre 1971). Thus, a spill of gas oil would not persist for long periods on the water surface. About half of the oil lost from the surface is dispersed into the water column and about half is lost to evaporation (Birchard and Nancarrow 1986). Once in the water column, the half-life of diesel at 0º to 2ºC may be more than 10 days (Gearing and Gearing 1982). Any spills would likely be small and quickly dispersed by wind, wave, and ship's propeller action. The effects of hydrocarbon spills on seabirds were reviewed in Husky (2012) and are not repeated in detail here.

The reported effects of hydrocarbon spills on seabirds vary with species, type of hydrocarbon, weather conditions, time of year and duration of the spill (Gorsline et al. 1981). Exposure to oil causes thermal and buoyancy deficiencies that typically lead to the deaths of affected marine birds. Although some may survive these immediate effects, long-term physiological changes may eventually result in death (Ainley et al. 1981; Burridge and Kane 1985; Frink and White 1990; Fry 1990). For some individual birds, oiling has not had lethal or marked sublethal effects. Among oiled, colour-banded Herring Gulls and Lesser Black-backed Gulls (*Larus fuscus*), most survived and cleaned themselves with a few weeks of oiling, some bred successfully and survived up to 20 years after oiling (Camphuysen 2011).

Waters off the southeast coast of Newfoundland are a major junction for international marine traffic destined for Canadian and U.S. ports. Analyses of the oil involved in bird strandings show that wastes are composed of mixtures of bunker C and marine diesel, indicating origins in the engine room bilges of ocean-going ships (Lock and Deneault 2000). The illegal discharge of oily bilge water off the southeast coast of Newfoundland is a chronic problem (Wiese and Ryan 1999, 2003). MKI project vessels will not engage in the illegal discharge of oily bilge water.

Exposure to fuel under calm conditions may harm or kill individual birds. Potential spills will likely be small, and evaporation and dispersion rapid, particularly given the fuel type. Spill response plans (SOPEPs) and equipment will be in place.

The residual effects of Project-related accidental releases on the seabird VEC will have a *low* magnitude during *<1 month* over an area of *<1 km*^{2} to *1–10 km*^{2} (see Table 5.10). Based on these criteria ratings, the residual effects of accidental releases on seabirds are predicted to be *not significant* (see Table 5.11). The level of confidence associated with this prediction is *medium* (see Table 5.11).

5.8.7 Marine Mammal and Sea Turtle VEC

The potential effects of seismic activities on marine mammals and sea turtles have previously been reviewed in the Southern Newfoundland SEA (LGL 2010a), previous EAs for seismic programs in the Laurentian sub-basin and Jeanne d'Arc Basin on the Grand Banks (e.g., LGL 2008, 2009b), and other reviews (e.g., Richardson et al. 1995; Gordon et al. 2004; Stone and Tasker 2006; Southall et al. 2007; Abgrall et al. 2008b). The following review is based largely on these documents with new and relevant literature included.

The assessment of impacts is based on the best available information; however, there are data gaps that limit the certainty of these impact predictions. We have discussed potential impacts separately for toothed whales, baleen whales, seals and sea turtles given their different hearing abilities and sensitivities to sound. Potential interactions between Project activities and marine mammals and sea turtles are shown in Table 5.12.

5.8.7.1 Airgun Sound

The potential effects of sound from airgun arrays on marine mammals and sea turtles are a common concern associated with seismic programs. Airgun arrays used during marine seismic operations introduce strong sound impulses into the water. These sound impulses could have several types of effects on marine mammals and sea turtles and are the main issue associated with the proposed seismic surveys. The effects of human-generated noise on marine mammals are quite variable and depend on numerous factors, including: species, activity of the animal when exposed to the noise, and distance of the animal from the sound source. This section includes a brief summary of the anticipated potential effects (or lack thereof) of airgun sounds on marine mammals and sea turtles. More comprehensive reviews of the relevant background information for marine mammals and sea turtles appear in Appendices 4 and 5, respectively. The characteristics of airgun sounds are also summarized in Appendix 4. Descriptions of the hearing abilities of marine mammals and sea turtles are also provided in Appendices 4 and 5, respectively.

The potential effects of airgun sounds considered in this assessment include: masking of natural sounds, behavioural disturbance, non-auditory physical or physiological effects, and at least in theory, temporary or permanent hearing impairment (Richardson et al. 1995; Gordon et al. 2004; Nowacek et al. 2007; Southall et al. 2007). Permanent hearing impairment or permanent threshold shift (PTS), in the unlikely event that it occurred, would constitute injury, but temporary threshold shift (TTS) is not an injury (Southall et al. 2007). Although the possibility cannot be entirely excluded, it is unlikely that the program would result in any cases of temporary or permanent hearing impairment, or any significant non-auditory physical or physiological effects. If marine mammals or sea turtles encounter the survey while it is underway, some behavioural disturbance could result, but this would be localized and short-term.

Table 5.12 Potential Interactions between Project Activities and Marine Mammal and Sea Turtle VEC.

Valued Environmental Component - Marine Mammal and Sea Turtle				
Project Activities	**Toothed Whales**	**Baleen Whales**	**Seals**	**Sea Turtles**
Underwater Sound				
Airguns	X	X	X	X
Seismic Vessel	X	X	X	X
Support Vessel	X	X	X	X
Supply Vessel	X	X	X	X
Echosounder	X	X	X	X
Helicopter [a]	X	X	X	X
Vessel Presence				
Seismic Vessel and Gear	X	X	X	X
Support Vessel	X	X	X	X
Supply Vessel	X	X	X	X
Vessel Lights				
Helicopter Presence	X	X	X	X
Sanitary/ Domestic Wastes	X	X	X	X
Atmospheric Emissions	X	X	X	X
Accidental Releases	X	X	X	X
Garbage [b]				
Shore Facilities [c]				
OTHER PROJECTS AND ACTIVITIES				
Oil and Gas Activities	X	X	X	X
Fisheries	X	X	X	X
Marine Transportation	X	X	X	X

[a] No helicopter use is planned for 2014 but helicopters may be used during 2015-2018.
[b] Not applicable as garbage will be brought ashore.
[c] There will not be any new onshore facilities. Existing infrastructure will be used.

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 infrequent. Masking effects of pulsed sounds (even from large arrays of airguns) on marine mammal calls and other natural sounds are expected to be limited, although there are very few specific data on this. Because of the intermittent nature and low duty cycle of seismic pulses, marine mammals and sea turtles can emit and receive sounds in the relatively quiet intervals between pulses. Some baleen and toothed whales are known to continue calling in the presence of seismic pulses, and their calls usually can be heard between the seismic pulses. The sounds important to toothed whales and pinnipeds are predominantly at much higher frequencies than are the dominant components of airgun sounds, thus limiting the potential for masking. Based on reviewed research, the potential for masking of marine mammal calls and/or important environmental cues is considered quite low from the proposed seismic program. Thus, masking is unlikely to be a significant issue for either marine mammals or sea turtles exposed to the sounds from seismic surveys.

Disturbance

Reactions to sound, if any, depend on species, state of maturity, experience, current activity, reproductive state, time of day, and many other factors (Richardson et al. 1995; Wartzok et al. 2004; Southall et al. 2007; Weilgart 2007). If a marine mammal or sea turtle does react briefly to an underwater sound by changing its behaviour or moving a small distance, the impacts of the change are unlikely to be significant to the individual, let alone the stock or population. However, if a sound source displaces marine mammals or sea turtles from an important feeding or breeding area for a prolonged period, impacts on individuals and populations could be significant (e.g., Lusseau and Bejder 2007; Weilgart 2007).

Baleen whales generally tend to avoid operating airguns, but avoidance radii are quite variable. Whales are often reported to show no overt reactions to pulses from large arrays of airguns at distances beyond a few kilometers, even though the airgun pulses remain well above ambient noise levels out to much longer distances. However, baleen whales exposed to strong noise pulses from airguns often react by deviating from their normal migration route and/or interrupting their feeding and moving away. In the cases of migrating gray and bowhead whales, the observed changes in behaviour appeared to be of little or no biological consequence to the animals. They simply avoided the sound source by displacing their migration route to varying degrees, but within the natural boundaries of the migration corridors.

Little systematic information is available on reactions of toothed whales to sound pulses. However, there are recent systematic studies on sperm whales, and there is an increasing amount of information about responses of various odontocetes to seismic surveys based on monitoring studies. Seismic operators and marine mammal observers on seismic vessels regularly see dolphins and other small toothed whales near operating airgun arrays, but in general there is a tendency for most delphinids to show some avoidance of operating seismic vessels. In most cases, the avoidance radii for delphinids appear to be small, on the order of 1 km or less, and some individuals show no apparent avoidance. The beluga, however, is a species that (at least at times) shows long-distance (10s of km) avoidance of seismic vessels. Captive bottlenose dolphins and beluga whales exhibited changes in behaviour when exposed to strong pulsed sounds similar in duration to those typically used in seismic surveys, but the animals tolerated high received levels of sound before exhibiting aversive behaviours. Odontocete reactions to large arrays of airguns are variable and, at least for delphinids, seem to be confined to a smaller radius than has been observed for the more responsive of the mysticetes and some other odontocetes.

Pinnipeds tend to be less responsive to airgun sounds than many cetaceans and are not likely to show a strong avoidance reaction to the airgun array. Visual monitoring from seismic vessels has shown only slight (if any) avoidance of airguns by pinnipeds, and only slight (if any) changes in behaviour. Based on available data, it is likely that sea turtles would exhibit behavioural changes and/or localized avoidance near a seismic vessel. To the extent that there are any impacts on sea turtles, seismic operations in or near areas where turtles concentrate are likely to have the greatest impact. However, turtles are expected to occur at low densities in the Project Area.

Hearing Impairment

Temporary or permanent hearing impairment is a possibility when marine mammals are exposed to very strong sounds. TTS has been demonstrated and studied in certain captive odontocetes and pinnipeds exposed to strong sounds (reviewed in Southall et al. 2007). However, there has been no specific documentation of TTS let alone permanent hearing damage, i.e., PTS, in free-ranging marine mammals exposed to sequences of airgun pulses during realistic field conditions. Current U.S. NMFS policy regarding exposure of marine mammals to high-level sounds is that cetaceans and pinnipeds should not be exposed to impulsive sounds ≥180 and 190 dB re 1 μPa_{rms}, respectively (NMFS 2000). Those criteria have been used in establishing the safety (=shut-down) radii planned for numerous seismic surveys conducted under U.S. jurisdiction and in some parts of Canada. However, those criteria were established before there was any information about the minimum received levels of sounds necessary to cause TTS in marine mammals. The 180 dB criterion for cetaceans is probably quite conservative (i.e., lower than necessary to avoid auditory injury), for at least some species including bottlenose dolphin and beluga.

Recommendations for science-based noise exposure criteria for marine mammals were published by Southall et al. (2007). Those recommendations were never formally adopted by NMFS for use in regulatory processes and during mitigation programs associated with seismic surveys, although some aspects of the recommendations have been taken into account in certain environmental impact statements and small-take authorizations. NMFS has recently proposed new noise exposure criteria taking at least some of the Southall et al. recommendations into account (NOAA 2013). The new noise exposure criteria for marine mammals account for the now-available scientific data on TTS, the expected offset between the TTS and PTS thresholds, differences in the acoustic frequencies to 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.

There is substantial overlap in the frequencies that sea turtles detect vs. the frequencies in airgun pulses. Sounds from an airgun array might cause temporary hearing impairment in sea turtles if they do not avoid the (unknown) radius where TTS occurs. However, monitoring studies show that some sea turtles do show localized movement away from approaching airguns. At short distances from the source, received sound levels diminish rapidly with increasing distance. In that situation, even a small-scale avoidance response could result in a significant reduction in sound exposure.

Several aspects of the planned monitoring and mitigation measures for this project are designed to detect marine mammals and sea turtles occurring near the airgun array, and to avoid exposing them to sound pulses that might, at least in theory, cause hearing impairment. In addition, many cetaceans and (to a limited degree) pinnipeds and sea turtles show some avoidance of the area where received levels of airgun sound are high enough such that hearing impairment could potentially occur. In those cases, the avoidance responses of the animals themselves will reduce or (most likely) avoid the possibility of hearing impairment.

Non-auditory Physical Effects

Non-auditory physical effects may also occur in marine mammals and sea turtles exposed to strong underwater pulsed sound. Possible types of non-auditory physiological effects or injuries that might (in theory) occur include stress, neurological effects, and organ or tissue damage. It is possible that some marine mammal species (i.e., beaked whales) may be especially susceptible to injury and/or stranding when exposed to strong pulsed sounds. However, there is no definitive evidence that any of these effects occur even for marine mammals or sea turtles in close proximity to large arrays of airguns. Such effects, if they occur at all, would presumably be limited to short distances and to activities that extend over a prolonged period. Marine mammals that show behavioural avoidance of seismic vessels, including most baleen whales, some odontocetes, and some pinnipeds, as well as sea turtles, are especially unlikely to incur non-auditory physical effects. The brief duration of exposure of any given animal and the planned monitoring and mitigation measures would further reduce the probability of exposure of marine mammals and sea turtles to sounds strong enough to induce non-auditory physical effects.

Sound Criteria for Assessing Impacts

Impact zones for marine mammals are commonly defined by the areas within which specific received sound level thresholds are exceeded. The U.S NMFS (1995, 2000) concluded that cetaceans should not be exposed to pulsed underwater noise at received levels exceeding 180 dB re 1 μPa_{rms}; the corresponding limit for seals was set at 190 dB re 1 μPa_{rms}. According to NMFS, these sound levels were the received levels above which one cannot be certain that there will be no injurious effects, auditory or otherwise, to marine mammals. For over a decade, it has been common for marine seismic surveys conducted in some areas of U.S. jurisdiction and in some areas of Canada (Canadian Beaufort Sea and on the Scotian Shelf), to include a "shutdown" requirement for cetaceans based on the distance from the airgun array at which the received level of underwater sounds is expected to diminish below 180 dB re 1 μPa_{rms}. An additional criterion that is often used in predicting "disturbance" impacts is 160 dB re 1 µPa; at this received level, some marine mammals exhibit behavioural effects. There is ongoing debate about the appropriateness of these parameters for impact predictions and mitigation (see Appendix 4), and NMFS has recently proposed new noise exposure criteria (NOAA 2013).

For marine seismic programs in Newfoundland and Labrador, the C-NLOPB (2012) recommends that seismic operators follow the "*Statement of Canadian Practice with Respect to the Mitigation of Seismic Sound in the Marine Environment*" (hereafter referred to as the *Statement*) issued by the DFO. The *Statement* does not include noise criteria as part of the recommended mitigation measures; rather it defines (see Point 6.a) a safety zone as "a circle with a radius of at least 500 metres as measured from the centre of the air source array (s)".

Assessment of Effects of Sound on Marine Mammals

The marine mammal effects assessment is summarized in Table 5.13 and discussed in detail below.

Table 5.13 Assessment of Effects of Project Activities on Marine Mammals.

Marine Mammals								
			Evaluation Criteria for Assessing Environmental Effects					
Project Activity	**Potential Positive (P) or Negative (N) Environmental Effect**	**Mitigation**	**Magnitude**	**Geographic Extent**	**Frequency**	**Duration**	**Reversibility**	**Ecological/ Socio-Cultural and Economic Context**
Underwater Sound								
Airguns	Hearing Impairment (N) Physical Effects (N)	Pre-watch; Ramp-up; Delay start[a]; Shutdown[b]	0-1	1-2	6	1-2	R	2
Airguns	Disturbance (N)	Pre-watch; Ramp-up; Delay start[a]; Shutdown[b]	1	3-4	6	1-2	R	2
Seismic Vessel	Disturbance (N)		0-1	1-2	6	1-2	R	2
Support Vessel	Disturbance (N)		0-1	1-2	6	1-2	R	2
Supply Vessel	Disturbance (N)		0-1	1-2	6	1-2	R	2
Echosounder	Disturbance (N)		0-1	1	6	1-2	R	2
Helicopter	Disturbance (N)		0-1	1-2	1	1	R	2
Vessel Presence								
Seismic Vessel and Gear	Disturbance (N)		0-1	1	6	1-2	R	2
Support Vessel	Disturbance (N)		0-1	1	6	1-2	R	2
Supply Vessel	Disturbance (N)		0-1	1	6	1-2	R	2
Helicopter Presence	Disturbance (N)	Maintain high altitude	0-1	1-2	1	1	R	2
Sanitary/Domestic Waste	Increased Food (N/P)	Treatment; containment	0-1	1	4	1-2	R	2
Atmospheric Emissions	Surface Contaminants (N)	Low sulphur fuel	0	1	6	1-2	R	2
Accidental Releases	Injury/Mortality (N)	Solid streamer[c]; Spill response	1	1-2	1	1	R	2

[a] Ramp-up will be delayed if any marine mammal is sighted within the 500 m safety zone.
[b] The airgun arrays will be shutdown if an *endangered* (or *threatened*) marine mammal is sighted within 500 m of the array.
[c] A solid streamer will be used for all seismic surveys.

Key:

Magnitude:
0 = Negligible, essentially no effect
1 = Low
2 = Medium
3 = High

Frequency:
1 = <11 events/yr
2 = 11-50 events/yr
3 = 51-100 events/yr
4 = 101-200 events/yr
5 = >200 events/yr
6 = continuous

Reversibility:
R = Reversible
I = Irreversible
(refers to population)

Duration:
1 = <1 month
2 = 1-12 months
3 = 13-36 months
4 = 37-72 months
5 = >72 months

Geographic Extent:
1 = <1 km^2
2 = 1-10 km^2
3 = 11-100 km^2
4 = 101-1,000 km^2
5 = 1,001-10,000 km^2
6 = >10,000 km^2

Ecological/Socio-cultural and Economic Context:
1 = Relatively pristine area or area not negatively affected by human activity
2 = Evidence of existing negative effects

Toothed Whales

Despite the relatively poor hearing sensitivity of toothed whales (at least the smaller species that have been studied) at the low frequencies that contribute most of the energy in seismic pulses, sounds are sufficiently strong that they remain above the hearing threshold of odontocetes at tens of kilometres from the source. Species of most concern are those that are designated under *SARA* Schedule 1 and that may occur in and near the Project Area (i.e., northern bottlenose, beluga, and Sowerby's beaked whale). The killer whale and harbour porpoise have special status under COSEWIC (the harbour porpoise is also listed as *threatened* under Schedule 2 of *SARA*), but are not expected to occur in large numbers in the Project Area. The received sound level of 180 dB re 1 μPa_{rms} criterion is accepted as a level that below which there is no physical effect on toothed whales. It is assumed that disturbance effects for toothed whales may occur at received sound levels at or above 160 dB re 1 μPa_{rms}. However, it is noted that there is no good scientific basis for using this 160 dB criterion for odontocetes and that a 170 dB re 1 μPa_{rms} is a more realistic indicator of the area within which disturbance is likely (see Appendix 4).

Hearing Impairment and Physical Effects

Given that whales typically avoid at least the immediate area around seismic (and other strong) noise sources, whales in and near the Project Area will likely not be exposed to levels of sound from the airgun array that are high enough to cause non-auditory physical effects or hearing impairment. It is highly unlikely that toothed whales will experience mortality or strand as a result of Project activities. The mitigation measure of ramping-up the airgun array (over a 30 min period) should allow whales close to the airguns to move away before the sounds become sufficiently strong to have potential for hearing impairment. Also, the airgun array will not be started if a toothed whale is sighted within the 500 m safety zone. There is reduced potential for toothed whales being close enough to the array to experience hearing impairment. If some whales did experience TTS, the effects would likely be quite "temporary". As per Table 5.13, MKI's seismic program is predicted to have *negligible* to *low* hearing impairment/physical effects on toothed whales during *<1 month* to *1 to 12 months* over an area of *<1* km^2 to *1-10* km^2. Therefore, hearing impairment and/or physical effects on toothed whales are predicted to be *not significant* (Table 5.14). The level of confidence associated with this prediction is *medium* (Table 5.14).

Disturbance

Based on our review, there could be behavioural effects on some species of toothed whales within the Project Area. Known effects may range from changes in swimming behaviour to avoidance of the seismic vessel. Based on available literature, a 160 dB re 1 μPa_{rms} sound level is used to assess disturbance effects, more specifically potential displacement from the area around the seismic source. This is likely a conservative criterion since some toothed whale species:

- have been observed in other areas relatively close to an active seismic source where received sound levels are greater than 160 dB; and
- individuals which may be temporarily displaced from an area will not be significantly impacted by this displacement.

Table 5.14 Significance of Potential Residual Environmental Effects of Proposed Activities on Marine Mammals.

Marine Mammals				
Project Activity	Residual Environmental Effect Rating	Level of Confidence	Likelihood [a]	
	Significance of Predicted Residual Environmental Effects		Probability of Occurrence	Scientific Certainty
Underwater Sound				
Airguns – hearing/physical effects	NS	2	-	-
Airguns – behavioural effects	NS	3	-	-
Seismic Vessel	NS	3	-	-
Support Vessel	NS	3	-	-
Supply Vessel	NS	3	-	-
Echosounder	NS	3	-	-
Helicopter	NS	3	-	-
Vessel Presence				
Seismic Vessel and Gear	NS	3	-	-
Support Vessel	NS	3	-	-
Supply Vessel	NS	3	-	-
Helicopter Presence	NS	3	-	-
Sanitary/Domestic Wastes	NS	3	-	-
Atmospheric Emissions	NS	3	-	-
Accidental Releases	NS	2	-	-

Key:

Significance is defined as either a high magnitude, or a medium magnitude with duration greater than 1 year and a geographic extent >100 km^2

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

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

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

Scientific Certainty: based on scientific information and statistical analysis or professional judgment:
1= Low
2= Medium
3= High

[a] Considered only in the case where 'significant negative effect' is predicted.

It is uncertain how many toothed whales may occur in the Study Area at various times of the year. The Study Area is not known to be an important feeding or breeding area for toothed whales (however, there has been little research to verify this). As per Table 5.13, disturbance effects from Project activity noise on toothed whales would likely be *low* during *<1 month* to *1 to 12 months* over an area of *11-100* to *101-1,000 km*^{2}. Therefore, potential effects related to disturbance, are predicted to be *not significant* for toothed whales (see Table 5.14). The level of confidence associated with this prediction is high (see Table 5.14).

Effects on Prey Species

It is unlikely that prey species for toothed whales will be impacted by seismic activities to a degree that inhibits their foraging success. If prey species exhibit avoidance of the seismic ship it will likely be transitory in nature (see Section 5.8.4) and over a small portion of a whale's foraging range within the Project Area. Potential effects of reduced prey availability on toothed whales are predicted to be *negligible*.

Baleen Whales

Baleen whales are thought to be sensitive to low-frequency sounds such as those that contribute most of the energy in seismic pulses. Species of most concern are those that are designated under *SARA* Schedule 1 and that may occur in and near the Project Area (i.e., North Atlantic right, blue, and fin whale). As with toothed whales, the 180 dB re 1 μPa_{rms} criterion is used when estimating the area where hearing impairment and/or physical effects may occur for baleen whales (although there are no data to support this criterion for baleen whales). For all baleen whale species, it is assumed that disturbance effects (avoidance) may occur at sound levels greater than 160 dB re 1 μPa_{rms}.

Hearing Impairment and Physical Effects

Given that baleen whales typically exhibit at least localized avoidance of seismic (and other strong) noise, baleen whales will likely not be exposed to levels of sound from the airgun array high enough to cause non-auditory physical effects or hearing damage. The mitigation measure of ramping-up the airgun array should allow any whales close to the airguns to move away before the sounds become sufficiently strong to have potential for hearing impairment. Also, the airgun array will not be started if a baleen whale is sighted within the 500 m safety zone. Therefore, there is reduced potential for baleen whales being close enough to the array to experience hearing impairment. If some whales did experience TTS, the effects would likely be quite "temporary". As per Table 5.13, MKI's seismic program is predicted to have *negligible to low* hearing impairment effects on baleen whales during *<1 month* to *1 to 12 months* over an area of *<1 km*^{2} to *1-10 km*^{2}. Therefore, hearing impairment and/or physical effects on baleen whales are predicted to be *not significant* (see Table 5.14). The level of confidence associated with this prediction is *medium* (see Table 5.14).

Disturbance

Based on the above review, there could be behavioural effects on some species of baleen whales within and near the Project Area. Reported effects range from changes in swimming behaviour to avoidance of the seismic vessel. The area where displacement would most likely occur would have a predicted scale of impact at *11-100 km²* to *101-1,000 km²*. This is likely a conservative estimate given that:

- some baleen whale species have been observed in areas relatively close to an active seismic source; and
- it is unlikely that displacement from an area constitutes a significant impact for baleen whales in the Project Area.

It is uncertain how many baleen whales may occur in the Study Area during the period when seismic activity is most likely to occur (May to November). Some locations within the Project Area, such as the Southeast Shoal of the Grand Banks, are known to be important feeding areas for baleen whales, particularly humpback whales. However, as per Table 5.13, disturbance effects on species of baleen whales would likely be *low* during *<1 month* to *1 to 12 months* over an area of *11-100 km²* to *101-1,000 km²*. Therefore, effects related to disturbance, are predicted to be *not significant* for baleen whales (see Table 5.14). The level of confidence associated with this prediction is *high* (see Table 5.14).

Effects on Prey Species

It is unlikely that prey species for baleen whales, particularly euphausiids, will be impacted by seismic activities to a degree that inhibits their foraging success. If prey species exhibit avoidance of the seismic ship it will likely be transitory in nature (see Section 5.8.4) and over a small portion of a whale's foraging range within the seismic area. Potential effects of reduced prey availability on baleen whales are judged to be *negligible*.

Seals

Seals are not expected to be abundant within the Study Area, particularly in the time period when seismic operations will likely occur. Harp and hooded seals are expected to have a more northerly distribution during the survey period, although they could be moving through the Study Area. Grey and harbour seals are likely not very abundant and would be most common in coastal areas. None of the species of seal that occur within the Study Area are considered at risk by COSEWIC or are designated on a *SARA* schedule (although some are COSEWIC *candidate species*, see Section 4.6).

Hearing Impairment and Physical Effects

Given that seals typically avoid the immediate area around a seismic array, seals are unlikely to be exposed to levels of sound from the airgun array (and other noise sources) high enough to cause non-auditory physical effects or hearing impairment. The mitigation measure of ramping-up the airgun array will allow seals close to the airguns to move away before the sounds become sufficiently strong to have potential for hearing impairment. Also, a ramp-up will not be initiated if a seal is sighted within the 500 m safety zone. Therefore, there is reduced potential for seals being close enough to an array to experience hearing impairment. If some seals did experience TTS, the effects would likely be quite "temporary". As per Table 5.13, MKI's seismic program is predicted to have *negligible* to *low* hearing impairment and/or physical effects on seals during *<1 month* to *1 to 12 months* over an area of *<1 km^2* to *1-10 km^2*. Therefore, hearing impairment and physical effects on seals are predicted to be *not significant* (see Table 5.14). The level of confidence associated with this prediction is *medium* (see Table 5.14).

Disturbance

Based on the above review, there could be behavioural effects on seals within and near the Project Area. Known effects include changes in diving behaviour and localized avoidance of the seismic vessel. It is uncertain how many seals may occur in the Project Area during the period when seismic operations will occur (May to November). There are no available criteria for assessing the sound level most likely to elicit avoidance reactions in seals. It is noteworthy that seals have been sighted inside the radius thought to cause TTS (190 dB) in other areas. A 160 dB re 1 μPa_{rms} sound level has been conservatively used to assess disturbance effects, more specifically potential displacement from the area around the seismic source. As per Table 5.13, MKI's proposed seismic program is predicted to have *low* disturbance effects on seals. However, as per Table 5.13, disturbance effects on seals would likely be *low* during *<1 month* to *1 to 12 months* over an area of *11-100 km^2*. Therefore, effects related to disturbance are predicted to be *not significant* for seals (see Table 5.14). The level of confidence associated with this prediction is *high* (see Table 5.14).

Effects on Prey Species

It is unlikely that prey species for seals will be impacted by seismic activities to a degree that inhibits their foraging success. If prey species exhibit avoidance of the seismic ship it will likely be transitory in nature (see Section 5.8.4) and over a small portion of the seal's foraging range within the seismic area. Potential effects of reduced prey availability on seals are expected to be *negligible*.

Assessment of Effects of Sound on Sea Turtles

The effects assessment for sea turtles is summarized in Table 5.15.

<u>Hearing Impairment and Physical Effects</u>

Based on available data, it is possible that sea turtles might exhibit temporary hearing loss if the turtles are close to the airguns (Moulton and Richardson 2000). 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. Also, it is likely that sea turtles will exhibit behavioural reactions or avoidance within an area of unknown size around a seismic vessel. The mitigation measure of ramping-up the airgun array over a 30 min period should permit sea turtles close to the airguns to move away before the sounds become sufficiently strong to have any potential for hearing impairment. Also, ramp-up will not commence if a sea turtle is sighted within the 500 m safety zone, and the airgun array will be shutdown if a sea turtle is sighted within the safety zone.

It is very unlikely that many sea turtles will occur in the Study Area. Therefore, there is likely limited potential for sea turtles to be close enough to an array to experience hearing impairment. If some turtles did experience TTS, the effects would likely be quite "temporary". As per Table 5.15, MKI's seismic program is predicted to have *negligible* to *low* physical effects on sea turtles during *<1 month* to *1-12 months* over an area of *<1 to 1-10* km^2. Therefore, auditory and physical effects on sea turtles are predicted to be *not significant* (Table 5.16). The level of confidence associated with this prediction is medium (Table 5.16).

<u>Disturbance</u>

It is possible that sea turtles will occur in the Project Area, although the cooler water temperatures likely preclude some species from occurring there. If sea turtles did occur near the seismic vessel, it is likely that they would exhibit avoidance within a localized area. Based on observations of green and loggerhead sea turtles, behavioural avoidance may occur at received sound levels of 166 dB re 1 μPa_{rms}. Based on available evidence, the area where displacement would most likely occur would have a scale of impact at *11-100* km^2. As per Table 5.15, MKI's seismic program is predicted to have *low* disturbance effects on sea turtles during *<1 month* to *1 to 12 months* over an area of *11-100* km^2. Therefore, effects related to disturbance, are predicted to be *not significant* for sea turtles (Table 5.16). The level of confidence associated with this prediction is *high* (Table 5.16).

<u>Prey Species</u>

Leatherback sea turtles are expected to feed primarily on jellyfish. It is unknown how jellyfish react to seismic sources, if these invertebrates react at all. Leatherbacks are also known to feed on sea urchins, tunicates, squid, crustaceans, fish, blue-green algae, and floating seaweed. It is possible that some prey species may exhibit localized avoidance of the seismic array but this is unlikely to impact sea turtles, which are also likely to avoid the seismic vessel and are known to search for aggregations of prey. Potential effects of reduced prey availability are predicted to be *negligible*.

5.8.7.2 Helicopter Sound

Available information indicates that single or occasional aircraft overflights will cause no more than brief behavioural responses in baleen whales, toothed whales and seals (summarized in Richardson et al. 1995). As per Table 5.13, disturbance effects are assessed as *negligible* to *low* during *<1 month* over an area *<1* km^2 to *1-10* km^2. Therefore, effects related to disturbance, are predicted to be *not significant* for marine mammals (see Table 5.14). The level of confidence associated with this prediction is *high* (see Table 5.14).

To the best of our knowledge, there are no systematic data on sea turtle reactions to helicopter overflights. Given the hearing sensitivities of sea turtles, they can likely hear helicopters, at least when the helicopters are at lower altitudes and the turtles are in relatively shallow waters. It is unknown how sea turtles would respond, but single or occasional overflights by helicopters would likely only elicit a brief behavioural response. As per Table 5.15, disturbance impacts are assessed as *negligible* during *<1 month* over an area of *<1* km^2 to *1-10* km^2. Therefore, impacts related to disturbance, are predicted to be *not significant* for sea turtles (see Table 5.16). The level of confidence associated with this prediction is *high* (see Table 5.14).

Table 5.15 Assessment of Effects of Project Activities on Sea Turtles.

Sea Turtles								
Project Activity	Potential Positive (P) or Negative (N) Environmental Effect	Mitigation	Evaluation Criteria for Assessing Environmental Effects					
			Magnitude	Geographic Extent	Frequency	Duration	Reversibility	Ecological/ Socio-Cultural and Economic Context
Underwater Sound								
Airguns	Hearing Impairment (N); Physical Effects (N)	Pre-watch; Ramp-up; Delay start[a]; Shutdown[b]	0-1	1-2	6	1-2	R	2
Airguns	Disturbance (N)	Pre-watch; Ramp-up; Delay start[a]; Shutdown[b]	1	3	6	1-2	R	2
Seismic Vessel	Disturbance (N)		0-1	1-2	6	1-2	R	2
Support Vessel	Disturbance (N)		0-1	1-2	6	1-2	R	2
Supply Vessel	Disturbance (N)		0-1	1-2	6	1-2	R	2
Echosounder	Disturbance (N)		0-1	1	6	1-2	R	2
Helicopter	Disturbance (N)		0-1	1-2	1	1	R	2
Vessel Presence								
Seismic Vessel and Gear	Disturbance (N)		0-1	1	6	1-2	R	2
Support Vessel	Disturbance (N)		0-1	1	6	1-2	R	2
Supply Vessel	Disturbance (N)		0-1	1	6	1-2	R	2
Helicopter Presence	Disturbance (N)	Maintain high altitude	0-1	1-2	1	1	R	2
Sanitary/Domestic Waste	Increased Food (N/P)	Treatment; containment	0-1	1	4	1-2	R	2
Atmospheric Emissions	Surface Contaminants (N)	Low sulphur fuel	0	1	6	1-2	R	2
Accidental Releases	Injury/Mortality (N)	Solid streamer[c]; Spill response	1	1-2	1	1	R	2

[a] Ramp-up will be delayed if a sea turtle is sighted within the 500 m safety zone.
[b] The airgun arrays will be shutdown if an *endangered* (or *threatened*) sea turtle is sighted within 500 m of the array.
[c] A solid streamer will be used for all seismic surveys.

Key:

Magnitude:
0 = Negligible, essentially no effect
1 = Low
2 = Medium
3 = High

Frequency:
1 = <11 events/yr
2 = 11-50 events/yr
3 = 51-100 events/yr
4 = 101-200 events/yr
5 = >200 events/yr
6 = continuous

Reversibility:
R = Reversible
I = Irreversible
(refers to population)

Duration:
1 = <1 month
2 = 1-12 months
3 = 13-36 months
4 = 37-72 months
5 = >72 months

Geographic Extent:
1 = <1 km^2
2 = 1-10 km^2
3 = 11-100 km^2
4 = 101-1,000 km^2
5 = 1,001-10,000 km^2
6 = >10,000 km^2

Ecological/Socio-cultural and Economic Context:
1 = Relatively pristine area or area not negatively affected by human activity
2 = Evidence of existing negative effects

Table 5.16 Significance of Potential Residual Environmental Effects of Proposed Activities on Sea Turtles.

Sea Turtles				
Project Activity	**Residual Environmental Effect Rating**	**Level of Confidence**	**Likelihood [a]**	
	Significance of Predicted Residual Environmental Effects		**Probability of Occurrence**	**Scientific Certainty**
Underwater Sound				
Airguns – hearing/physical effects	NS	2	-	-
Airguns – behavioural effects	NS	3	-	-
Seismic Vessel	NS	3	-	-
Support Vessel	NS	3	-	-
Supply Vessel	NS	3	-	-
Echosounder	NS	3	-	-
Helicopter	NS	3	-	-
Vessel Presence				
Seismic Vessel and Gear	NS	3	-	-
Support Vessel	NS	3	-	-
Supply Vessel	NS	3	-	-
Helicopter Presence	NS	3	-	-
Sanitary/Domestic Wastes	NS	3	-	-
Atmospheric Emissions	NS	3	-	-
Accidental Releases	NS	2	-	-

Key:

Significance is defined as either a high magnitude, or a medium magnitude with duration greater than 1 year and a geographic extent >100 km^2

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

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

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

Scientific Certainty: based on scientific information and statistical analysis or professional judgment:
- 1= Low
- 2= Medium
- 3= High

[a] Considered only in the case where 'significant negative effect' is predicted.

5.8.7.3 Vessel Presence

During the proposed seismic program, there will be one seismic ship at all times and a support vessel on site during most of the program. There is some risk for collision between marine mammals and vessels, but given the slow surveying speed (~4.5 knots; 8.3 km/h) of the seismic vessel (and its support vessel), this risk is likely to be minimal (e.g., Laist et al. 2001; Vanderlaan and Taggart 2007; Gende et al. 2011; Wiley et al. 2011). Marine mammal responses to ships are presumably responses to noise, but visual or other cues are also likely involved. Marine mammal response (or lack thereof) to ships and boats (pre-1995 studies) are summarized in Richardson et al. (1995), p. 252 to 274. More recent studies are described in Husky (2012). Marine mammal responses to the presence of vessels are variable. Seals often show considerable tolerance to vessels. Toothed whales sometimes show no avoidance reactions and occasionally approach vessels; however, some species are displaced by vessels. Baleen whales often interrupt their normal behaviour and swim rapidly away from vessels that have strong or rapidly changing noise, especially when a vessel heads directly towards a whale. Stationary vessels or slow-moving, "non-aggressive" vessels typically elicit very little response from baleen whales.

There are few systematic studies on sea turtle reactions to ships and boats but it is thought that response would be minimal relative to responses to seismic sound. Hazel et al. (2007) evaluated behavioural responses of green turtles to a research vessel approaching at slow, moderate, or fast speeds (4, 11, and 19 km/h, respectively). Proportionately fewer turtles fled from the approaching vessel as speed increased, and turtles that fled from moderate to fast approaches did so at significantly shorter distances from the vessel than those that fled from slow approaches. The authors concluded that sea turtles cannot be relied on to avoid vessels with speeds greater than 4 km/h. However, studies were conducted in a 6 m aluminum boat powered by an outboard engine, which would presumably be more challenging for a sea turtle to detect than a seismic or support vessel. Lester et al. (2012) reported variable behavioural responses of a semi-aquatic turtles to boat sounds.

Sea turtles may also become entangled with seismic gear (e.g., cables, buoys, streamers, etc.) or collide with the vessel (Pendoley 1997; Ketos Ecology 2007; Weir 2007; Hazel et al. 2007). Entanglement of sea turtles with marine debris, fishing gear, dredging operations, and equipment operations are a documented occurrence and of elevated concern for sea turtles. Turtles can become wrapped around cables, lines, nets, or other objects suspended in the water column and become injured or fatally wounded, drowned, or suffocated (e.g., Lutcavage et al. 1997; NMFS 2007). Seismic 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). With dedicated monitoring by trained biological observers, no incidents of entanglements of sea turtles with this gear have been documented in over 40,000 n.mi. (74,000 km) of NSF-funded seismic surveys (e.g., Smultea and Holst 2003; Haley and Koski 2004; Holst 2004; Smultea et al. 2004; Holst et al. 2005a,b; Holst and Smultea 2008). Towing of the hydrophone streamer or other equipment is not expected to significantly interfere with sea turtle movements, including migration, unless they were to become entrapped as indicated above.

However, the Project Area is not a breeding area for sea turtles and it is not known or thought to be an important feeding area. Thus, it is not expected that high concentrations of sea turtles could potentially be physically affected.

Effects of the presence of vessels on marine mammals or sea turtles, including the risk of collisions, are predicted to be *negligible to low during <1 month* to *1-12 months* over an area of *1-10 km*^{2}. Therefore, effects related to the presence of vessels, are predicted to be *not significant* for marine mammals and sea turtles (see Tables 5.12 to 5.16). The level of confidence associated with this prediction is *high* (see Tables 5.14 and 5.16).

5.8.7.4 Accidental Releases

All petroleum hydrocarbon handling and reporting procedures on board will be consistent with MKI's policy, and handling and reporting procedures. A fuel spill may occur from the seismic ship and/or the support vessel. Any spills would likely be small and quickly dispersed by wind, wave, and ship's propeller action. The effects of hydrocarbon spills on marine mammals and sea turtles were reviewed in Section 11.4.3 of Husky (2012) and are not repeated here. Based on multiple studies, 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). Sea turtles are thought to be more susceptible to the effects of oiling than marine mammals but effects are primarily believed to be sublethal (Husky 2012). Camacho et al. (2013) reported that 88% of loggerhead turtles that stranded due to crude oil in the Canary Islands, Spain, survived; those that died showed signs of ingested oil and internal lesions. Lesions on the skin, carapace, and plastron tend not to be fatal (Camacho et al. 2013). Effects of a small accidental spill on marine mammals or sea turtles would be *low* during *<1 month* over an area *<1 km*^{2} *to 1-10 km*^{2} and are predicted to be *not significant* (see Tables 5.12 to 5.16). The level of confidence associated with this prediction is *medium* (see Tables 5.14 and 5.16).

5.8.7.5 Other Project Activities

There is potential for marine mammals and sea turtles to interact with domestic and sanitary wastes, and atmospheric emissions from the seismic ship and the support vessel. Any effects from these interactions are predicted to be *negligible* (see Tables 5.12 to 5.16).

5.8.8 Species at Risk VEC

A biological overview of all species considered at risk under *SARA* and/or by COSEWIC that have reasonable likelihood of occurrence in the Study Area was provided in Section 4.6. No critical habitat has been defined for the Study Area. As discussed in previous sections and presented in Table 5.17, *SARA* Schedule 1 species/groups of relevance to the Study Area include:

- White shark, northern wolffish, spotted wolffish, and Atlantic wolffish;
- North Atlantic right whale, blue whale, northern bottlenose whale (Scotian Shelf population), beluga (St. Lawrence Estuary population), Sowerby's beaked whale, and fin whale (Atlantic population); and
- Leatherback sea turtle.

Species not currently designated on Schedule 1 of *SARA* but listed on Schedule 2 or 3 or being considered for addition to Schedule 1 (as per their current COSEWIC listing of *endangered, threatened* or *special concern*), are not included in the Species at Risk VEC here but have been assessed in the relevant VEC in Sections 5.8.4 (Fish), 5.8.6 (Marine Birds) and 5.8.7 (Marine Mammals and Sea Turtles) of this EA. If species not currently designated on Schedule 1 of *SARA* do become listed on this legal list during the remainder of the life of the Project (2014–2018), the Proponent will re-assess these species considering the prohibitions of *SARA* and any recovery strategies or action plans that may be in place. Possible mitigation measures as they relate to Species at Risk will be reviewed with DFO and Environment Canada. Potential interactions between the Project and SAR are shown in Table 5.17.

As per the detailed effects assessment in Section 5.8.4, physical effects of the Project on the various life stages of wolffishes and the white shark will range from *negligible* to *low* in magnitude during *<1 month* to *1-12 months* over an area of *<1* km^2 (Table 5.18). Behavioural effects may extend out to a larger area but are still predicted to be *not significant* (Table 5.19). The mitigation measure of ramping-up the airgun array (over a 30 min period) is expected to minimize the potential for impacts on wolffishes and the white shark.

Table 5.17 Potential Interactions between the Project Activities and Species at Risk VEC.

Valued Environmental Component: Species at Risk			
Project Activities	**Wolffishes, White Shark**	**North Atlantic Right, Blue, Northern Bottlenose, Beluga, Sowerby's Beaked and Fin Whales**	**Leatherback Sea Turtle**
Underwater Sound			
Airguns	X	X	X
Seismic Vessel	X	X	X
Support Vessel	X	X	X
Supply Vessel	X	X	X
Echosounder	X	X	X
Helicopter [a]		X	X
Vessel Presence			
Seismic Vessel and Gear		X	X
Support Vessel		X	X
Supply Vessel		X	X
Vessel Lights			
Helicopter Presence		X	X
Sanitary/ Domestic Wastes	X	X	X
Atmospheric Emissions	X	X	X
Accidental Releases	X	X	X
Garbage [b]			
Shore Facilities [c]			
OTHER PROJECTS AND ACTIVITIES			
Oil and Gas Activities	X	X	X
Fisheries	X	X	X
Marine Transportation	X	X	X

[a] No helicopter use is planned for 2014 but helicopters may be used during 2015-2018.
[b] Not applicable as garbage will be brought ashore.
[c] There will not be any new onshore facilities. Existing infrastructure will be used.

Table 5.18 Assessment of Effects of Project Activities on Species at Risk VEC.

Valued Environmental Component: Species at Risk								
Project Activity	**Potential Positive (P) or Negative (N) Environmental Effect**	**Mitigation**	**Evaluation Criteria for Assessing Environmental Effects**					
			Magnitude	**Geographic Extent**	**Frequency**	**Duration**	**Reversibility**	**Ecological/ Socio-Cultural and Economic Context**
Underwater Sound								
Airguns	Hearing Impairment (N) Physical Effects (N)	Ramp-up; delay start[a]; shutdown [b]	0-1	1-2	6	1-2	R	2
Airguns	Disturbance (N)	Ramp-up; delay start[a]; shutdown [b]	0-1	1-4	6	1-2	R	2
Seismic Vessel	Disturbance (N)		0-1	1-2	6	1-2	R	2
Support Vessel						1-2		
Supply Vessel	Disturbance (N)		0-1	1-2	6	1-2	R	2
Echosounder	Disturbance (N)		0-1	1	6	1-2	R	2
Helicopter	Disturbance (N)	Maintain high altitude	0-1	1-2	1	1	R	2
Vessel Presence								
Seismic Vessel and Gear	Disturbance (N)		0-1	1-2	6	1-2	R	2
Support Vessel	Disturbance (N)		0-1	1-2	6	1-2	R	2
Supply Vessel	Disturbance (N)	Maintain high altitude	0-1	1-2	1	1-2	R	2
Vessel Lights	Attraction (N); Mortality (N)	Turn off non-essential lighting; release protocols for seabirds	0-1	1-2	2-3	1-2	R	2
Helicopter Presence	Disturbance (N)	Maintain high altitude	0-1	1-2	1	1	R	2
Sanitary/Domestic Wastes	Increased Food (N/P)	Treatment	0-1	1	4	1-2	R	2
Atmospheric Emissions	Surface Contaminants (N)	Use of low-sulphur fuel; Equipment maintenance	0	1	6	1-2	R	2
Accidental Releases	Injury/Mortality (N)	Solid streamer[c]; spill response	0-2	1-2	1	1	R	2

[a] Ramp-up will be delayed if any marine mammal or sea turtle is sighted within the 500 m safety zone.
[b] The airgun arrays will be shutdown if an *endangered* (or *threatened*) marine mammal or sea turtle is sighted within 500 m of the array.
[c] A solid streamer will be used for all seismic surveys.

Key:

Magnitude:
0 = Negligible, essentially no effect
1 = Low
2 = Medium
3 = High

Frequency:
1 = <11 events/yr
2 = 11-50 events/yr
3 = 51-100 events/yr
4 = 101-200 events/yr
5 = >200 events/yr
6 = continuous

Reversibility:
R = Reversible
I = Irreversible
(refers to population)

Duration:
1 = <1 month
2 = 1-12 months
3 = 13-36 months
4 = 37-72 months
5 = >72 months

Geographic Extent:
1 = <1 km^2
2 = 1-10 km^2
3 = 11-100 km^2
4 = 101-1,000 km^2
5 = 1,001-10,000 km^2
6 = >10,000 km^2

Ecological/Socio-cultural and Economic Context:
1 = Relatively pristine area or area not negatively affected by human activity
2 = Evidence of existing negative effects

Table 5.19 Significance of Potential Residual Environmental Effects of Project Activities on Species at Risk VEC.

Valued Environmental Component: Species at Risk				
Project Activity	Residual Environmental Effect Rating	Level of Confidence	Likelihood [a]	
	Significance of Predicted Residual Environmental Effects		Probability of Occurrence	Scientific Certainty
Underwater Sound				
Airguns – hearing/physical effects	NS	2	-	-
Airguns – behavioural effects	NS	3	-	-
Seismic Vessel	NS	3	-	-
Support Vessel				
Supply Vessel	NS	3	-	-
Echosounder	NS	3	-	-
Helicopter	NS	3	-	-
Vessel Presence				
Seismic Vessel and Gear	NS	3	-	-
Support Vessel	NS	3	-	-
Supply Vessel	NS	3	-	-
Vessel Lights	NS	3	-	-
Helicopter Presence	NS	3	-	-
Sanitary/Domestic Wastes	NS	3	-	-
Atmospheric Emissions	NS	3	-	-
Accidental Releases	NS	2-3	-	-

Key:

Significance is defined as either a high magnitude, or a medium magnitude with duration greater than 1 year and a geographic extent >100 km^2

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

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

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

Scientific Certainty: based on scientific information and statistical analysis or professional judgment:
- 1= Low
- 2= Medium
- 3= High

[a] Considered only in the case where 'significant negative effect' is predicted.

Based on available information, the North Atlantic right whale, blue whale, Sowerby's beaked whale, beluga whale, and leatherback sea turtle are not expected to occur regularly in the Study Area. Although uncommon, northern bottlenose whales (Scotian Shelf population), designated as *endangered*, are expected to occur in the Study Area during summer months and perhaps also at other times of the year. There are finalized recovery strategies for leatherback sea turtles (ALTRT 2006), blue whales in Atlantic Canada (Beauchamp et al. 2009), the Scotian Shelf population of northern bottlenose whales (DFO 2010e), and North Atlantic right whales (Brown et al. 2009). In addition, a recovery strategy has been proposed for the St. Lawrence Estuary population of beluga whale (DFO 2011b). Mitigation and monitoring designed to minimize potential effects of airgun array noise on *SARA*-listed marine mammals and sea turtles will include those detailed in Section 5.6. These include the following:

- prewatch of the safety zone before the array is activated;
- ramp-up of the airgun array over a 30 min period;
- monitoring by MMO(s) during daylight hours that the airgun array is active;
- shutdown of the airgun array when an *endangered* or *threatened* marine mammal or sea turtle is sighted within the 500 m safety zone; and
- delay of ramp-up if any marine mammal or sea turtle is sighted within the 500 m safety zone.

With these mitigation measures in place and as per the detailed effects assessment in Section 5.8.7, the Project is predicted to have *no significant effect* (hearing impairment/physical or behavioural) on SAR marine mammals and sea turtles (see Tables 5.18 and 5.19).

In summary, potential effects of the proposed 2D and 3D seismic program are not expected to contravene the prohibitions of *SARA* (Sections 32(1), 33, 58(1)).

5.8.9 Sensitive Areas VEC

An overview of sensitive areas either overlapping or proximate to the Study Area was provided in Section 4.7. The habitual preferences of biota potentially inhabiting these sensitive areas, including invertebrates, fishes, marine mammals, sea turtles and seabirds, were detailed in Sections 4.2 to 4.5, and species at risk were described in Section 4.6.

Based on the conclusions of Sections 5.8.4 to 5.8.8, the Project is predicted to have *no significant effect* on sensitive habitat or the species therein within the Study Area.

5.9 Cumulative Effects

This EA has assessed cumulative effects within the Project and thus, the residual effects described in preceding sections include any potential cumulative effects from the MKI geophysical program activities in the Project Area.

It is also necessary to assess cumulative effects from other non-Project activities that are occurring or planned for the Regional Area. These activities may include:

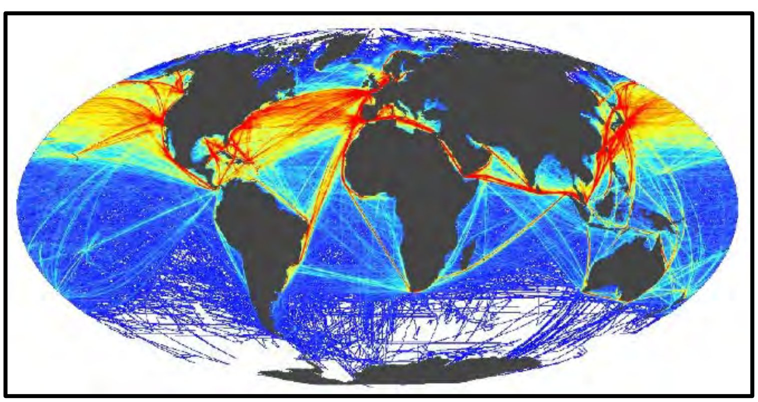
- fisheries (commercial and research);
- marine transportation; and
- other oil and gas activities.

5.9.1 Fisheries

Fisheries has been discussed and assessed in Sections 4.3 and 5.8.5. Fishing, by its nature, causes mortality and disturbance to fish populations and may cause incidental mortalities or disturbance to seabirds, marine mammals, and sea turtles. It is predicted that the seismic surveys will not cause any mortality to these VECs (with the potential exception of small numbers of petrels) and thus, there will be *no* or *negligible* cumulative effects from mortalities. There is some potential for cumulative effect from disturbance (e.g., fishing vessel noise) but there will be directed attempts by both industries to mitigate effects and to avoid each other's active areas and times. The seismic surveying will also spatially and temporally avoid DFO research vessels during multi-species trawl surveys. Any cumulative effects (i.e., disturbance), if they occur, will be additive (not multiplicative or synergistic) and predicted to be *not significant*.

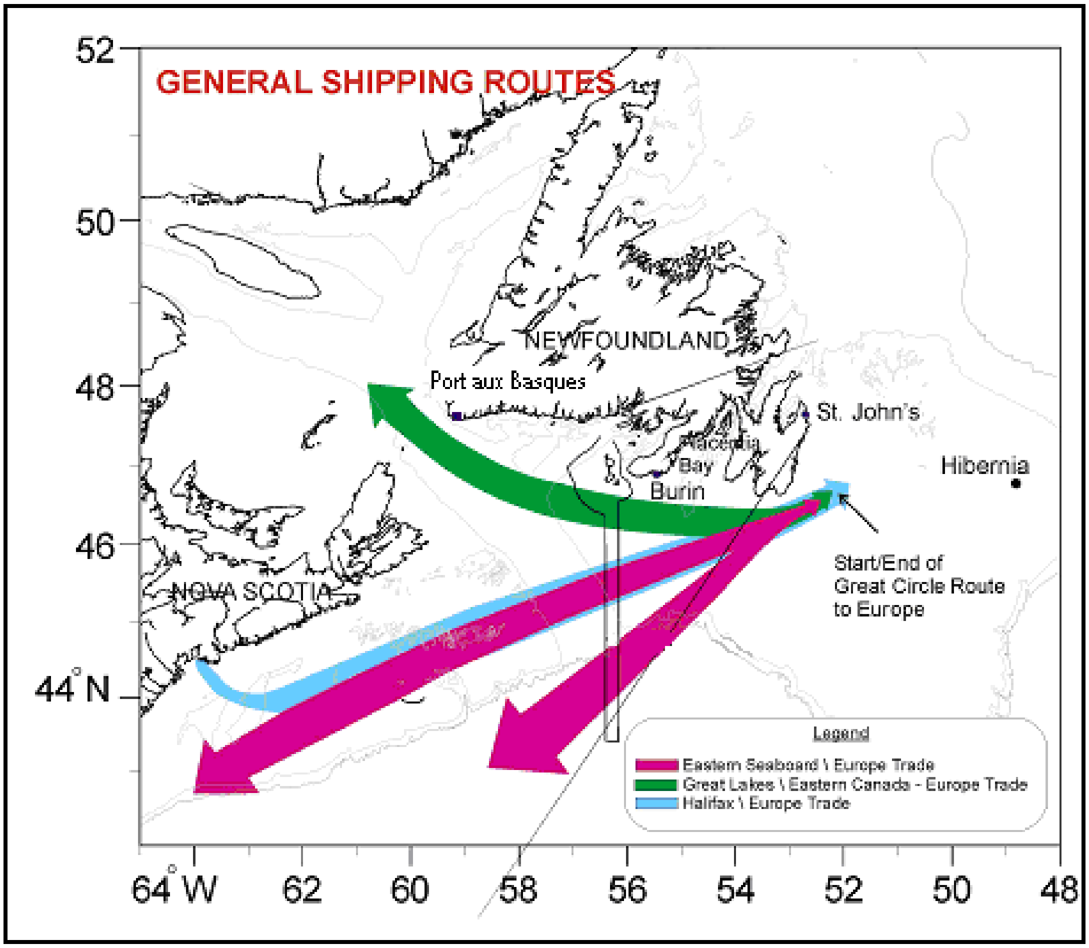
5.9.2 Marine Transportation

Based on voluntary reporting, extensive marine shipping occurs through and near the Project Area (Figure 5.1). The Eastern Seaboard/Europe and Halifax/Europe trade routes pass through the Project Area while the Eastern Canada and Great Lakes trade route with Europe occurs in the northern proximity of the Project Area (Figure 5.2). In the summer, the main North Atlantic shipping lanes between Europe and North America lie to the north of the Grand Banks through the Strait of Belle Isle. However in the winter, far less traffic passes through this area as navigation can be affected by the presence of pack ice and icebergs. Accordingly, traffic shifts to the main shipping lanes along the southern Grand Banks into the Gulf of St. Lawrence (Koropatnick et al. 2012).



Source: Additional Resources in Halpern et al. 2008.

Figure 5.1 Frequency of Global Shipping Traffic Along Major Shipping Routes, Ranging from Low (Blue) to High (Red).

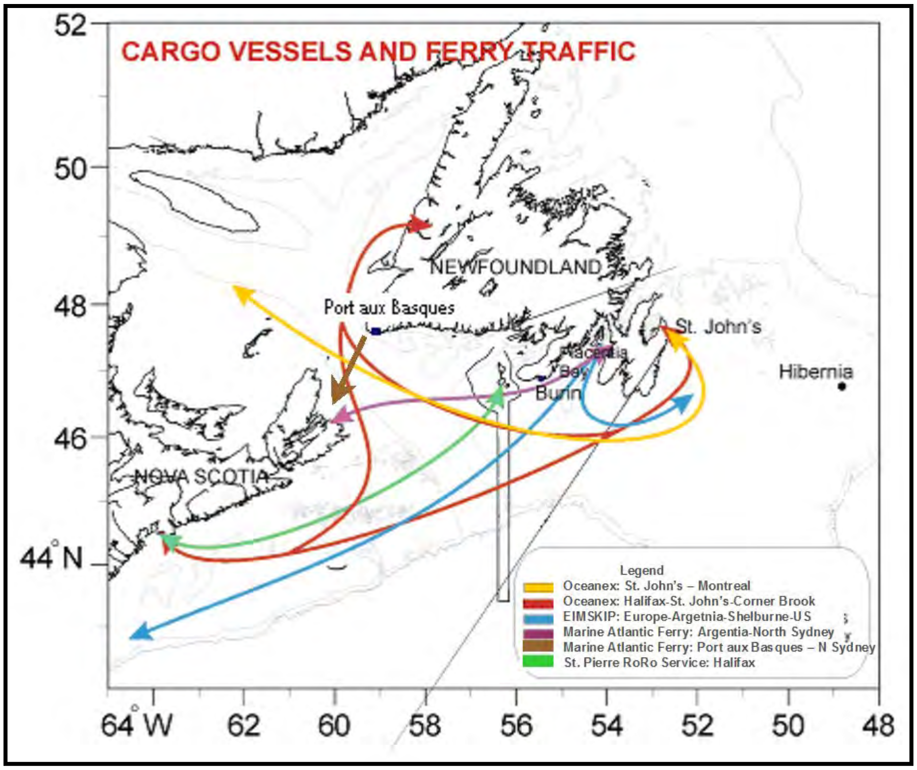


Source: JW 2007.

Figure 5.2 General Shipping Routes in Eastern Canada.

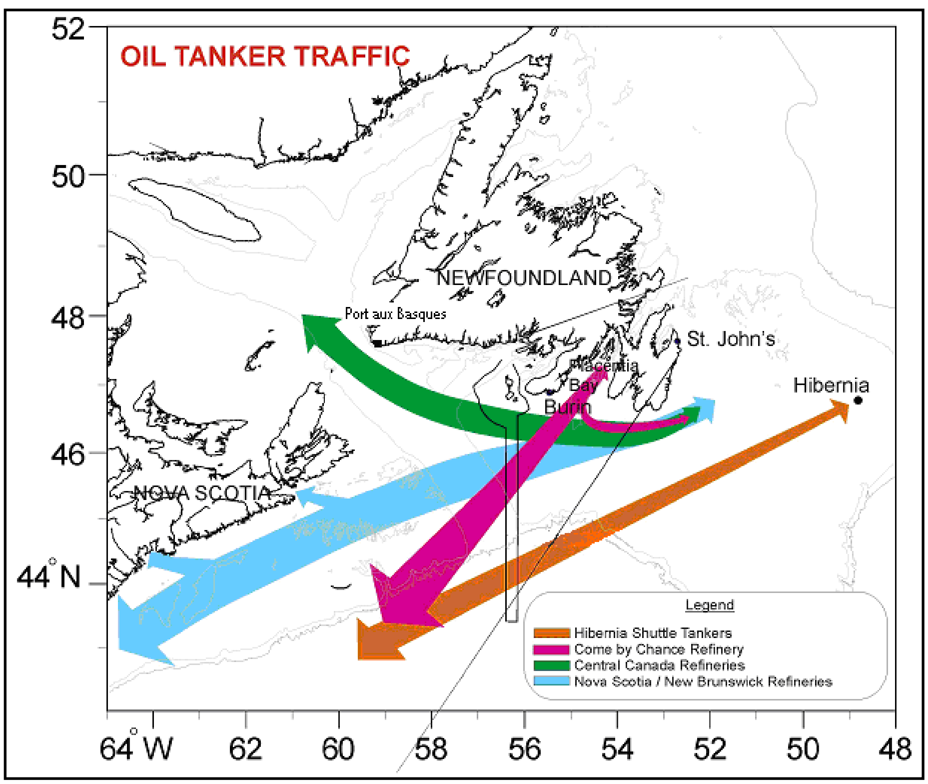
Oceanex and Eimskip use cargo routes that pass through the Project Area (Figure 5.3). Nova Scotia-Newfoundland ferries as well as cruise ships pass through the Project Area (Figure 5.3). There is also potential oil tanker traffic from the Newfoundland Transshipment Terminal, Come by Chance Oil Refinery in Placentia Bay, Hibernia shuttle tankers or other locations sailing for east coast refineries (Figure 5.4).

In mapping and analyzing vessel tracks in Atlantic Canada from February 2010 to February 2011, Koropatnick et al. (2012) found high levels of traffic along the Grand Banks centered in the northwest region of the Project Area (see Figure 8 *in* Koropatnick et al. [2012]). The greatest number of vessel tracks were observed in August 2010 while the fewest were observed in February 2010.



Source: JW 2007.

Figure 5.3 Cargo Vessels and Ferry Traffic off Nova Scotia and Newfoundland.



Source: JW 2007.

Figure 5.4 Oil Tanker Traffic off Nova Scotia and Newfoundland.

Underwater sound generated by marine transportation affects a much greater area than does seismic surveying. Compared to underwater sound produced by marine transportation, the amount of underwater sound produced by seismic surveying is small, especially considering its limited spatial and temporal scopes. The seismic survey vessels are not likely to add much marine traffic congestion. Ships may need to divert around the immediate seismic survey area, but this will not prevent or impede the passage of either vessel as the *Shipping Act* and standard navigation rules will apply. Thus, potential for cumulative effects with other shipping is predicted to be *low* and *not significant*.

5.9.3 Other Oil and Gas Activities

Potential offshore oil and gas industry activities in the Regional Area (as pre the C-NLOPB public registry, www.cnlopb.nl.ca) include:

- TGS NOPEC Geophysical Company ASA and Multi Klient Invest AS Offshore Labrador Seafloor and Seabed Sampling Program, Newfoundland and Labrador Offshore Area, 2014-2019;
- ARKeX Ltd. TGS-NOPEC Labrador Sea Gravity Gradient Survey, 2014-2018;
- Electromagnetic Geoservices Canada, Inc. (EMGS) Controlled Source Electromagnetic (CSEM) Survey, 2014-2018;
- GXT GrandSPAN Marine 2d Seismic Gravity and Magnetic Survey, 2014-2018;
- Multi Klient Invest AS Labrador Sea 2D/3D seismic program, 2014-2018;
- Suncor Energy’s Eastern Newfoundland Offshore Area 2D/3D/4D Seismic Program, 2014-2024;
- Hibernia Management and Development Company Ltd. (HMDC) 2D/3D/4D seismic surveys in the Jeanne d’Arc Basin, 2013 to the remaining life of the Hibernia oil and gas production field;
- GXT 2D seismic, gravity and magnetic survey for the Labrador Shelf Area, 2013-2015;
- Multi Klient Invest AS Northeast Newfoundland Slope seismic program, 2012-2017;
- Husky Energy’s Jeanne d’Arc Basin Flemish Pass regional seismic program, 2012-2020;
- Statoil Canada Limited 2011-2019 Jeanne d’Arc and North Ridge/Flemish Pass Basin geophysical program;
- Chevron Canada Resources Northern Grand Banks regional seismic program, 2011-2017;
- InvestCan Energy Labrador seismic program, 2010-2017;
- Chevron Canada Resources Labrador seismic program, 2010-2017;
- Husky Energy Labrador Shelf seismic program, 2010-2017;
- Petro-Canada Jeanne d’Arc basin exploration drilling program, 2009-2017;
- StatoilHydro Canada E&P Inc. Jeanne d’Arc Basin seismic survey program, 2008-2016;
- Statoil Hydro Canada E&P Inc. exploration/appraisal/delineation drilling program for offshore Newfoundland, 2008-2016;
- Husky exploration and delineation drilling program in Jeanne d’Arc Basin, 2008-2017; and
- Husky White Rose new drill centre construction and operations program, 2008-2015.

While the above list suggests potential for many programs to run concurrently, it should be noted that the East Coast operators tend to coordinate their logistics. As a result, based on historical levels of activities, there typically would be no more than two or three drill rigs and two or three seismic programs operating off Newfoundland and Labrador during any one season.

In addition, there are three existing offshore production developments (Hibernia, Terra Nova, and White Rose) on the northeastern part of the Grand Banks. A fourth development (Hebron) began construction in October 2012. Additional production development (White Rose Extension Program, WREP) is anticipated to commence installation in the near future. The existing developments fall inside of the boundaries of MKI's Regional Area but do not create the same levels of underwater noise as seismic, geohazard, or VSP programs. Any cumulative effects (i.e., disturbance), if they occur, will be additive (not multiplicative or synergistic) and predicted to be *not significant*.

There is potential for cumulative effects with other seismic programs proposed for 2014-2018 (e.g., Statoil, Husky, MKI). Different seismic programs could potentially be operating in close proximity. During these periods, marine mammals may be exposed to noise from each of the seismic survey programs. It will be in the interests of the different parties for good coordination between programs in order to provide sufficient buffers and to minimize acoustic interference. Effects on marine mammals (and other VECs) are predicted to be *not significant*. However, there are uncertainties regarding this prediction. The potential for temporal and spatial overlap of future activity of seismic programs (2014-2018) in the area will be assessed in the EA update process. Uncertainty due to the large identified Study Area will be reduced as specific survey designs (covering smaller area) become available.

As discussed in this EA, negative effects on key sensitive VECs such as marine mammals appear unlikely beyond a localized area from the sound source. In addition, all programs will use mitigation measures such as ramp-ups, delayed start ups, and shutdowns of the airgun arrays. Thus, it seems likely that while some animals may receive sound from one or more geophysical programs, the current scientific prediction is it that *no significant residual effects* will result.

5.10 Mitigations and Follow-up

Project mitigations are summarized in the text provided below and in Table 5.20. MKI will adhere to mitigations detailed in Appendix 2 of the *Geophysical, Geological, Environmental and Geotechnical Program Guidelines* (C-NLOPB 2012) including those in the *Statement of Canadian Practice with Respect to the Mitigation of Seismic Sound in the Marine Environment*.

Fishers who may be operating in the area will be notified of the timing and location of planned activities by means of a CCG "Notice to Mariners" and a "Notice to Fishers" on the CBC Radio Fisheries Broadcast. If necessary, individual fixed gear fishers will be contacted to arrange mutual avoidance. Any contacts with fishing gear with any identifiable markings will be reported to the C-NLOPB within 24 h of the contact (in accordance with the C-NLOPB Incident Reporting and Investigation Guidelines). Fishing gear may only be retrieved from the water by the gear owner (i.e., fishing license owner). This includes buoys, radar reflectors, ropes, nets, pots, etc., associated with fishing gear and/or activity. If gear contact is made during seismic operations, it should not be retrieved or retained by the seismic vessel. There are conditions that may warrant gear being retrieved or retained if it becomes entangled with seismic gear; however, further clarification on rules and regulations regarding fishing gear should be directed to the Conservation and Protection Division of Fisheries and Oceans Canada (NL Region). MKI will advise the C-NLOPB prior to compensating and settling all valid lost gear/income claims promptly and satisfactorily.

Table 5.20 Summary of Mitigations Measures.

Potential Effects	Primary Mitigations
Interference with fishing vessels	• Upfront planning to avoid high concentrations of fishing vessels to the greatest extent possible • SPOC • Advisories and communications • FLO for 2D/3D/4D programs • Planned transit route to and between Survey Areas (if required)
Fishing gear damage	• Upfront planning to avoid high concentrations of fishing gear to the greatest extent possible • SPOC • Advisories and communications • FLO for 2D/3D/4D programs • Compensation program
Interference with shipping	• SPOC • Advisories and communications • FLO for 2D/3D/4D programs
Interference with DFO/FFAW research vessels	• Communications and scheduling; avoidance to the greatest extent possible
Temporary or permanent hearing damage/disturbance to marine animals	• Delay start-up if marine mammals or sea turtles are within 500 m • Ramp up of airguns over 30 min-period • Shutdown of airgun arrays for *endangered* or *threatened* marine mammals and sea turtles within 500 m • Use of MMO(s) to monitor for marine mammals and sea turtles during daylight seismic operations
Temporary or permanent hearing damage/ disturbance to Species at Risk or other key habitats	• Delay start-up if any marine mammals or sea turtles are within 500 m • Ramp up of airguns • Shutdown of airgun arrays for *endangered* or *threatened* marine mammals and sea turtles • Use of qualified MMO(s) to monitor for marine mammals and sea turtles during daylight seismic operations.
Injury (mortality) to stranded seabirds	• Daily monitoring of vessel • Handling and release protocols • Minimize unnecessary lighting when practical and safe to do so
Exposure to hydrocarbons	• Adherence to International Convention for the Prevention of Pollution from Ships (MARPOL) • Spill contingency plans; bunkering at sea procedures • Use of solid streamer when feasible

Specific mitigations to minimize potential conflicts and any negative effects with other vessels include:

- Timely and clear communications (VHF, HF Satellite, etc.);
- Utilization of fisheries liaison officers (FLOs) during 2D/3D/4D seismic programs for advice and coordination in regard to avoiding fishing vessels and fishing gear;
- MMO(s) on board;
- Posting of advisories with the Canadian Coast Guard and the CBC Fisheries Broadcast;
- Compensation program in the event any project vessels damage fishing gear; and
- Single Point of Contact (SPOC).

MKI will also coordinate with the FFAW and DFO to avoid any potential conflicts with fishing and research survey vessels that may be operating in the area. MKI commits to ongoing communications with other operators with active seismic programs within the general vicinity of its seismic program to minimize the potential for cumulative effects on VECs.

Mitigation measures designed to reduce the likelihood of impacts on marine mammals and sea turtles will include ramp ups, no initiation of airgun array if a marine mammal or sea turtle is sighted 30 min prior to ramp up within 500 m safety zone of the energy source, and shutdown of the energy source if an endangered (or threatened) whale or sea turtle is observed within the 500 m safety zone. Prior to the onset of the seismic survey, the airgun array will be gradually ramped up. One airgun will be activated first and then the volume of the array will be increased gradually over a recommended 30 min period. An observer (MMO) aboard the seismic ship will watch for marine mammals and sea turtles 30 min prior to ramp up. If a marine mammal or sea turtle is sighted within 500 m of the array, then ramp up will not commence until the animal has moved beyond the 500 m zone or 20 min have elapsed since the last sighting. The observers will watch for marine mammals and sea turtles when the airgun array is active (during daylight periods) and note the location and behaviour of these animals. The seismic array will be shutdown if an *endangered* or *threatened* marine mammal or sea turtle is sighted within the safety zone. The planned monitoring and mitigation measures, including ramp-ups, visual monitoring, and shutdown of the airguns when *endangered* or *threatened* marine mammals or turtles are seen within the "safety radius", will minimize the already low probability of exposure of marine animals to sounds strong enough to induce hearing impairment. Any dead or distressed marine mammals or sea turtles will be recorded and reported to the C-NLOPB and DFO.

Any seabirds that become stranded on the vessel (most likely Leach's Storm-petrel) 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.). Data collection for seabirds at sea will be in accordance with Gjerdrum et al. (2012). It is understood by MKI that a CWS *Migratory Bird Handling Permit* will be required and that it will be secured as it has been in the past. MKI will adhere to the conditions stipulated on the CWS permit. In the unlikely event that marine mammals, turtles or birds are injured or killed by Project equipment or accidental releases of hydrocarbons, a report will immediately be filed with the appropriate agencies (CWS, C-NLOPB) and the need for follow-up monitoring will be assessed.

Marine mammal and seabird observations will be made during ramp-ups and data acquisition periods, as well as at other times on an opportunistic basis. As per the *Geophysical, Geological, Environmental and Geotechnical Program Guidelines* (C-NLOPB 2012), monitoring protocols for marine mammals and sea turtles will be consistent with those developed by LGL and outlined in Moulton and Mactavish (2004). Seabird data collection protocols will be consistent with those provided by CWS in Wilhelm et al. (n.d.). Data will be collected and a monitoring report will be submitted to the C-NLOPB within one year after completion of the surveys.

5.11 Assessment Summary

A summary of the Project's residual effects on the environment are shown in Table 5.21. MKI's proposed geophysical program is predicted to have *no significant* effects on VECs.

Table 5.21 Significance of Potential Residual Environmental Effects of MKI's Proposed Geophysical Program on VECs Occurring within the Study Area.

Valued Environmental Component: Fish and Fish Habitat, Fisheries, Birds, Marine Mammals, Turtles, Species at Risk, Sensitive Areas				
Project Activity	Significance Rating	Level of Confidence	Likelihood [a]	
	Significance of Predicted Residual Environmental Effects		Probability of Occurrence	Scientific Certainty
Underwater Sound				
Airguns	NS	2-3	-	-
Seismic Vessel	NS	3	-	-
Support Vessel	NS	3	-	-
Supply Vessel	NS	3	-	-
Echo Sounder	NS	3	-	-
Helicopter				
Vessel Presence			-	-
Seismic Vessel	NS	3	-	-
Support Vessel	NS	3	-	-
Supply Vessel	NS	3	-	-
Vessel Lights	NS	3	-	-
Helicopter Presence	NS	3	-	-
Sanitary/Domestic Wastes	NS	3	-	-
Atmospheric Emissions	NS	3	-	-
Accidental Releases	NS	2-3	-	-

Key:

Significance is defined as either a high magnitude, or a medium magnitude with duration greater than 1 year and a geographic extent >100 km^2

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

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

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

Scientific Certainty: based on scientific information and statistical analysis or professional judgment:
1= Low
2= Medium
3= High

[a] Considered only in the case where 'significant negative effect' is predicted.

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List of Appendices