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5 Effects Assessment

The following chapter provides the assessment of all potential effects resulting from the proposed project. In order to undertake the assessment two general types of effects have been considered in the assessment:

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

In order to assess potential impacts, the effects assessment methodology used in this document is similar to the one used in recent east coast offshore seismic and drilling EAs (e.g. *LGL, 2013 and AMEC, 2015*) and guidance provided in Operational Policy Statement: Determining Whether a Project is Likely to Cause Significant Adverse Environmental Effects under the Canadian Environmental Assessment Act, 2012 (*CEAA, 2015*). These documents also conform to the (now repealed) Canadian Environmental Assessment Act (CEAA) of 1992 and its associated Responsible Authority's Guide and the CEA Agency Operational Policy Statement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 final February 3rd 2016 Scoping Document for the Project stated that the assessment shall include consideration of the following factors:

- The purpose of the Project;
- The environmental effects of the Project, including those due to unplanned events that may occur in connection with the Project and any change to the Project that may be caused by the environment;
- Cumulative environmental effects of the Project that are likely to result from the project in combination with other projects or activities that have been or will be carried out;
- The significance of the environmental effects, including the cumulative effects;
- Measures including contingency and compensation measures as appropriate, that are technically and economically feasible and that would mitigate any significant adverse environmental effects of the project;
- The significance of adverse environmental effects following the employment of mitigative measures, including the feasibility of additional or augmented mitigative measures; and
- Report on consultations undertaken by Polarcus with interested other ocean users who may be affected by program activities and/or the general public respecting any of the matters described above.
- In addition, various stakeholders were contacted for input (see below, Section 5.2). Another aspect of scoping for the effects assessment involved reviewing relevant and recent EAs that were conducted in Newfoundland and Labrador waters including (but not limited to) the Suncor Energy Eastern Newfoundland EA (*LGL, 2013*), the Multi Klient Invest AS Labrador Sea EA (*LGL, 2014*) and the WesternGeco's Southeastern Newfoundland Offshore Seismic Program EA (*LGL, 2015*). Reviews of present state of knowledge on the effects of seismic as well as the biological setting of the Study Area were also conducted.

5.2 Consultations

5.2.1 Polarcus Consultation Policy and Approach

Polarcus'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. Polarcus will initiate meetings and respond to requests for meetings with the interested groups throughout this period. After the survey is complete Polarcus will conduct follow-up discussions. The same approach would be followed before, during and after any survey work for 2017-2022. In summary, each year Polarcus 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 MMSO and FLO reports.

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

5.2.2 Stakeholder Consultations

During preparation of the environmental assessment for Polarcus proposed Eastern Newfoundland Offshore Seismic Program, 2016-2022, consultations were undertaken with stakeholders. The objectives of these consultations were to describe the proposed seismic program, identify any issues and concerns, and gather additional information relevant to the EA.

The consultations were organized and coordinated by RPS. The Project Description was emailed to stakeholders and they were asked to review this information and if they would be available for an in-person meeting. These emails were followed up with telephone calls to schedule meetings for the week of February 8th, 2016.

Consultations for the proposed program were undertaken with the following stakeholders:

- Fish, Food and Allied Workers Union (FFAW-Unifor);
- Association of Seafood Producers (ASP);
- Ocean Choice International (OCI); and
- Newfound Resources Ltd.

The in-person meetings were held in Newfoundland. Whilst in Newfoundland, Polarcus took the opportunity to meet with the C-NLOPB to discuss their further plans in Newfoundland, Canada and introduce their company.

Appendix C presents 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, relevant chapters of the EA have been referenced in the responses.

A meeting had been scheduled with One Ocean but this had to be cancelled due to weather. This meeting will be re-scheduled, however Polarcus got the opportunity to meet with One Ocean members at the industry workshop on Marine Seismic Surveying organized by One Ocean and C-NLOPB on February 8th (see Appendix C).

RPS did not contact DFO to plan an in-person meeting as they have been informed in the past by the Freshwater Habitat Section that the department would be providing comments on the proposed program and its potential interactions with fish and invertebrates, fisheries, marine mammals and sea turtles, and DFO RV surveys, through the C-NLOPB's EA review process.

5.2.3 Follow-Up

As described above, Polarcus 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 at risk species or habitats (as defined by COSEWIC and SARA);
- species or habitats that are unique to an area, or are valued for their aesthetic properties;
- species that are harvested by people (e.g., commercial fish species); and
- species that have at least some potential to be affected by the Project.

VECs were identified based on the scoping document received from the C-NLOPB and consultations with other stakeholders and agencies.

The defined VECs and the rationale for their inclusion are as follows:

- **Fish and Fish Habitat** with emphasis on the three principal commercial species: (1) northern shrimp, (2) snow crab, and (3) Greenland halibut (turbot), and SARA species (e.g., wolffish). It is recognized that there are many other fish species, commercial or prey species, that could be considered but 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 and Other Ocean Users** (primarily commercial harvesting) were the most referenced VEC of concern during consultations. While they are directly linked to the fish 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 (which are conducted using types of fishing gear), those 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), and SARA species (e.g., Red-throated Pharlope). Newfoundland waters support some of the largest seabird colonies in the world. They are important socially, culturally, economically, aesthetically, ecologically and scientifically. This VEC is of 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) or SARA species (e.g., blue whale). Whales and seals are key elements in the social and biological environments of Newfoundland. 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 very uncommon in the Study Area, are mostly threatened and endangered on a global scale, and the leatherback sea turtle which forages in eastern Canadian waters is considered endangered under SARA. While they are of little or no economic, social or cultural importance to Newfoundland, 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 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

In order to undertake the assessment, boundaries have been defined for the temporal and spatial extent of the project:

- The temporal boundary of the Project is defined as a seven year period (2016 – 2022) with seismic survey operations potentially occurring between May and November in any given year.
- The project was scoped on the basis of Polarcus conducting seismic surveys over one or more years between 2016 and 2022. This document provides an Environmental Assessment of the Project during the 2016-2022 period. However, the earliest that field work would take place, is May 2017.The typical duration of a seismic survey in any given year is between 90 and 120 days. The 'Project Area' is defined as the area within the C-NLOPB jurisdiction where all project activities will take place (see Figure 1.1). The coordinates of the Project Area (WGS84, unprotected geographic coordinates) are presented in Table 5.1.
- The 'Affected Area' varies according to the distribution and sensitivities of the VECs of interest (i.e. their vertical and horizontal distribution within the marine environment) and is defined as that area within which effects (physical or important behavioural ones) have been reported to occur within scientific literature. The 'Affected Area' is contained within the 'Study Area'.
- The 'Study Area' is an area larger than (i.e. 50 kilometres beyond) the Project Area that encompasses any potential effects (including those from accidental events) reported in the literature.
- The 'Study Area' is the area which could potentially be affected by project activities beyond the Project Area.
- The 'Regional Area' - The regional boundary is the boundary as defined in the Eastern Newfoundland SEA (*C-NLOPB, 2014*) Study Area and is retained here for consistency.
- The 'Regional Area' is the area extending beyond the study area boundary.

The boundaries of the Project Area and Study Area and Regional Area are presented in Table 5-1.

Table 5-1 Coordinates of the Project Area Corners

Project Area 'Corner'	WGS84 (Decimal Degrees)	
	Latitude (°N)	**Longitude (°W)**
Northwest	51.04506	50.19496
Northeast	51.0478	44.95272
Southwest	46.32127	50.1959
Southeast	46.32257	44.95159
Study Area 'Corner'	**WGS84 (Decimal Degrees)**	
	Latitude (°N)	**Longitude (°W)**
Northwest	51.52525	50.9079
Northeast	51.52525	44.23973
Southwest	45.87144	50.9079
Southeast	45.87144	44.23973

5.5 Effects Assessment

This assessment process follows a structured methodology for the identification and, where necessary, quantification of project aspects e.g. emissions and discharges and their subsequent environmental and social effects. This process enables determination of the significance of the potential identified effects and allows reporting of the mitigation measures required to prevent, avoid, minimize and mitigate the identified effects. All data included is based on estimates from the Project Description in Chapter 2.

The methodology used in EA for the systematic assessment of potential effects is undertaken using a process which involves three steps:

- Assessing the interface between the Project and the environment using a matrix to identify where operations and the environment interact;
- Identification and evaluation of potential effects *including* evaluation of the effectiveness of mitigation measures and the significance of residual effects after the implementation of mitigation; and
- Evaluation of cumulative effects.

The project description provided in Chapter 2 was used to make an assessment of the environmental risks of the proposed seismic acquisition program. This assessment also took into account the physical, biological and social environmental conditions of the study Area described in Chapters 3 and 4 of this EA and information presented in the Eastern Newfoundland SEA (*C-NLOPB, 2014*).

The assessment of the interactions between the project and the key receptors is made for both planned and unplanned events. The potential effects of the project events are then assessed to determine their significance. The criteria used for the risk assessment are defined in the following sections.

5.5.1 Identification of Interactions

An interaction matrix is presented in Table 5.2 and has been prepared to identify all possible Project activities which could interact with any of the VECs. The matrix is used to identify whether interactions between project activities and any of the VECs could occur and the interactions are not qualified but simply identified for further consideration in the assessment. Interactions are then evaluated for their potential to cause effects. Where the effect of an interaction is considered to be extremely unlikely or impossible, these interactions were scoped out of any further assessment, thus ensuring that the assessment focussed on key issues and key effects that do have the potential to occur.

Gravity and magnetic data will be gathered passively as part of the proposed seismic acquisition program. The use of this equipment will not result in environmental emissions or other disturbances, and therefore, these activities are not likely to result in interactions with VECs. Thus this activity has not been considered further within the assessment and additional mitigation specific to this proposed project activity is not required or proposed.

Interactions between project activities and VECs are considered to produce a potential effect if the abundance or distribution of VECs, the prey species or habitats used by VECs could be negatively affected to some degree. In this manner only potential interactions that are considered to be *adverse* are considered within the assessment.

The potential for an effect to occur was assessed by considering:

- The location of the interaction (i.e. whether the location where the interaction would occur is particularly sensitive, such as breeding or key feeding grounds);
- The timing of the interaction (i.e. whether the time period over which of the interaction would occur is particularly sensitive, such as during reproductive activity or migration);
- The literature on similar interactions and associated effects (seismic EAs for offshore Newfoundland and Labrador as well as other relevant areas);
- When necessary, consultation with other experts; and
- Results of similar effects assessments, especially monitoring studies undertaken in other areas during seismic survey activity.

Table 5-2 Potential Interactions between Project Activities and VECs

Project Activities	Fish and Fish Habitat VEC					Fisheries and Other Ocean Users VEC			Seabirds VEC	Marine Mammals VEC and Sea Turtles VEC				Sensitive Areas VEC
	Water and Sediment Quality	Eggs and Larvae	Juveniles	Pelagic Fish	Bottom dwelling fish	Mobile Invertebrates and Fishes (e.g. gillnet and trawls)	Sedentary Benthic Invertebrates (e.g. crab pots	Research Surveys (e.g. trawls and crab pots		Toothed Whales	Baleen Whales	Seals	Sea Turtles	
Underwater Noise														
Airgun Array														
Seismic Vessel														
Supply / Support														
Physical Presence of:														
Seismic Vessel														
Supply Vessel														
Helicopter[1]														
Onshore[2] facilities														
Vessel Lights														
Sanitary/Domestic Waste														
Liquid Waste														
Atmospheric Emissions														
Garbage[3]														
Unplanned Events														
Other Projects and Activities														
Offshore Oil and Gas Activities														
Fisheries														
Marine Transportation														

Note: The possible interactions between the Project and the species at risk VEC have not been included in Table 5.2 as the possible interactions are specific to the individual species that comprise the species at risk. VEC. The possible

[1] Crew change will occur via ship to ship transfer, helicopters will only be used in the event of an emergency situation.
[2] There will be no new onshore facilities as existing infrastructure will be used.
[3] Not applicable as garbage will be brought onshore

*interactions between the project and the species at risk VEC are presented in Section 5.8.5.*Uncertainty and Level of Confidence

The significance of the residual environmental effects is based on a review of relevant literature, consultation with experts, and professional judgment.

In some cases sufficient data was not available to allow precise evaluation of potential effects. Making predictions of potential residual environmental effects can therefore be difficult because of the limitations of available data or data gaps. Ratings are therefore provided to indicate, qualitatively, the level of confidence for each prediction.

As a result predictions were made based on professional judgement by experienced practitioners and the certainty in prediction noted within the assessment.

5.5.2 Mitigation

A key component of the assessment process is to explore practical ways of avoiding or reducing potentially significant effects of the proposed activities. These are commonly referred to as *mitigation measures* and are incorporated into the proposed project as commitments. Mitigation is intended to prevent or reduce significant negative effects while optimizing the viability and potential benefits of the project, if applicable. The objectives of mitigation are often established through Company Policy, within the framework of national legal or international conventions. However, where such legal standards are not available, mitigation measures may be framed by reference to international and industry best practices.

A common approach to describing mitigation measures for critical impacts is to specify a range of targets with a predetermined acceptable range and an associated monitoring and evaluation plan. To ensure successful implementation, mitigation measures are unambiguous statements of actions and requirements that are practical to execute. The following summarize the different approaches used in prescribing and designing mitigation measures:

- **Avoidance**: mitigation by not carrying out a proposed action on a specific site, but rather on a more suitable site;
- **Minimization**: mitigation by scaling down the magnitude of a development, reorienting the layout of the Project or employing technology to limit undesirable environmental effects;
- **Restoration**: mitigation through the restoration of environments affected by project activities; and
- **Compensation / offset**: mitigation through the creation, enhancement or acquisition of similar environments to those affected by the action.

Where needed, mitigation measures appropriate for each effect predicted in the relevant matrices for each VEC have been identified (Section 5.6). *The assessment has then been undertaken assuming that appropriate mitigation measures have already been applied*. The residual impacts remaining after the implementation of proposed mitigation measures are then described and a final evaluation of their significance provided.

5.5.3 Effects Assessment Criteria

The environmental effects assessment is therefore focussed upon assessing and describing the likely residual environmental effects of the Project – namely, those which might occur after the implementation of the effects management / mitigation measures identified and proposed in the Environmental Assessment. The Canadian Environmental Assessment Agency (CEAA, 1994 and 2015) provides guidance on the criteria that should be considered during the evaluation of significance (Stage 2 in CEAA, 2015). These are described as follows:

- Magnitude (the degree of change from the existing baseline conditions, which may vary depending on the VEC and the activity taking place and their interaction with each other);
- Geographic extent (the spatial extent affected by each Project activity which may vary according to the activity being assessed and the relevant VEC affected);
- Timing (the timing of project activates and their overlap with key temporal events such as breeding seasons or migration activity);
- Duration and frequency (the length of time and the number of times that a project activity and/or environmental effect will occur); and
- Reversibility (the ability of a VEC, once activities have ceased, to return to the same (or improved) condition as their baseline status).

In addition, the assessment considers the ecological, socio-cultural and economic context of the environment that may potentially be affected and considers the current status of the area affected by the Project in terms of existing pressures on the environment. The Study Area is not considered to be strongly affected by human activities.

Magnitude

For the purpose of this assessment, criteria for the assessment of magnitude of an effect are defined in Table 5.3. Definitions of magnitude used in this EA have been used previously in numerous offshore seismic survey environmental assessments in Canadian waters including: WesternGeco's Southeastern Newfoundland Offshore Seismic Program EA (LGL, 2015); Multi Klient Invest AS Labrador Sea Seismic Program EA (LGL, 2014) and Suncor Energy's Eastern Newfoundland Offshore Area 2D/3D/4D Seismic Program EA (LGL, 2013).

Table 5-3 Magnitude Definitions

Ranking	Biological VECs Criteria	Fisheries VECs Criteria
Negligible (N)	Although there is the potential for an interaction between Project activities and VECs, any interaction would lead to a change that is not detectable from natural variability.	
Low (L)	Affects <10 percent of individuals / habitat in the Study Area. Effects may be mortality, sublethal effects, disturbance or exclusion of individuals, or destruction or degradation of habitat.	Affects <10 percent of fishing activity in the Study Area. Effects may be disturbance of fishing activity, changes in catch rates and conflict with gear.
Medium (M)	Affects 10 to 25 percent of individuals / habitat in the Study Area. Effects may be mortality, sublethal effects, disturbance or exclusion of individuals, or destruction or degradation of habitat.	Affects 10 to 25 percent of fishing activity in the Study Area. Effects may be disturbance of fishing activity, changes in catch rates and conflict with gear.
High (H)	Affects more than 25 percent of individuals / habitat in the Study Area. Effects may be mortality, sublethal effects, disturbance or exclusion of individuals, or destruction or degradation of habitat.	Affects more than 25 percent of fishing activity in the Study Area. Effects may be disturbance of fishing activity, changes in catch rates and conflict with gear.

Geographic Extent

The geographic extent criteria are defined in Table 5.4:

Table 5-4 Geographic Extent Definitions

Ranking	Criteria
1	< 1 km^2
2	1 to 10 km^2
3	11 to 100 km^2
4	101 to 1,000 km^2
5	1,001 to 10,000 km^2
6	>10,000 km^2

Timing

Timing is defined as the environmental effect either overlapping (O) or not overlapping (N) with Project activities.

Duration and Frequency

The duration and frequency criteria are as defined in Table 5.5:

Table 5-5 Duration and Frequency Definitions

Ranking	Duration Criteria	Frequency Criteria
1	< 1 month	<11 events / year
2	1 to 12 months	11 to 50 events / year
3	13 – 36 months	51 – 100 events / year
4	37 – 72 months	101 – 200 events / year
5	>72 months	>200 events / year
6	N/A	Continuous

Reversibility

Environmental effects are defined as either reversible (R) or irreversible (I).

5.5.4 Cumulative Environmental Effects

As also specified in the Scoping Document, the Environmental Assessment Report also assesses and evaluates any cumulative environmental effects that might result from the Project in combination with other projects or activities that have been or will be carried out. The cumulative effects assessment is consistent with the principles provided in the CEAA “Cumulative Effects Practitioner’s Guide” (*Hegmann et al., 199*9) and the CEA Agency Operational Policy Statement on addressing cumulative effects (*CEAA, 2007*).

A cumulative impact, in relation to an activity, is the impact of an activity that may not be significant in isolation, but may become significant when added to the existing and potential impacts arising from similar or other activities in the area. Cumulative impacts represent incremental impacts of the activity as a whole, and other past, present and reasonably foreseeable future activities.

The cumulative effects assessment does not consider past and on-going projects and activities as their effects are reflected in the existing (baseline) environmental conditions for each VEC (see Chapters 3 and 4). As these activities already influence baseline conditions and therefore, the overall sensitivity or resiliency of VECs to further disturbance or change, these factors have already been integrally considered throughout the environmental effects assessment. For the most part, unless otherwise indicated, project cumulative effects are fully integrated within this assessment.

The cumulative affects assessment considers likely future activities and projects (outside of the current Project); these are described in Section 6.

5.5.5 Significance Rating

Significant 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. An environmental effect that does not meet these criteria is considered not significant. Significance definitions are developed and used on a VEC-specific basis within this assessment.

An effect can be considered significant, not significant, or positive.

5.5.6 Likelihood

Following the determination of significance, the next stage is to determine whether a predicted effect is likely to occur. The determination of likelihood is based on the consideration of probability and uncertainty, and is considered only once it is established that residual effects are potentially significant. The likelihood of occurrence is based on the effects probability of occurrence based on available information from knowledge and experience with similar past projects and environmental effects. The full life cycle of the project is considered in determining the probability of occurrence of each effect.

5.5.7 Monitoring

Because any effects of this type Project on the environment are relatively short-term and transitory, follow-up monitoring is not required.

However, there will be a need for monitoring (See Section 5.6.5) during the course of the Project to ensure effects are as predicted within the assessment. If observations during project activities indicate evidence of an unanticipated effect on a VEC or an accidental release of fuel, then there may be the need for follow-up monitoring and other actions. The need for such actions will be assessed in consultation with the C-NLOPB.

5.6 Mitigation Measures

The effects assessments that follow in this chapter (in Sections 5.8.1–5.8.6) consider the potential effects of the Eastern Newfoundland 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 5.3). Polarcus 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 C), and for other relevant EAs;
- The C-NLOPB Scoping Documents, and the Environmental Planning, Mitigation and Reporting guidance of the Board's Geophysical, Geological, Environmental and Geotechnical Program Guidelines (*C-NLOPB, 2016*);
- DFO's Statement of Practice with respect to the Mitigation of Seismic Sound in the Marine Environment (website 2013);
- National acts, regulations or international 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
- Industry best practices and expert judgement/experience from past surveys.

The mitigations that follow are organized under principal categories, that is (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. Because 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), the relevant VECs are noted for each of the measures.

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)

The survey operations are expected to be concentrated on areas which have current exploration licences, are newly licenced or are potential licence areas (see Figure 1.1). The Exploration license aggregated area = 56,227 sq km and the Study Area = 308, 384 sq km totalling a percentage of 18.2%. 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 kilometres / hour, for any given location, the survey will be 10–20 kilometres 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, which is the type of survey planned for 2017, includes more narrowly spaced lines meaning that exposures at any location within the survey area will occur more frequently. 4D seismic may be planned between 2018 and 2022 and uses the same survey layout as the 3D survey; however the 4D element means data is acquired repeatedly over the same area over a number of months or years. The western limit of the Project Area is about 180 kilometres away at its closest point of approach to the more sensitive coastal areas. The survey overlaps with the Placentia Bay/ Grand Banks Large Ocean Management Area. The expected concentration of the survey operations over areas which have current exploration licences, are newly licenced or are potential licence areas will help to avoid fisheries operations that are concentrated out with these areas based on past fish harvesting locations (see Section 4.8).

5.6.2 Communications and Liaison

(Fisheries and Other Ocean Users, Effects of the Environment on the Project)

Consultations and Discussions. For this Project, these 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 minimizes interference with 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.

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

Mapping of past fish harvesting activities (see Section 4.8) 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-Unifor Petroleum Information Liaison person, the FLO, direct contacts with representatives of the Newfoundland fisheries organizations, and with DFO (for fisheries survey/research information and access VMS.). Operational details of these communications will be finalized with the relevant organizations as the fishing season information and plans are known.

Weekly Status Meetings. Polarcus will have a shore based representative in St John's throughout the project and this person will be available to provide weekly update meetings with FFAW-Unifor and other invited fishery groups. Status maps will be provided at these meetings where the past week's acquisition will be reviewed and the expected plan for the upcoming week will be provided and discussed. Minutes of the meeting will be agreed to, and maps and information will be forwarded to other interested parties.

Fisheries Liaison Officer (FLO). The survey will place at least one FLO on board the seismic vessel or the guard vessel to communicate with fishing vessels at sea, and relay information to shore as needed. The FLO is the primary at-sea liaison between the commercial fishing industry and the seismic survey program. In past seismic surveys, the FLO has 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 One Ocean Protocol document, "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 will include the following:

- While stationed on the seismic vessel and/or 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) 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 also notes that the FFAW-Unifor/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, and continues to provide data to the FLO while on an as-needed basis throughout the program.

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

- 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 FLO, the FFAW-Unifor, other fishing organizations and One Ocean;
- Providing information directly to fishers when requested via email or phone 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;
- Providing a point of contact for Maritime Forces Atlantic (MARLANT);
- 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).

FFAW-Unifor/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-Unifor. 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-Unifor. Polarcus will utilize the PIL as the key contact for communications between the Project and FFAW-Unifor-represented fishing interests.

VMS Data. Polarcus will use Vessel Monitoring System (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 VMS data 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. Polarcus will request (through One Ocean / DFO) that the Project have access to this data.

Notices to Shipping. As a standard procedure and requirement, Polarcus 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 phone number) for the survey's Single Point of Contact.

Survey Start-Up Sessions (Project Vessels' Crews). Polarcus places a strong emphasis on informing the at-sea Project personnel on each vessel before the survey begins, through several presentation modules, about the environmental issues and concerns in the area in which they will be working, Polarcus's environmental commitments and regulatory requirements, safety, emergency response, the duties and authority of the MMSOs and the FLO. 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 survey FLO, MMSOs and Polarcus Project Manager will be present at these meetings.

Communications Follow-Up. Polarcus will continue to consult with fisheries (and other) groups before and during the survey (with the active participation of Polarcus 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.

Other Notifications/Communication. Polarcus will also follow several procedures/vehicles to facilitate excellent communications for the survey, including the following:

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

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

5.6.3 Fisheries Avoidance

(Fisheries, Science Surveys)

Avoiding Fishing Areas.
Seismic activities will be scheduled to avoid heavily fished areas, to the extent possible. Polarcus will implement operational arrangements to ensure that the vessel and local fishing interests are informed of each other's planned activities. Communication throughout survey operations with fishing interests in the area will be maintained. The use of a "Fisheries Liaison Officer" (FLO) onboard the seismic vessel is considered best practice in this respect. The use of a support/Guard vessel is also considered best practice in this respect.

Polarcus will avoid active fishing areas during the seismic survey. Specifically, Polarcus will monitor the location of fishing activities and 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 Polarcus to have the information to plan around and away from fish harvesting. Continuing contact between the Project and fishing group representatives, the on-board FLO, the SPOC, DFO and the FFAW-Unifor PIL will be essential for this process.

Polarcus 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).

No Gear Deployment En Route to Project Area. Polarcus will not deploy its array or streamer (s) in NL waters during transits to the Project Area. In addition, the FLO will advise the vessel en-route to the area to ensure fishing gear is avoided by the ships during transits.

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 NL surveys, a temporal and spatial separation plan has been implemented (on DFO advice) to ensure that seismic operations did not interfere with the research survey. Seismic surveys will be scheduled, to the extent possible, to reduce potential for impact or interference with Fisheries and Oceans Canada (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.

Use of Support / Guard Vessel. If there is a possibility of the survey program working in areas adjacent to active fishing, Polarcus will use a support 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 FLO.

Monitoring and Follow-up. As described above, Polarcus in discussions with relevant groups and mechanisms (such as the FLO), 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)

Fishing Gear Damage or Loss Compensation Program. A Gear compensation Program will be made available by Polarcus 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. 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., contact through fisheries organizations).

For responding to a claim, Polarcus will follow procedures (which have been employed successfully in the past by other Operators) similar to those outlined in the One Ocean Protocol document.

Damage or Loss Incident Response. The One Ocean Protocol describes responses to a gear conflict to be followed on board a Project ship. Polarcus 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, the FLO will follow the following procedures:

- If personnel on board the seismic and/or support 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;
- 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, photographs of the gear or gear debris in the water and after recovery should be taken;
- If necessary, any of the gear debris will be secured and retained;
- The incident will be recorded in the Daily Report;
- A Fishing Gear Incident Report will be filed and given to the on-board Polarcus Party Chief; and
- Any contact with fishing gear must be reported to the C-NLOPB immediately even if no damage to the gear has occurred.

Appendix F of the One Ocean Protocol document contains an incident reporting form which meets the requirements of the C-NLOPB Guidelines in assessing a claim. Polarcus 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 Polarcus (Project Manager and Environmental Manager) by their on board Client Representative; Polarcus will then report it to the C-NLOPB following the Board's incident reporting guidelines.

5.6.5 Marine Mammal / Wildlife Protection

(Marine Mammals, Sea Turtles, Seabirds, Fish)

The *Statement of Canadian Practice with respect to the Mitigation of Seismic Sound in the Marine Environment* specifies the mitigation requirements that must be met during the planning and conduct of marine seismic surveys, in order to minimize impacts on life in the oceans.\

Polarcus will implement a seabird and marine mammal observation program throughout all C-NLOPB authorized program activities. Such a program should involve a designated observer trained in marine mammal and seabird observations. For marine mammal monitoring, the monitoring protocol outlined in ESRF Report #156 *Recommended Seabird and Marine Mammal Observation Protocols for Atlantic Canada* (2004) should be implemented. The report is available on the internet at the following link: (C-NLOPB Guidelines 2016)

For seabird monitoring, the Canadian Wildlife Service (CWS) has developed a pelagic seabird monitoring protocol that should be used when undertaking seabird observations. Copies of the *Eastern Canada Seabirds at Sea (ECSAS) standardized protocol for pelagic seabird surveys from moving and stationary platforms*

The following marine mammal and sea turtle related measures are based on the Statement of Canadian Practice which is also contained in Appendix II of the C-NLOPB Guidelines (C-NLOPB, 2016).

Use of a Safety Zone. The survey (MMSOs) will establish a safety zone which is a circle with a radius of at least 500 metres as measured from the centre of the air source array. The safety zone will be used at all times.

Pre-Start Up Watch. A qualified MMSO 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.

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.

Shut-down of Array. The air source array will be shut down immediately if any of the following is observed by the MMSO 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.

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.

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.

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 Polarcus that a CWS Migratory Bird Handling Permit will be required and in place prior to the initiation of methods stated in the aforementioned instructions. Polarcus will request the ships to minimize lighting on board to the extent that it does not affect safety.

Wildlife Data Collection. Marine mammal/sea turtle observations will be made during ramp-ups and during data acquisition periods, and at other times (i.e. during downtime, standby or transit) 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 MMSOs 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 (*Gjerdrum et al., 2012*) and ECCC- CWS pelagic seabird monitoring protocol will be utilized. 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 metres and adequate light conditions permit positive species identification. Data will be collected by a qualified environmental observer(s) (MMSO).

Reporting. A final environmental report will be submitted to the C-NLOPB on January 31st after completion of each of the surveys as per the C-NLOPB Guidelines. A report of the seabird monitoring program, together with any recommended changes, will be submitted to ECCC-CWS on a yearly basis after completion of each of the surveys. 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,)

Waste Management. As described in the Project Description chapter 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. Polarcus has a waste management plan in place for all its vessels. The Polarcus waste management plan forms part of the Polarcus certified ISO 14001:2004 Environmental Management System. A waste log will be kept onboard the survey vessel. 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 Polarcus waste management plan, which will be filed with the C-NLOPB.

Discharge Prevention and Management. The Polarcus seismic fleet carries the stringent DNV Clean-Design (DNV BWM-T) notation and Polarcus are the first seismic company to hold the notation which means the vessels operate a ballast water management system which is 100% chemical free, posing no threat for introducing harmful foreign ballast waters to local ecosystems. 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. Polarcus operate state of the art bilge water treatment plants that clean the contaminated water to <5ppm, which is 300% below the regulatory level of 15ppm. 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.

Atmospheric Emissions Control. Polarcus make use of the latest technologies available in the geophysical and maritime industries including; the use of low sulphur fuels and SCR (Selective Catalytic Reduction) catalysts to reduce exhaust emissions. Polarcus are the first and only seismic company to receive the DNV Vessel Emissions Qualification Statement which qualifies the methodology and accuracy of their emission measurements, verifying their ability to predict the exhaust emissions footprint for any project and then, post-project, to subsequently provide actual emissions measurements. 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. Support 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. The Polarcus seismic vessel will use Marine Gas Oil, which has a sulphur content of less than 0.2%.

Response to Unplanned Events. In the unlikely event of the unplanned release of hydrocarbons during the Project, Polarcus will implement the measures outlined in the Shipboard Oil Pollution Emergency Plans (SOPEPs) which will be filed with the C-NLOPB.

Polarcus will prior to the start of the project have in place a project specific Emergency Response Plan approved by the C-NLOPB in their Geophysical Program Application.

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 specifically contain such equipment as listed below, this list may be augmented to address any local regulations.

- 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.

Use of Solid Core Streamer. Polarcus will use a solid core streamer, so streamer floatation fluid will not cause a leakage hazard.

The following table summarizes these mitigations organized by potential effect on VECs (Table 5.6).

Table 5-6 Summary of Mitigation Measures

Potential VEC Affected	Potential Effects	Primary Mitigations
Fisheries and Other Ocean Users VEC	Interference with fishing vessels/mobile (e.g. gillnet) and fixed (e.g. crab pots) gear fisheries from physical presence of Project vessels	• Upfront communications, liaison and planning to avoid fishing activity • Continuing communications throughout the program • FLO • SPOC • Advisories and communications • VMS data • Avoidance • Start-up meetings on ships
	Fishing gear damage from physical presence of Project Vessels	• Upfront communications, liaison and planning to avoid fishing gear • Use of guard/support vessel • SPOC • Advisories and communications • FLO • Gear Compensation program • Reporting and documentation • Start-up meetings on ships
	Interference with Other Ocean Users from physical presence of Project Vessels	• Advisories and at-sea communications • FLO • Use of guard/support vessel • SPOC (fishing vessels) • VMS data
	Interference with fisheries research surveys from physical presence of Project Vessels	• Communications and scheduling • Avoidance
Marine Mammals VEC and Sea Turtles VEC, Fish and Fish Habitat VEC, Species at Risk VEC	Temporary or permanent hearing damage/disturbance to marine animals from underwater noise associated with airgun array (including Species at Risk)	• Pre-watch of safety zone • Delay start-up if marine mammals or sea turtles are within 500 metres • Ramp-up of airguns • Shutdown of airgun arrays for endangered or threatened marine mammals and sea turtles within 500 metres • Use of qualified MMO(s) to monitor for marine mammals and sea turtles during daylight seismic operations
Seabirds VEC, Species at Risk VEC	Injury (mortality) to stranded seabirds caused by physical presence of Project Vessels	• Daily monitoring of vessel • Handling and release protocols • Minimize lighting on vessels if safe
	Seabird oiling caused by unplanned event	• Adherence to MARPOL • Spill contingency and response plans • Use of solid streamer

5.7 Effects of the Environment on the Project

A description of the physical environment of the study Area is presented in Chapter 3 of this EA and the Eastern Newfoundland Offshore Area SEA (*C-NLOPB, 2014*). This information has been used to assess the effects of the environment on the Project. The effects on the Project are important to consider because they may sometimes lead to accidents and consequent effects on the environment. The safety plan of the project will be assessed in detail in the Geophysical Program Authorization process and have not been considered here.

The key physical environmental factors affecting the Seismic operations are ice, weather (wind/waves/visibility), and currents. The Project will occur during the period of May to November, given this timing and the requirement of a seismic survey to avoid periods and locations of sea ice, it can be concluded that sea ice should not have an effect on the Project. Icebergs in the early summer may cause some survey delays if survey lines have to be altered to avoid them. Most physical environmental constraints on seismic surveys are those imposed by wind and wave. The Project scheduling avoids the most continuous extreme weather conditions, and Polarcus and its contractors are familiar with east coast operating conditions, having operated previous projects in the North Atlantic offshore the coast of Greenland. As a prediction of the effects of the environment on the Project, Polarcus will likely use an estimate of 20% weather-related down time for the Project for planning purposes. The vessels will have systems for storm tracking and weather forecasting services.

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.

The socio-economic environment, in particular commercial fisheries activity in the Project Area, is expected to affect the project. Commercial fishing activities may require that the seismic vessel avoid certain zones within the Project Area at certain times, when harvesting is active, especially when fishing gear is in the water. The effects on the Project will be minimized through advanced planning and good communications before and during the survey, as described in the Mitigation measures (Section 5.6).

Effects of the biological environment on the Project are unlikely, other than for array shutdowns if required when marine mammals or sea turtles enter the Safety Zone.

Collectively, these potential effects cannot be considered to cause a significant effect on the Project, otherwise the Project would not be acceptable to the Proponent.

5.8 Effects of the Project on the Environment

A detailed effects assessment is presented in this section, which focuses on the effects of underwater noise from the seismic guns (primarily on marine mammals, fish and fisheries) and the towed seismic streamer (primarily on fishing gear), as these two aspects are the major distinction between the effects of seismic surveys versus the effects of other marine vessels. An overview of underwater noise generated from seismic survey sources is presented in Section 2 to provide background information to the reader. The applicable mitigation measures (detailed in Section 5.6) are also noted for the relevant activity.

5.8.1 Fish and Fish Habitat VEC

The interactions between the Project activities and the Fish and Fish Habitat VEC are summarized in

Table 5.2.

The potential interaction between project activities and the fish habitat component of the Fish and Fish Habitat VEC (i.e., water and sediment quality, plankton and benthos) has been identified as the probability for interaction exists. Given the seismic program will not result in direct physical disturbance to the bottom substrate and the probability of an unplanned event (i.e., hydrocarbon release) of sufficient magnitude to cause a significant effect is low, the residual effects to the water and sediment quality, plankton and benthos (Fish and Fish Habitat VEC) are predicted to be negligible and therefore not significant. For this reason no further reference of the fish habitat component of the Fish and Fish Habitat VEC is made in the assessment section.

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

Potential Environmental Effects and Existing Knowledge

Noise will be generated below the sea surface from the airgun array. Underwater noise has the potential to impact fauna in the area, particularly some fish species, modifying their behaviour patterns (changes in swimming). More significantly and in extreme cases, the pressure waves associated with noise can inflict physical harm and possibly be lethal. The potential for effects is dependent on the magnitude of the sound, its frequency and the proximity of the fish to the sound source. It is important to note that the magnitude of the sound manifests itself as pressure, i.e. force acting over a given area. It is expressed in terms of ‘sound levels’, which use a logarithmic scale of the ratio of the measured pressure to a reference pressure (decibels (dB)). A background to underwater noise is provided in Section 2 and so is not repeated here.

A considerable amount of research has been conducted on the effects of offshore seismic surveys (including various sound types and intensities) and other anthropogenic activities on marine fish. This has included scientific research, monitoring studies and anecdotal reports of observed reactions by various fish species. Although overall knowledge and understanding of the effects of seismic and other anthropogenic noise on marine fish and invertebrates remain incomplete in some areas, the effects of seismic activities and other noise sources have been documented in a variety of fish and invertebrate species in numerous studies. It should be noted, however, that many of the studies occur within a laboratory setting with captive animals, and the documented effects may not replicate natural conditions. An overview of the research and studies on seismic noise and fish is presented below broken down by the possible effect it may have on the Fish and Fish Habitat VEC.

Ability of Fish and Invertebrates to Detect Noise

Underwater sound can potentially have a negative impact on fish species ranging from physical injury / mortality to behavioural effects. The hearing system of most fishes is sensitive to sound pressures between 50 hertz and 500 hertz (*Ladich and Fay, 2012*), which overlaps the predominant frequency range of seismic noise emissions (10 to 300 hertz, *McCauley et al., 2000*). Sound is perceived by fish through the ears and the lateral line (the acoustico-lateralis system) which is sensitive to vibration. Some species of teleost or bony fish have a structure linking the gas filled swim bladder to the ear. The swim bladder is sensitive to the pressure component of a sound wave, which it resonates as a signal that stimulates the ears (*Hawkins, 1993*). These species, therefore, usually have increased hearing sensitivity over the same range, and sensitivity to sound at higher frequencies extending above 3,000 hertz. Such species are considered to be more sensitive to anthropogenic underwater noise sources than species, such as cod, (*Gadus* spp.) that do not possess a structure linking the swim bladder and inner ear. Fish species that either do not possess a swim bladder (e.g. elasmobranchs and scombrid fish (mackerel and tunas)) or have a much reduced swim bladder (e.g. flatfish) tend to have relatively low auditory sensitivity.

The effect of noise on fish may be either physiological (e.g. injury or mortality) or behavioural, and criteria for the assessment of both of these impacts are discussed below.

Physical Injury Criteria

Data for fish show that exposure to moderately loud noises can result in temporary hearing loss called Temporary Threshold Shift (TTS) in a few species that have been studied including goldfish (*Carassius auratus*) and other fishes specialized for hearing (*Popper and Clarke, 1976; Scholik and Yan, 2001; Amoser and Ladich, 2003; Amoser et al., 2004; Smith et al., 2004a and 2004b*).

Popper and Hastings (2009) found that exposure of fish to high noise levels could cause rupture of blood vessels leading to superficial or internal bleeding. Seismic surveys have also been reported to cause some damage to the sensory hair cells in the auditory system of the pink snapper; however, it was unknown if this resulted in hearing loss and no mortality was recorded (*McCauley et al., 2003*).

A comprehensive sound exposure guideline by Popper *et al*., (2014) sets out threshold sound limits, which have been widely adopted by the scientific community (*Popper et al., 2014*).

Thresholds are provided for three types of fish: those with no swim bladder, those with swimbladder not involved in hearing and those with swimbladder involved in hearing. Corresponding sound pressure level and sound exposure levels are provided for mortality and potential injury as well as impairment (See Table 5.7).

While these criteria have been developed for pile driving, they are deemed applicable to the seismic survey noise, as pile driving and seismic survey have similar noise levels. This is a conservative approach to estimating seismic noise impacts because the seismic source continues to move between successive airgun discharges, resulting in lower exposure of individuals.

Table 5-7 Thresholds for Impulsive Noise Exposure to Fish (adopted from Popper et al., 2014)

Type of Fish	Mortality and Potential Mortal Injury	Impairment	
		Recoverable Injury[1]	Temporary Threshold Shift (TTS)
Type 1 - no swim bladder (particle motion detection)	>213 dB re 1uPa (SPL_{peak})	>216 dB re 1uPa[2] (SEL_{cum}) or >213 dB re 1uPa (SPL_{peak})	>186 dB re 1uPa[2] (SEL_{cum})
Type 2 - Swim bladder is not involved in hearing (particle motion detection)	>207 dB re 1uPa (SPL_{peak})	>203 dB re 1uPa[2] (SEL_{cum}) or >207 dB re 1uPa (SPL_{peak})	>186 dB re 1uPa[2] (SEL_{cum})
Type 3 - Swim Bladder involved in hearing (primarily pressure detection)	>207 dB re 1uPa (SPL_{peak})	203 dB re 1uPa[2] (SEL_{cum}) or >207 dB re 1uPa (SPL_{peak})	186 dB re 1uPa[2] (SEL_{cum})

Note 1: Recoverable injury : injuries, including hair cell damage, minor internal or external hematoma, etc. None of these injuries are likely to result in mortality.

Fish are generally more sensitive to low frequency sounds that are difficult to reproduce in a laboratory therefore there is limited data on the impact of noise on fish (*Hawkins, 2011*). There are very few experimental studies that directly address how these sources affect fish in their natural habitat (*Popper et al., 2005*).

Direct injuries occur when the fish, at whatever life stage, comes within a few metres of the sound source where SPLs are most extreme (*Swan et al., 1994; Turnpenny and Nedwell, 1994*). However, where injury effects have been demonstrated, these have been under experimental conditions which are either unrepresentative of normal operational use or which would arise only in special circumstances. There is no recorded evidence that energy sources have killed fish or caused injuries during seismic survey operations (*Turnpenny and Nedwell, 1994*). Although there have been reports of reduced fish catches following seismic surveys (*Popper and Hastings, 2009; Hawkins, 2011*), it is unclear whether this would be attributed to mortality or displacement of individuals.

The maximum noise level from Polarcus' seismic source is anticipated to be 246 dB re 1µPa @ 1 metre. Assuming spherical dispersion of the noise in the water column (model proposed by *Richardson et al., 1995*), the expected sound propagation of the seismic source is illustrated in Figure 5.1 below. Assumptions made by spherical modelling include the presence of a homogenous medium and infinite space. The model does not take into account transmission loss due to attenuation by absorption and scattering and resonance or reflections from the seabed and its irregular topography. The model does not take into account the directivity of the source. It does therefore portray a 'worst case' scenario in which the majority of the noise emitted will be transmitted through the water. In reality, lateral noise levels are expected to be approximately 10 dB lower than under the source (*McCauley et al., 2000*).

There have been several instances reported when fish will inexplicably remain in the vicinity of noise sources, such as vessels, even when the threshold for physiological damage is exceeded. This has been shown to incur physiological impacts, including increased production of the stress hormone cortisol which if sustained, may eventually impact on overall stress levels and the fish's immune system, as well as tissue damage. In contrast, several studies have also reported fish moving from noisy vessels (*Slabbekoorn et al., 2010*). Physical damage is more of a threat to fish eggs and larvae, which have limited mobility and therefore cannot readily move away from a potentially harmful noise source and are more sensitive to noise.

The effects of anthropogenic noise from the seismic survey will however be localized. As illustrated in Figure 5.1, in the immediate vicinity of the seismic energy source, the threshold for mortality or injury of fish both with swim bladder or no swim bladder is contained within 80 metres and 40 metres of the source respectively.

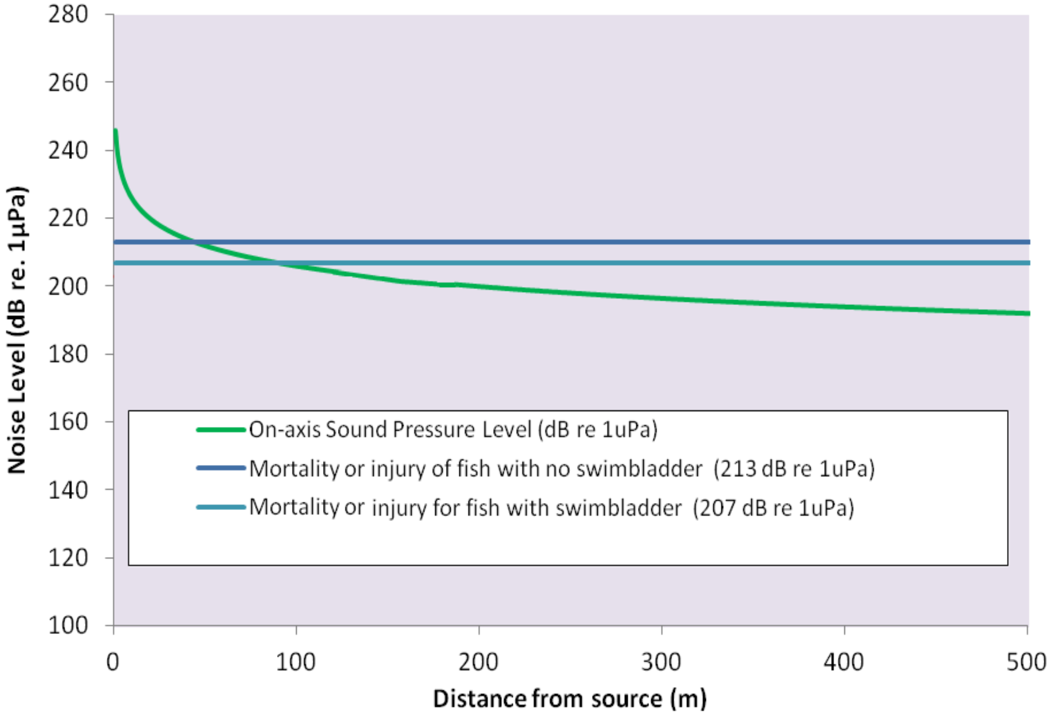


Figure 5-1 Sound Pressure Level Thresholds for the Onset of Fish Injuries (after Popper et al., 2014)

Davis *et al.,* (1998) estimated up to one percent of the ichthyoplankton in the top 50 metres of the water column within close proximity to the sound source could be killed during 3-D seismic survey off Nova Scotia. Kenchington *et al.,* (2001) also estimated a plankton mortality rate of six percent if they were concentrated in the upper 10 metres in close proximity to the sound source. In Norway, it was estimated that 0.45 percent of planktonic organisms in the top 10 metres of water could be killed by high intensity seismic noise (*Sætre and Ona, 1996*). Mortality of fish eggs, caused by exposure to seismic array noise, was very low compared to natural mortality and was considered not significant to fish recruitment (*Sætre and Ona, 1996*). Snow crab exposed under the conditions of an actual seismic program in deep waters off Cape Breton did not suffer acute or mid-term mortality, survival of embryos being carried by female crabs and locomotion of resulting larvae after hatch were unaffected (*DFO, 2004)*.. There was also no evidence of leg loss or other appendages. However, bruised ovaries and injuries to the equilibrium receptor system or statocysts were observed (*DFO, 2004)*).

<u>*Behavioural Criteria*</u>

There are currently no internationally accepted criteria for assessing behavioural impacts of anthropogenic sound on fish. Although studies on the behavioural response of fish to underwater low frequency impulsive sounds are limited, there is some evidence that the behaviour of free swimming fish can be influenced by sound, for example falls in fish catch rates have been observed following seismic surveying (*Engås et al., 1996; Webb et al., 2008; Løkkeborg et al., 2010*).

In fish, typical behavioural responses to underwater noise which have been reported include a startle response (*Pearson et al., 1992; McCauley et al., 2000*) or a change in the vertical distribution of individuals (*Slotte et al., 2004*) (Table 5.). At levels above 200 dB re 1 µPa, fish make active efforts to avoid the noise source and attempt to distance themselves from the noise source. At levels over 168 dB re 1 µPa, there is a general increase in activity and changes in schooling or position in the water column Table 5-8 Summary of Behavioral Criteria for Generic Fish Species.

Table 5-8 Summary of Behavioral Criteria for Generic Fish Species

Potential response	**Peak Pressure Threshold (dB re 1 µPa)**
General change in swimming and schooling behaviour with possible moderate to strong avoidance (*McCauley et al., 2000*)	168
Startle response (*Pearson et al., 1992*)	200

Behavioural effects on fish species as a result of the proposed seismic survey are predicted to be dependent on the nature of the receptors, with larger impact ranges predicted for pelagic fish than for groundfish species. As outlined in Chapter 4, many of the key species recorded in the study area are likely to be pelagic species (e.g. Atlantic bluefin tuna, albacore tuna, Atlantic herring, Atlantic mackerel and various shark species); groundfish species found offshore include Atlantic cod, Atlantic halibut, haddock and monkfish.

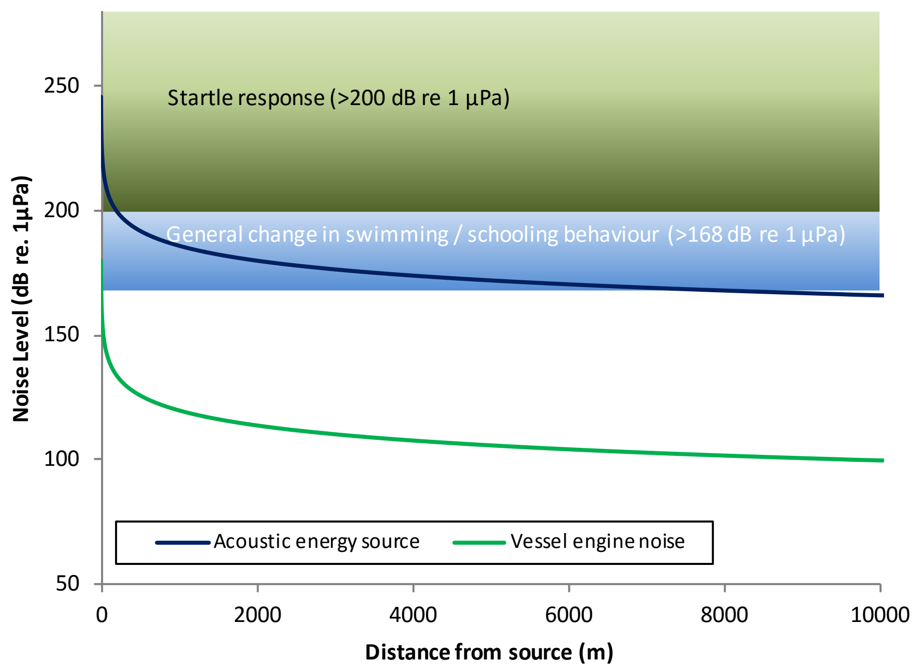


Figure 5-2 Fish Behavioral Responses to 3D Seismic Noise (McCauley et al., 2000; Pearson et al., 1992)

Attenuation curves based on noise modelling, full details are provided in Section 2.4.1

Noise produced by the survey operations could lead to a startle response within 200 metres of the acoustic energy source. Other short-term behavioural changes (e.g. general changes in behaviour, with a return to pre-exposure behaviour within minutes / hours) are likely to be observed in fish populations extending up to eight kilometres from the acoustic energy source.

The behavioural responses predicted as a result of the seismic survey may be sufficient to result in temporary avoidance of these areas by fish, with some temporary displacement to areas outside the affected areas. However, depending on the activities which individuals are engaged in at the time of the survey (i.e., feeding), it may be that avoidance responses do not occur (*Pena et al., 2013; Hawkins et al., 2014*).

In cases where behaviour is affected, fish returned to normal behavioural patterns within 14 to 30 minutes after the cessation of seismic noise emissions (*McCauley et al., 2000*). The noise cessation would occur either when the acoustic energy source has passed beyond the eight kilometre distance (approximately two hours) or upon completion of the survey when all seismic activity ceases.

Environmental Effects Assessment

An assessment and evaluation of the potential effects of the Project on the Fish and Fish Habitat VEC is presented in this section. Mitigation measures to help eliminate or reduce potential effects are presented earlier in Section 5.6. and these are considered integrally within and throughout the effects assessment as applicable.

Underwater Noise

As presented previously, a variety of physiological and behavioural responses by marine fish to seismic sound have been reported in the literature. Previous studies indicate that such effects vary by species, life stage, and intensity of sound, distance from seismic source and in the case of fishing effects, by gear type. Individual species differ in their sensitivity and reactions to underwater noise. More mobile fish species and life stages are able to avoid possible effects of seismic survey noise exposure by moving away from the acoustic energy source, whereas some larval stages and immobile species may be unable to avoid such exposure. Even in very close proximity (a few metres), however, these have been shown to exhibit only modest levels of mortality, particularly in comparison to natural causes. Therefore, potential instantaneous injury ranges for fish are relatively small and instantaneous injury / mortality to fish would only be likely to occur in extreme proximity to the acoustic energy source.

Transient stunning of fish species (noise greater than 190 dB re 1µPa) may occur within 630 metres of the acoustic energy source when operating at full power. This impact is therefore localized to the vicinity of the survey vessel during operations.

A range of behavioural responses to acoustic energy source noise have been observed and reported. Responses are expected to be observed within eight kilometres from the source and be temporary in nature. The use of a gradual “ramp-up” or soft start procedure over a minimum 20 minute period allows mobile marine animals to move away from the area if they are disturbed by the underwater sound levels associated with the seismic survey. This will help to further avoid fish injury or morality, as will the planned shut-down of the seismic array (reduction to the smallest source element, firing intermittently) during line changes and any required maintenance activities.

Due to the localized and short term nature of the underwater noise disturbance from the survey, the potential for adverse effects to the Fish and Fish Habitat VEC has been ranked low for the magnitude, 2 for geographic extent and 1 for duration and frequency of the effect and is therefore found to have a non-significant effect.

Presence of Vessels and Associated Emissions

The Project will involve the use of vessel support in the Project Area during the months of May to November over multiple years. This will include the presence and movements of the seismic survey vessel itself as well as any associated support ships. As is the case for all marine traffic, the operation of these vessels will introduce a number of potential disturbances into the environment, including the noise, vessel lights and other possible emissions (e.g. atmospheric and waste) that are typically associated with such activities.

Although the presence of these marine vessels may result in some degree of attraction, avoidance or other behavioural responses by individual fish (depending upon the species involved), marine fish will likely not be disturbed by Project-related vessel activity, due to its transitory nature and thus its short term presence at any one location, and because the Project's vessel movements will create noise types and levels that are similar to daily and frequent marine traffic in the area. During seismic survey operations, due to the acoustic outputs of the seismic source arrays, vessel noise will not be a material or detectable contributor to any Project-related noise and its possible effects on marine biota.

Other potential environmental emissions from survey vessels and equipment relate to the possible release of environmental discharges such as deck drainage, liquid and solid wastes, atmospheric emissions from exhausts, and other possible sources of environmental discharges from offshore vessels. Any such potential discharges to the marine environment will be managed through strict adherence to applicable regulations and standards (Chapter 2) and mitigation measures included Section 5.6, designed to prevent adverse effects to fish and their habitats. The use of solid seismic streamers will eliminate the risk of fluid discharges into the marine environment during seismic survey programs. Although the likelihood that a Project vessel will result in the introduction and spread of an invasive species is low, all Project vessels – in the unlikely event that one is carrying ballast - would comply with the requirements of the Canada Shipping Act, including the associated Ballast Water Control and Management Regulations, and measures will be taken to minimize biofouling on the ships' hulls and seismic array. The Polarcus seismic vessel will operate the Alfa Laval Pure Ballast water management system which is 100% chemical free and eliminates all invasive species from the ballast water.

Again, because the proposed Project will not result in the recovery of petroleum resources, the potential for, and possible magnitude of, any accidental spill are relatively low. Indeed, these would be of no greater likelihood or potential volume than for any other marine vessel of similar size. Each of the vessels involved in this Project will use, store and handle fuels / oils and other such materials in an environmentally acceptable manner, in accordance with applicable regulations and standards. The vessels will have appropriate equipment and procedures in place to prevent any such accidental spills into the marine environment, as well as SOPEPs in the unlikely event of a spill.

It is therefore very unlikely that any fish will be displaced from key habitats or disrupted during key activities over extended areas or periods, or be otherwise affected in a manner that causes negative and detectable effects to fish populations in the region. A summary of the predicted (residual) environmental effects of the Project on Marine Fish and Fish Habitat VEC is provided in Table 5.9.

Table 5-9 Assessment of Residual Environmental Effects on the Fish and Fish Habitat VEC

Project Activity	Fish and Fish Habitat Valued Environmental Component					
	Potential Environmental Effect Positive (P) Negative (N) No Effect (NE)	Evaluation Criteria for Assessing Environmental Effects				
		Magnitude	Geographic Extent	Duration	Frequency	Reversibility
Underwater Noise						
Airgun Array	N	L	2	1	1	R/I
Seismic Vessel	N	L	2	1	1	R
Supply/Support vessel	N	L	2	1	1	R

Project Activity	Fish and Fish Habitat Valued Environmental Component					
	Potential Environmental Effect Positive (P) Negative (N) No Effect (NE)	Evaluation Criteria for Assessing Environmental Effects				
		Magnitude	Geographic Extent	Duration	Frequency	Reversibility
Helicopter	N	L	2	1	1	R
Physical Presence of:						
Seismic Vessel	N	N	2	1	1	R
Supply /Support vessel	N	N	2	1	1	R
Helicopter	N	N	2	1	1	R
Vessel Lights	N	N	2	1	1	R
Sanitary/Domestic Waste	N	N	2	1	1	R
Liquid Waste	N	N	2	1	1	R
Atmospheric Emissions	N	N	2	1	1	R
Unplanned Events	N	L	2	1	1	R

Note: see Section 5.5.4 for definitions of the evaluation criteria used for assessing effects

In summary, the proposed Project is not likely to result in significant adverse environmental effects on Marine Fish and Fish Habitat VEC and there is a high level of certainty for this prediction.

5.8.2 Fisheries and Other Ocean Users VEC

Marine fisheries are an important and long-standing element of the socioeconomic environment of Newfoundland and Labrador, including many of the communities and regions that surround the Study Area. A number of other anthropogenic components and activities also occur throughout the Study Area, including various commercial and recreational pursuits.

The interactions between the Project activities and the Fisheries and Other Ocean Users VEC are summarized in Table 5.2. Possible interactions may include:

- Potential damage to fishing gear, vessels, equipment or other components as a result of direct interactions with oil and gas related vessels, equipment, activities or their environmental discharges;
- Decreased access to preferred fishing grounds or other marine areas during offshore oil and gas activities, with possible resulting decreases in the success, efficiency, enjoyment or value of these pursuits;
- Indirect effects on fisheries or other uses of the marine environment due to possible biophysical effects on the presence, distribution, abundance or quality of marine fish or other resources or environmental features, resulting from planned activities or accidental events;
- Potential economic effects to individuals, businesses and communities as a result of the above; and
- Possible interference with governmental / industry fish survey activities, including direct disturbance and/or effects upon research results and associated management decisions.

Environmental Effects Assessment

An assessment and evaluation of the potential effects on the Fisheries and Other Ocean Users VEC is presented in this section. Mitigation measures to help eliminate or reduce potential effects are presented earlier in Section 5.6 and these are considered integrally within and throughout the effects assessment as applicable.

A description of commercial fisheries within the Study Area was provided in Chapter 4, based upon existing and available catch statistics and geospatial data provided by DFO. As presented, a variety of fisheries occur within and throughout the Study Area at various times of the year, and the region is characterized by a complex and somewhat dynamic spatial and temporal mix of fishing and other marine pursuits, including with regard to the location, timing and intensity of specific activities, the particular marine resource (species) of interest, the equipment types used, and other factors.

The potential for the Project to interact with and affect marine fisheries and other commercial activities will depend upon the specific nature, location and timing of these activities, and the equipment or gear involved (such as the possible presence of fixed fishing gear (such as crab pots) along or near a survey line at the same time as planned Project activities). In general, however, the data on fishing and other commercial and recreational pursuits shows occurrence throughout the planned Project timeframes (May-November). It is therefore inevitable that the planned timing of the Project survey work will overlap with periods of fishing and other offshore pursuits. This will require advanced planning and avoidance to minimize the potential for affecting Project activities and fisheries, as well as on-going cooperation and communication between the survey vessel and other marine vessels to avoid potential interactions (e.g. collision) for safety and other reasons. (SIMOPS Planning).

At this stage of the Project, detailed plans for the proposed seismic survey operations and the potential seven years of activity are not available, since the specific location and other characteristics of a particular year's activities will depend on the previous year's survey and its findings, exploration interests and priorities, and other logistical considerations. At this stage it is therefore not possible to identify and specify particular locations and times at which Project activities will be undertaken or curtailed in order to avoid or reduce the potential for interactions with other marine users, and program planning will therefore continue to occur based on a variety of factors, primarily relying on industry communications and advice and applying the mitigations described in Section 5.6.2. As is also a typical condition of Environmental Assessment approval for such marine exploration activities in the Newfoundland Offshore Area, Polarcus will submit annual updates to C-NLOPB in relation to this multi-year program which will describe the previous year's activities, recent and ongoing stakeholder consultations, outline the proposed survey work for the coming year and evaluate the continued applicability and validity of the EA predictions and associated mitigations, through amendments to the EA as necessary.

The mobile and transitory nature, spatial extent and timing of the planned offshore survey activities that will be associated with this Project will mean that activity will occur at any one location for a very short period of time. Typically, only small portions of some of the planned survey lines would pass near key active fishing areas at any one time, which would therefore result in minimal (and likely very brief) potential interaction or disturbance at any particular site and time. As described in Section 5.6.2 there will be on-going coordination and effective and timely communication between the survey operator and the fishing industry and other marine interests as outlined in the One Ocean Protocol document. These measures and compliance with the document will help to avoid and reduce adverse interactions between offshore geophysical programs and other ocean users, and are widely used (and effective) in the Newfoundland and Labrador Offshore Area.

The area of interest for the planned surveys is over 183 kilometres from the closest landfall and the limited amount of vessel activity that will or may take place in coastal locations (such as crew changes or re-supply) will occur at an existing and established commercial port (St John's) The Project is therefore not expected to interact with, or otherwise adversely affect, other human activities that occur on land or near shore, including relevant recreational activities such as hunting, fishing and other pursuits.

Any Project-related biophysical effects to marine resources could potentially result in a subsequent change in the nature, quality and/or value of one or more of the marine activities that utilize or depend upon them (economic or otherwise). As described throughout this Chapter, the proposed Project is not expected to result in detectable (and certainly, not significant) adverse effects upon marine biota or their habitats. Although the underwater noise and other potential interactions that will be associated with the Project have the potential to interact with marine biota, these activities will be undertaken in strict compliance with relevant standards and guidelines that pertain to vessel traffic, management of waste and liquid discharges and other potential environmental emissions. The mitigation measures identified in this EA will also be adhered to as a condition of the regulatory approvals. As stated throughout this chapter, disturbance to marine biota will be localized and of very short-term duration at any one location. It is therefore unlikely that any individuals will be displaced from key areas for extended periods, or be otherwise affected or disrupted in a manner that would then translate into effects on the overall availability or quality of a marine resource. As also discussed in Section 5.6.6, adequate and appropriate spill prevention and response measures will also be in place for the duration of Project operations.

A summary of the predicted (residual) environmental effects of the Project on Fisheries and Other Ocean Users VEC is provided in Table 5.10

Table 5-10 Assessment of Residual Environmental Effects on the Fisheries and Other Ocean Users VEC

Project Activity	Fisheries and Other Ocean Users Valued Environmental Component					
	Potential Environmental Effect Positive (P) Negative (N) No Effect (NE)	Evaluation Criteria for Assessing Environmental Effects				
		Magnitude	Geographic Extent	Duration	Frequency	Reversibility
Underwater Noise						
Airgun Array	N	N	2	1	1	R / I
Seismic Vessel	N	N	2	1	1	R
Supply/Support vessel	N	N	2	1	1	R
Helicopter	NE	-	-	-	-	-
Physical Presence of:						
Seismic Vessel	N	L	2	1	1	R
Guard Vessel	N	L	2	1	1	R
Helicopter	NE	-	-	-	-	-
Vessel Lights	NE	-	-	-	-	-
Sanitary/Domestic Waste	NE	-	-	-	-	-
Liquid Waste	N	N	2	1	1	R
Atmospheric Emissions	NE	-	-	-	-	-
Unplanned Events	N	L	2	1	1	R

Note: see Section 5.5.4 for definitions of the evaluation criteria used for assessing effects

In summary, the proposed Project is not likely to result in significant adverse environmental effects on Fisheries and Other Ocean Users VEC and there is a high level of certainty for this prediction.

5.8.3 Seabird VEC

The interactions between the Project activities and the Seabird VEC are summarized in Table 5.2.

The main potential interactions between offshore oil and gas exploration activities and Marine/ Migratory Birds are presented in the Eastern Newfoundland Offshore Area SEA. The interactions relevant to the Project have been summarised as follows:

- Attraction of night flying birds to vessels including their lights and emissions, resulting in possible injury or mortality;
- Disturbance to birds and their activities from movements of vessels, aircraft and the presence of offshore structures and activities and their associated disturbances (lights, noise);

- Possible injury of birds as a result of exposure to noise within the water column during seismic exploration activities (particularly diving birds) or other resulting disruptions to and changes in their feeding and other behaviors;
- Changes in the availability, distribution and/or quality of feed sources or habitats for marine birds; and
- Changes in the presence, abundance, distribution and/or health of marine birds (individuals and populations) as a result of exposure to accidental oil spills from vessels, which may affect individuals (physical exposure, ingestion) and important habitats.

The following sections discuss the project activities that will interact with the Seabird VEC, and include an assessment of the potential effects of these interactions.

Potential Environmental Effects and Existing Knowledge

There are many species of seabirds and related species that can be found associated with the waters of proposed survey area. Bird species at risk or which are otherwise species of conservation concern that have potential to occur in the waters off of Eastern Newfoundland are: Barrow's Goldeneye, Harlequin Duck, Ivory Gull and Red-necked Phalarope. Of these species, only Red-necked Phalaropes have been sighted in the Study Area during ECSAS surveys. Environment Canada protocols for seabird observations will be used for seabirds for this project.

Ability of Seabirds to Detect Underwater Noise

The available evidence suggests that avian hearing underwater is poorer than in air, given that the avian middle ear constricts under the increased pressure associated with diving (*Dooling and Therrien, 2012; cited in AMEC, 2015*). Unlike some other marine animals, seabirds do not communicate vocally underwater, and a heightened auditory sensitivity in water is thus unlikely to have developed.

Potential for Injury

Many of the birds that might forage in the study area are divers, such as the Thick-billed Murre, Dovekie and Atlantic Puffin that dive quite deeply and may spend considerable time under water. Murres regularly dive to depths of 100 metres and have been recorded underwater for more than three minutes (*Gaston and Jones, 1998; cited in LGL, 2013*). These diving birds may be at a higher risk to injury from exposure to underwater noise during the seismic survey due to spending time underwater. These species dive from a resting position on the water in search of small fish and invertebrates, and are capable of reaching great depths (20 to 60 metres) and spending considerable time (25 to 40 seconds) underwater (*Gaston and Jones 1998; cited in AMEC, 2015*). The sudden diving action and immersion of the head of these species could potentially expose them to high noise levels without the steady gradient associated with ramp up procedures which other animals such as marine mammals and fish may benefit from.

There is very little scientific information about impacts of seismic array sounds on birds. The information presented here was sourced in the Eastern Newfoundland SEA and has been expanded upon. Evans *et al.,* (1993) made observations from operating seismic vessels in the Irish Sea. They noted that, when seabirds were in the vicinity of the seismic boats, there was no observable difference in their behaviour, birds neither being attracted nor repelled by seismic activities. Also Lacroix *et al.,* (2003) studied moulting long-tailed ducks in the Beaufort Sea and found no changes in movements or diving behaviour during seismic surveys. Davis *et al.,* (1998) reports that Stemp (1985) made observations on the reactions of birds to seismic exploration programs in southern Davis Strait over three summer periods. No distributional or mortality effects were detected.

Vessel and Associated Equipment

In Atlantic Canada, nocturnal migrants and night-flying seabirds (e.g. storm-petrels) are the migratory birds most at risk of attraction to lights and flares. Attraction to lights at night or in poor visibility conditions during the day may result in collision with lit structures or their support structures, or with other migratory birds. Disoriented migratory birds are prone to circling light sources and may deplete their energy reserves and either die of exhaustion or be forced to land where they are at risk of depredation (*C-NLOPB, 2014*).

Offshore seabirds attracted by discharged waste, may aggregate around a vessel and scavenge through the discharge (*Skov and Durinck, 2001*). This could lead to a minimal negative change in the community and population densities of offshore seabirds.

Komenda-Zehnder *et al.,* (2003) observed the disturbance effect of aircraft overflights on wintering waterbirds and the associated increased energy expenditure of birds due to escape reactions. Other possible disturbance effects of aircraft overflights on birds include: temporary loss of useable habitat, increased energy expenditure of birds due to escape reactions, lower food intake due to interruptions and other interactions (*Ellis et al., 1991*).

Schummer and Eddleman (2003) observed an increase in alertness and escape activities of birds in response to marine vessels, which may have an energetic consequence. Additionally Bramford *et al., (*1990) noted that birds vacated areas of vessel use indicating a potential for loss of bird habitat in areas disturbed by vessels.

Environmental Effects Assessment

An assessment and evaluation of the potential effects of the Seabird VEC is presented in this section. Mitigation measures to help eliminate or reduce potential effects are presented earlier in Section 5.6. and these are considered integrally within and throughout the effects assessment as applicable.

Underwater Noise

Seabirds are unlikely to be adversely affected by underwater noise associated with the seismic source as there is a minimal potential for interaction between the acoustic sound source and avifauna underwater. Since the seismic source array will be gradually ramped-up at each start, and the seismic source array will generate impulses every 13 seconds, seabirds will be warned as they approach the vessel and array. This will reduce or remove the likelihood that birds will choose to come close enough to the array to experience hearing damage or other physical harm. In addition the noise from the seismic source array is directed downwards and is highly attenuated at the surface thereby reducing the likelihood of a negative impact on birds at the surface or diving.

Vessel and Associated Equipment

As discussed above a key issue relating to seabirds is lighting from vessels, which can affect birds. The seismic survey operations will be conducted throughout the night and on board lighting will be required for safety and regulatory reasons. Seabirds can be attracted to vessel lighting, and some species can fly into the lights and other equipment resulting in possible injury or mortality due to strikes/stranding's. MMSOs will conduct a monitoring and release program for seabirds which may become stranded on board the vessel (see section 5.6.5 for more information). The distance a vessel light is visible in the offshore environment will depend upon weather conditions (i.e. fog versus clear skies) and it is most likely that any such disturbance will be worse during periods of poor visibility. During Project operations, efforts will be made to minimize the use of high-intensity work lights in the evening, and lighting may be turned off in inclement weather where this is possible and practical without affecting Project activities or posing any safety risks to the vessel, its crew or other marine users. Overall, the planned presence of Project related vessels and equipment in the Project Area would be a negligible addition to the total amount of lighting in this region, especially as compared to the fishing boats, commercial traffic and other vessel movements that regularly move to and through the Study Area throughout the year.

Given the short term presence of the seismic vessel at any one location it is unlikely that seabirds will be disturbed. In addition the presence of the seismic vessel, associated project vessels is nothing out with marine traffic activity that has occurred in the region for years. The planned survey area is far offshore, and therefore the Project is not expected to interact with or otherwise adversely affect coastal breeding bird colonies.

Seabirds rafting on the surface of the water are vulnerable to the effects of hydrocarbon releases. Oil clings to their feathers, reducing the insulating properties of their plumage. This can subsequently lead to hypothermia and possibly eventual mortality. Birds are also vulnerable to toxic effects through ingestion of the oil through the attempted cleaning of their plumage and potential ingestion of contaminated prey. Birds are particularly vulnerable to hydrocarbon spills on water as they often show no avoidance behaviour of oiled areas.

Concentrations of birds are most vulnerable to oil pollution during the breeding season near their colonies and at other times of the year over the feeding grounds. Evidence suggests that spills are relatively rare and in most cases, are unlikely to have long term effects overall on bird populations unless a substantial portion of the population is restricted to the immediate area of the spill.

As marine diesel oil is a light hydrocarbon, the majority of spilt oil will evaporate rapidly, therefore the chance of contact with bird species is low, and is much reduced when compared to a similar spill of more persistent crude oil.

Interactions and adverse effects on the Seabird VEC are therefore unlikely. If disturbance did occur it would be intermittent and short-term over a localised area, and will therefore not have adverse effects upon individuals or populations. The distance from the Study Area to the nearest coastline at St John's is over 180 kilometres, therefore any birds in coastal locations and at nesting sites will not be subject to any disturbance due to noise from seismic activities. No changes in the presence, abundance or concentration of prey or potential displacement from key foraging areas are anticipated.

A summary of the predicted (residual) environmental effects of the Project on Seabird VEC is provided in Table 5.11.

Table 5-11 Assessment of Residual Environmental Effects on the Seabird VEC

Project Activity	Seabird Valued Environmental Component					
	Potential Environmental Effect Positive (P) Negative (N) No Effect (NE)	Evaluation Criteria for Assessing Environmental Effects				
		Magnitude	Geographic Extent	Duration	Frequency	Reversibility
Underwater Noise						
Airgun Array	N	N	1	1	1	R
Seismic Vessel	N	N	1	1	1	R
Guard Vessel	N	N	1	1	1	R
Helicopter	N	N	1	1	1	R
Physical Presence of:						
Seismic Vessel	N	L	2	1	1	R
Supply Vessel	N	L	2	1	1	R
Helicopter	N	L	2	1	1	R
Vessel Lights	N	L	2	1	1	R
Sanitary/Domestic Waste	N/P	N	2	1	1	R
Liquid Waste	N	N	2	1	1	R
Atmospheric Emissions	N	N	2	1	1	R
Unplanned Events	N	L	2	1	1	R

Note: see Section 5.5.4 for definitions of the evaluation criteria used for assessing effects

In summary, the proposed Project is not likely to result in significant adverse environmental effects on Seabird VEC and there is a high level of certainty for this prediction.

5.8.4 Marine Mammals and Sea Turtles VEC

The interactions between the Project activities and the Marine Mammals and Sea Turtles VEC are summarized in Table 5.2.

The main potential interactions between offshore oil and gas exploration activities and Marine Mammals and Sea Turtles are presented in the Eastern Newfoundland Offshore Area SEA. The interactions relevant to the Project have been summarized as follows:

- The avoidance of certain areas that would otherwise be used by the individuals affected, with these behavioral changes altering the presence, abundance and overall distribution of marine mammals and sea turtles and their movements, feeding and other activity. This is of key concern if any such areas are especially important / rare habitats and are disturbed repeatedly;
- The possible attraction of individuals to seismic vessels, resulting in increased potential for injury or mortality through collisions, contamination or other interactions;

- Interference with (and the masking of) sounds in the marine environment that originate from and/or are used by marine mammals, such as in communication, the identification and detection of prey, reproduction, echolocation and other activities and requirements;
- Temporary hearing impairment or permanent injury or mortality from very loud and instantaneous sounds, such as which may be experienced in close proximity to a seismic airgun;
- Potential changes in the availability, distribution or quality of feed sources and/or habitats for marine mammals and sea turtles as a result of seismic activities and their planned and routine environmental emissions; and
- Changes in the presence, abundance, distribution and/or health (injury or mortality) of marine mammals and sea turtles as a result of unplanned events such as accidental oil spills from vessels (through physical exposure, ingestion, effects on prey and habitats, etc.).

The following sections discuss the project activities that will interact with the Marine Mammals and Sea Turtles, and include an assessment of the potential effects of these interactions.

Potential Environmental Effects and Existing Knowledge

Physical and Behavioural Effects from Seismic and Vessel Noise

Marine mammals use sound for foraging, orientation, communication, navigation, echolocation of prey and predator avoidance (*Richardson et al., 1995*). Therefore, high levels of anthropogenic underwater sound can potentially have a negative impact on marine mammals ranging from changes in their acoustic communication, displacing them from an area and, in more severe cases, causing physical injury or mortality (*Richardson et al., 1995*).

Seismic operators and MMSOs on seismic vessels regularly detect dolphins and other cetaceans in the vicinity of seismic surveys. Some studies have detailed dolphins to show some avoidance of operating seismic vessels (*Stone, 2003; Stone and Tasker, 2006*). In these studies the avoidance radii for dolphins are observed to be small, in the order of one kilometre or less, whilst some individuals show no apparent avoidance (*National Science Foundation, 2011*).

At levels where the underwater sound wave may not directly injure animals or cause hearing impairment, the underwater sound may have the potential to cause behavioural disturbance where an animal may incur a sustained or chronic disruption of behaviour, possibly introducing a significant change from their expected distribution. Southall *et al*., (2007) discuss a range of likely behavioural reactions that may occur. These include orientation or attraction to a noise source, increased alertness, modification of characteristics of their own sounds, cessation of feeding or social interaction, alteration of movement/diving behaviour, temporary or permanent habitat abandonment and in severe cases, panic, flight or stranding.

Behavioural effects may result in animals being displaced from preferred foraging grounds to potentially less optimal areas, experiencing increased competition or greater energy costs associated with finding food. The effect may be a reduction in the individual's long-term fitness and survival.

Seals have been observed to react behaviourally to seismic surveys and other human-induced noise in the marine environment, although if it occurs any such disturbance is usually localized in extent and short-term in duration (Richardson et al., 1995).

The vast majority of scientific studies focus on the behavioural response of turtles to noise. There have been no scientific studies conducted regarding the impacts of marine anthropogenic sound on the physiology of sea turtles.

Studies of marine turtles (*Yost, 2007; as cited in Dow Piniak et al., 2012*) suggested animals may experience a temporary or permanent auditory sensitivity threshold shift (TTS or PTS), or loss of hearing a particular frequency or frequencies. Popper et al., 2014 presents that exposure to seismic source noise greater than 207 dB re 1 µPa may result in potential injury and mortality to marine turtles.

It has been proposed that marine turtles use acoustic cues in perception of their local and distant environment on their long (sometimes thousands of kilometres) migrations between nesting and foraging sites (*Swan et al., 1994; Godley et al., 2003*). From previous research it is evident that marine turtles can detect sound and that their hearing is confined to lower frequencies, mainly below 1,000 hertz (*Bartol, Musick and Lenhardt, 1999*).

Behavioural studies carried out by Lenhardt (1994) showed that marine turtles increased their movements after seismic noise emissions and did not return to the depth at which they usually rested. Researchers have also attempted to monitor marine turtle avoidance to sound during an active seismic survey (*Weir, 2007; DeRuiter and Doukara, 2010*. *McCauley et al.,* (2000)) conducted controlled experiments on a caged loggerhead turtle and a caged green turtle and observed two responses:

I. Exposure to noises from seismic sources louder than 166 dB re 1 µPa increased their swimming activity; and

II. Exposure to noises louder than 175 dB re 1 µPa resulted in erratic swimming behaviour, possibly indicating the turtles were in an agitated state.

<u>*Acoustic Masking*</u>

If the frequency of anthropogenic noise overlaps with the frequencies used by marine mammals, this may reduce the animal's ability to detect important sounds for navigation, communication and prey detection (*Weilgart, 2007*). This is termed acoustic masking, which may occur anywhere within an organism's auditory range (*Wright et al., 2007; Richardson et al., 1995*). Masking of important cetacean vocalisations will result in increasing information ambiguity and, in extreme circumstances, may culminate in cetaceans being unable to orientate themselves or hunt / evade predation in the marine environment (*Wright et al., 2007*).

The hearing thresholds of marine mammals vary between species. Hearing sensitivity is based on both the frequency range of marine mammals and their threshold of hearing (i.e., the level of sound at which they perceive noise). Based on current knowledge of functional hearing in marine mammals, a study by Southall *et al.,* (2007) defined five distinct, functional hearing categories. Species known to be found within the region of the proposed Project Area (refer to Chapter 4) can be classed into two of these groups as follows in Table 5.8.

- **Low-frequency cetaceans**: with an estimated hearing range of 7 hertz to 22 kilohertz; and
- **Mid-frequency cetaceans:** with an estimated hearing range of 150 hertz to 160 kilohertz.

As discussed earlier, given the frequency range of the seismic sound source (between 10 and 200 hertz) (*OGP, 2011*), the sound from seismic operations would primarily affect low and mid-frequency cetaceans.

Noise levels produced by support vessels are typically between 50 hertz and 300 hertz depending on the vessel activity (e.g. standing by, cruising or on transit) (*DECC, 2011*) and may affect low frequency cetaceans.

Table 5-12 Eastern Newfoundland Offshore Cetacean Hearing Frequencies (adapted from Southall et al., 2007)

Common Name	Functional Hearing Group
White-beaked dolphin	Mid Frequency (150 hertz to 160 kilohertz)
Sowerby's beaked whale	
Harbour Porpoise	
Killer whale	
Long-finned pilot whale	
Atlantic white-sided dolphin	
Northern bottlenose whale	
Sperm whale	
Short-beaked common dolphin	
Blue whale	Low-Frequency (7 hertz to 22 kilohertz)
North Atlantic right whale	
Fin whale	
Humpback whale	
Minke whale	
Sei whale	

The frequency of the noise emitted by the acoustic energy source is expected to overlap (at least partially) with the hearing bandwidth of low and mid-frequency cetaceans (*National Environmental Research Institute, 2011*). The noise produced by acoustic energy source is also likely, in the vicinity of the source, to mask the vocalizations of the low frequency cetacean species such as the humpback and minke whale.

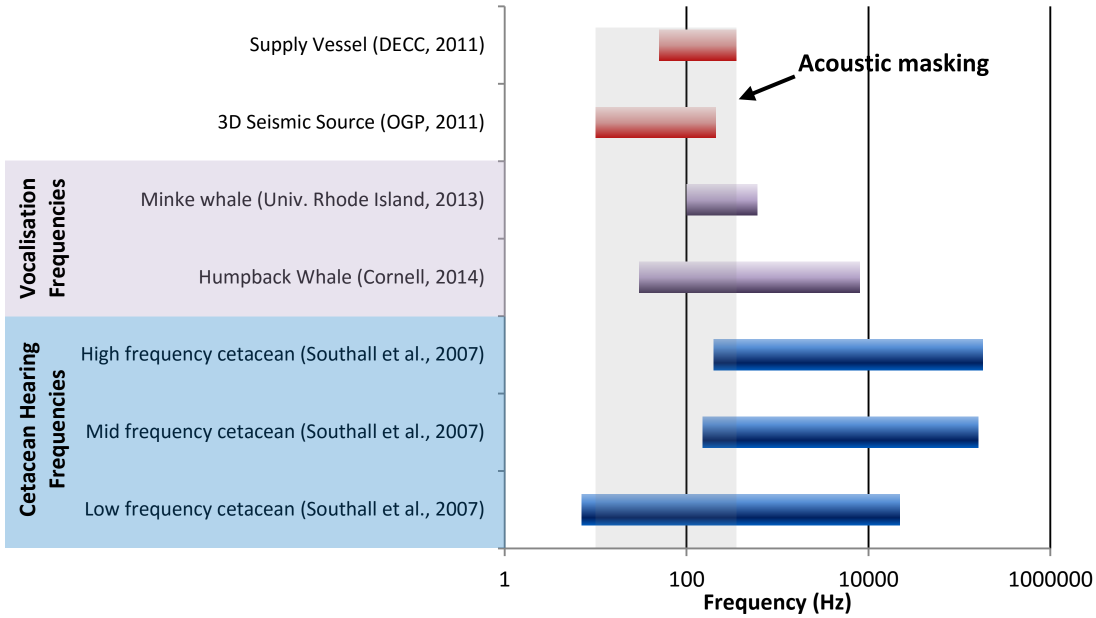


Figure 5-3 Summary of Vocalization and Hearing Frequencies for Cetacean Species Potentially Masked by the Acoustic Energy Source and Vessel Engine Noise

Although marine turtles do not appear to vocalize or use sound for communication, sound may be used for navigation, locating prey, avoiding predators, and general environmental awareness (*Dow Piniak et al., 2012*).

Studies on green turtles in the Atlantic Ocean have shown that adult turtles have a hearing range of between 100 and 800 hertz, with the greatest sensitivity between 200 and 400 hertz (*Bartol and Ketten, 2006*). Juvenile green turtles have a wider hearing range extending from 100 to 800 hertz, with the highest sensitivity between 600 and 700 hertz.

Leatherback turtle are able to detect sounds underwater over a wide range, between 50 and 1200 hertz in water. Studies showed that the highest sensitivity was between 100 and 400 hertz (*Dow Piniak et al., 2012*).

As discussed previously, the sound from seismic operations is primarily low frequency (between <1 and 200 hertz), therefore, there is a substantial degree of overlap between the frequencies generated by the seismic survey and the audible range of marine turtles (*Ridgway et al., 1969*). The acoustic energy source may therefore have a direct impact on turtle behaviour from masking effects.

The localized and short-term nature of underwater disturbance at any one location and time during the seismic program considerably reduces the potential for adverse effects upon marine mammals and turtles (individuals or populations) to occur. With the seismic vessel moving continuously, the reoccurrence interval of firing the seismic source array within a one kilometre radius of a particular survey point in a 10,000 square kilometres 3D survey block would be greater than 48 hours, and could be greater than 96 hours based on an acquisition speed of 4.5 knots and 3-4 hour line turns, given that the lines are acquired in a widely separated “racetrack” type pattern. This minimizes the potential for localized and repeated environmental disturbances at a particular location, and affecting a particular environmental receptor. It is therefore very unlikely that any individuals will be displaced over extended areas or timeframes. Given that the likely zone of influence of the Project at any one time or location will represent a very small proportion of the feeding, breeding or migration area of any species, marine mammals and turtles will not be displaced from any key habitats or during important activities, or be otherwise affected in a manner that causes negative and detectable effects to overall populations in the region.

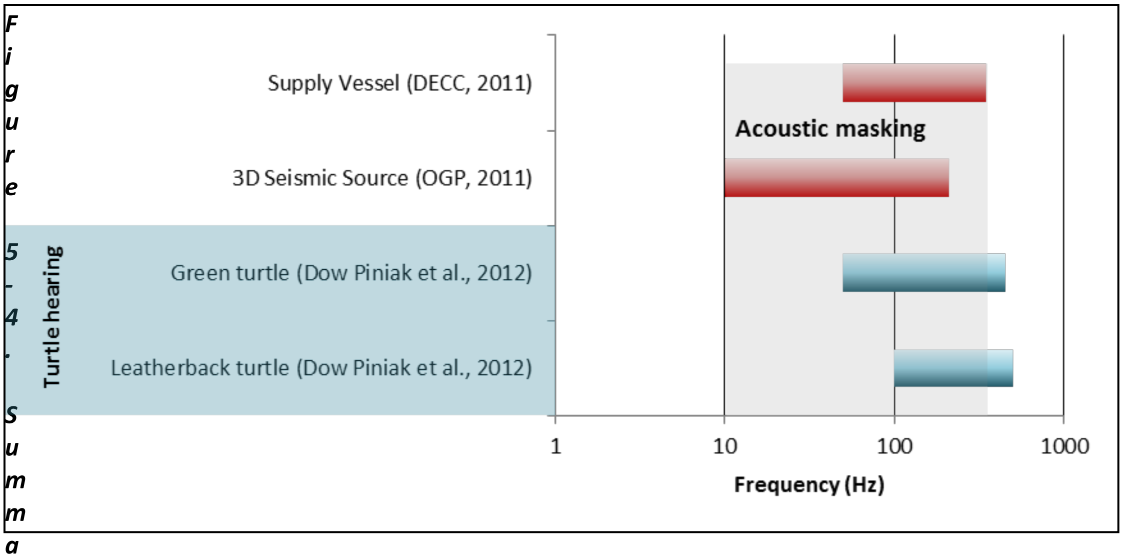


Figure 5-5 History of Hearing Frequencies for Turtle Species Potentially Masked by the Acoustic Energy Source and Vessel Engine Noise

The Southall *et al.,* (2007) study defined the functional hearing categories for pinnipeds as follows:

- **In water:** with an estimated hearing range of 75 hertz to 75 kilohertz; and
- **In air:** with an estimated hearing range of 75 hertz to 30 kilohertz.

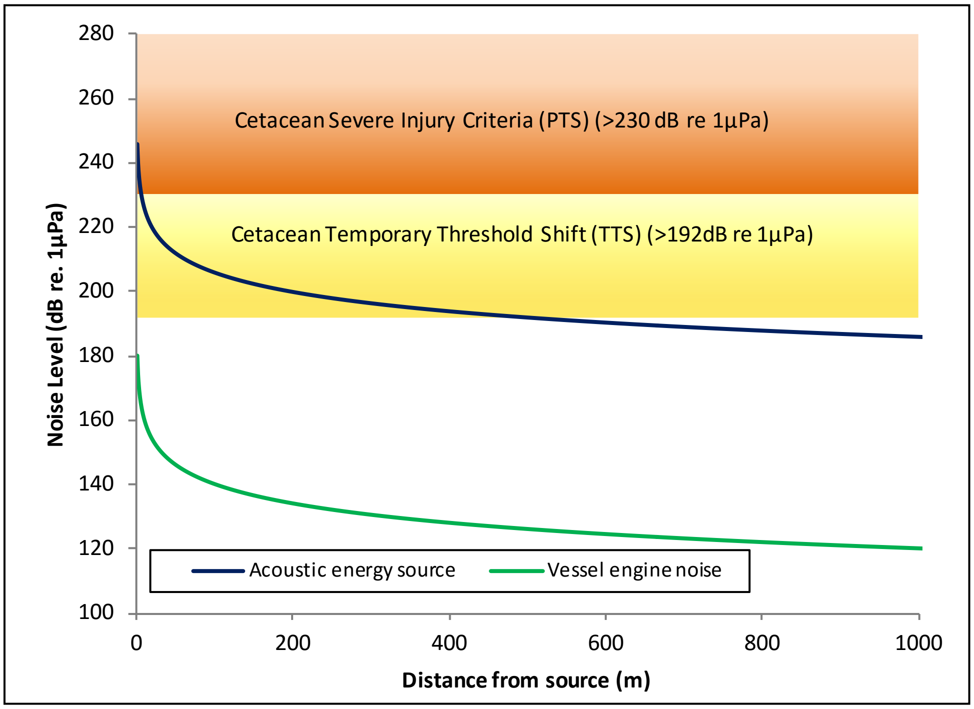
Environmental Effects Assessment

<u>*Seismic Sound Energy*</u>

High exposure levels from underwater sound sources can cause hearing impairment. This can take the form of a temporary loss in hearing sensitivity, known as a Temporary Threshold Shift (TTS), or a permanent loss of hearing sensitivity known as a Permanent Threshold Shift (PTS). In addition, PTS may also result from prolonged exposure to noise at lower levels sufficient to cause a TTS. Although most animals are able to recover fully from TTS, particularly as they move away from the source, there is potential for hearing loss to become permanent if hearing does not return to normal after several weeks.

Sound levels of the seismic energy source are estimated to fall below the established PTS criteria for multiple pulse sources (230 dB re 1 µPa) within seven metres of the source (Figure 5.5). Such an impact would be direct, local and permanent to an individual animal. Further, if such an injury occurred and was detected in the form of a stricken animal, it would be of concern to Polarcus (it would be reported as an environmental incident), the C-NLOPB and non-governmental organisations. However, it is considered remote that a marine mammal will be within seven metres of the acoustic energy source at full power during seismic operations as it is assumed that cetaceans are unlikely to move towards the airgun array once it is operating.

The possibility of cetaceans being exposed to noise levels that induce a temporary threshold shift in hearing is greater than for PTS as the distance from source to the TTS threshold level is modelled at just less than 500 metres. Given cetaceans are seen frequently in the area, the likelihood of inducing TTS in individual animals is assessed as likely or, for a larger group, possible. In general this direct impact would be short term, the animal recovering as the noise diminishes and local to the vessel position.



Attenuation curves based

Figure 5-6 Peak (flat) Sound Pressure Levels for the Onset of Potential Physical Injury for Cetaceans (adopted from Southall et al., 2007) against Acoustic Energy Source Levels

As can be seen from, the noise levels associated with the vessel engines (180 dB re 1 µPa is insufficient to cause an injury in cetaceans (190 dB re 1 µPa).

The noise levels from the seismic source are modelled to fall below the upper threshold level expected to induce behavioural reactions in cetaceans (180 dB re 1 µPa) at 1.9 kilometres from the noise source).

Underwater noise impacts resulting in behavioural effects in cetaceans are predicted to be localized, i.e. within the Project Area, short term and reversible. The Project Area is not noted as being within a particularly important migration, feeding or reproducing area for cetaceans. Eleven species of whale, five species of dolphin and a single porpoise species (see Section 4.6.1) have been sighted in the Project Area. It is therefore expected that individuals will be encountered and so the potential for an impact on cetacean behaviour is considered to be likely.

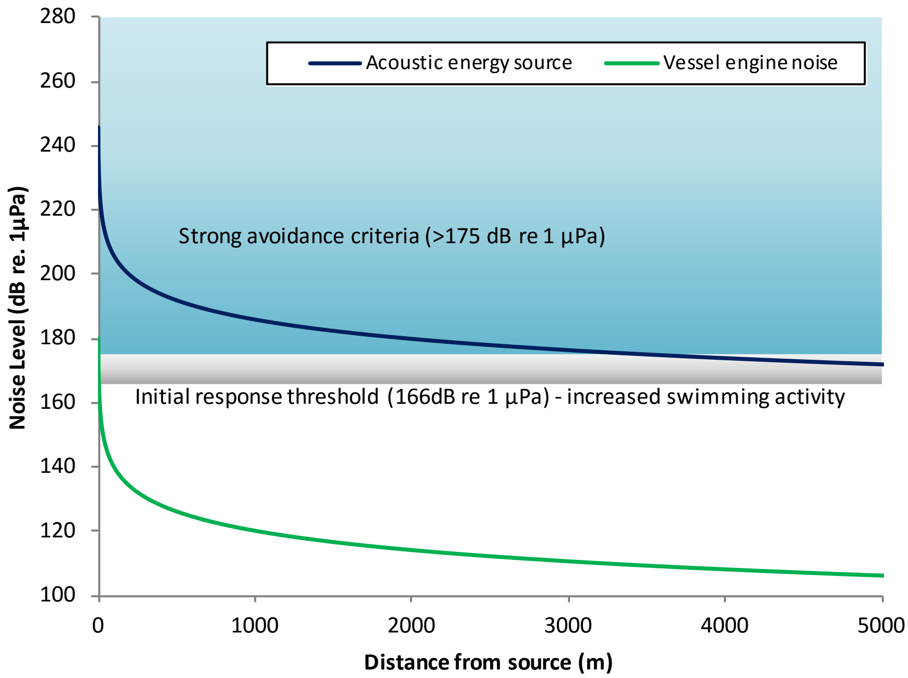


Figure 5-7 Sound Pressure Level Thresholds for Onset of Turtle Behavioural Changes Showing the Noise Levels from a Seismic Energy Source (based on McCauley et al., 2000; Finneran and Jenkins, 2012)

The noise level from the acoustic energy source falls below the strong avoidance threshold (175dB re 1 µPa) for turtles at approximately 3.5 kilometres from the acoustic energy source. The sound levels drop below the initial behavioural threshold at approximately 10 kilometres.

Such behavioural changes are not, however, expected to be long-term, and, for an individual would only last for as long as the vessel is within these ranges (approximately 1 hour and 2.5 hours respectively). In general no residual effect on behaviour would be expected upon cessation of the seismic activities.

There are three species of marine turtle that may occur in the regional area, the leatherback, Kemp's ridley, and loggerhead species. None of these species nest along the Newfoundland coastline and the Kemp's ridley is only rarely found in Canadian waters and is considered an accidental visitor. Leatherbacks are thought to be a regular part of the Newfoundland marine fauna but uncommon. Loggerheads are less common than leatherbacks in the Study Area. Off Eastern Newfoundland, Loggerhead Sea Turtles from all Atlantic nesting beaches forage over the Grand Banks (*COSEWIC, 2010*), which encompasses part of the Project Area. The presence of turtle species within the Project Area is unlikely, although it cannot be ruled out.

Vessel Noise

Underwater noise occurring from vessels may have an effect on the behaviour of cetaceans as it is above the lower threshold limit for approximately three kilometres (Figure 5.5). Noise from vessel engines (180 dB re 1 µPa) drops below both turtle disturbance thresholds within five metres. Therefore there is no impact expected on turtle behaviour from the project vessels.

The marine mammal and sea turtles species that occur within the Study Area during these times will not be disturbed by Project-related vessel activity due to its transitory nature and short-term presence at any one location, and because it is generally in keeping with the overall marine traffic that has occurred throughout the region for years. When the seismic source is firing, vessel noise will not be a contributor to project related effects on marine mammals.

Underwater noise frequencies generated by the acoustic energy source and vessel engine noise are expected to overlap a small part of the hearing / vocalization spectrum of low and medium frequency cetaceans and will therefore have a direct effect on certain cetaceans in the area.

A summary of the predicted (residual) environmental effects of the Project on the Marine Mammals and Sea Turtles VEC is provided in Table 5.9.

Table 5-13 Assessment of Residual Environmental Effects on the Marine Mammals and Sea Turtles VEC

Project Activity	Marine Mammals and Sea Turtles Valued Environmental Component					
	Potential Environmental Effect Positive (P) Negative (N) No Effect (NE)	Evaluation Criteria for Assessing Environmental Effects				
		Magnitude	Geographic Extent	Duration	Frequency	Reversibility
Underwater Noise						
Airgun Array	N	N	1	1	1	R
Seismic Vessel	N	N	2	1	1	R
Guard Vessel	N	N	2	1	1	R
Helicopter	N	N	2	1	1	R
Physical Presence of:						
Seismic Vessel	N	L	2	1	1	R
Supply Vessel	N	L	2	1	1	R
Helicopter	N	L	2	1	1	R
Vessel Lights	N	L	2	1	1	R
Sanitary/Domestic Waste	N	N	2	1	1	R
Liquid Waste	N	N	2	1	1	R
Atmospheric Emissions	N	N	2	1	1	R
Unplanned Events	N	L	2	1	1	R

Note: see Section 5.5.4 for definitions of the evaluation criteria used for assessing effects

In summary, the proposed Project is not likely to result in significant adverse environmental effects on Marine Mammals or Turtles VEC and there is a high level of certainty for this prediction.

5.8.5 Species at Risk VEC

The interactions between the Project activities and the Species at Risk VEC are summarized in

Table 5.2. The following sections discuss the project activities that will interact with the Species at Risk VEC, and include an assessment of the potential effects of these interactions.

An overview of species considered at risk under *SARA* and/or by COSEWIC that are likely or may occur in the Study Area was provided in Section 4.4.2, Section 4.5.1 and Section 4.6.3. No critical habitat has been defined for the Study Area. As discussed in previous sections and presented in Table 4.5, Table 4.7 and Table 4.10, *SARA* species of relevance to the Study Area include:

- White shark, and northern, spotted, and Atlantic wolffish;
- Harlequin Duck, Barrow's Goldeneye, Ivory Gull, Red Knot (rufa subspecies), Piping Plover, Peregrine Falcon, Olive-sided Flycatcher, and Short-eared Owl.
- Blue, north Atlantic right, northern bottlenose, Sowerby's beaked, fin and killer whales; harbor porpoise; and
- Leatherback and loggerhead sea turtle.

Potential Environmental Effects and Existing Knowledge

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 5.8.1 (Fish), 5.8.3 (Seabirds) and 5.8.4 (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.

Environmental Effects Assessment

As per the detailed effects assessment in Section 5.8.1, physical effects of the Project on the various life stages of wolffishes and the white shark will range from negligible to low over a duration of less than one month, within an area of <1 square kilometer and are predicted to be not significant (Table 5.14). The mitigation measure of ramping-up the airgun array (over a minimum 20 min period) is expected to minimize the potential for impacts on wolffishes and the white shark.

As per the detailed effects assessment in Section 5.8.3, the predicted effect of the Project on the Ivory gull, harlequin duck, and Barrow's goldeneye is not significant. These species are unlikely to occur in the Study Area, particularly during the summer when seismic surveys are likely to be conducted. In addition, the foraging behavior (and location of foraging areas) would not likely expose them to underwater sound from the Project. Furthermore, these bird species are not known to be prone to stranding on vessels. The mitigation measure of monitoring the seismic vessel for stranded birds that will be released and ramping-up the airgun array will minimize the potential for impacts on these species.

As per the detailed effects assessment in Section 5.8.4, the predicted effect of the Project on the Blue, north Atlantic right, northern bottlenose, Sowerby's beaked, fin and killer whales; harbor porpoise; and leatherback and loggerhead sea turtles is not significant. The mitigation measure of ramping-up the airgun array (over a minimum 20 min period) is expected to minimize the potential for impacts on these marine mammals and turtles.

A summary of the predicted (residual) environmental effects of the Project on the Species at Risk VEC is provided in Table 5.10.

Table 5-14 Assessment of Residual Environmental Effects on the Species at Risk VEC

Project Activity	Species at Risk Valued Environmental Component					
	Potential Environmental Effect Positive (P) Negative (N) No Effect (NE)	Evaluation Criteria for Assessing Environmental Effects				
		Magnitude	Geographic Extent	Duration	Frequency	Reversibility
Underwater Noise						
Airgun Array	N	L	1	1	1	R/I
Seismic Vessel	N	L	1	1	1	R
Supply/Support vessel	N	L	1	1	1	R
Helicopter	N	L	1	1	1	R
Physical Presence of:						
Seismic Vessel	N	L	2	1	1	R
Supply Vessel	N	L	2	1	1	R
Helicopter	N	L	2	1	1	R
Vessel Lights	N	L	2	1	1	R
Sanitary/Domestic Waste	N/P	L	2	1	1	R
Liquid Waste	N	L	2	1	1	R
Atmospheric Emissions	N	N	2	1	1	R
Unplanned Events	N	L	2	1	1	R

In summary, the proposed Project is not likely to result in significant adverse environmental effects on the Species at Risk VEC and there is a high level of certainty for this prediction.

5.8.6 Sensitive Areas VEC

An overview of sensitive areas overlapping 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 4.1 to 4.8.

Based on the conclusions of Sections 5.8.1 to 5.8.5, the proposed Project is not likely to result in significant adverse environmental effects on Sensitive areas VEC and there is a high level of certainty for this prediction.

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6 Cumulative Effects

The environmental effects of individual projects and activities in the marine environment are not necessarily mutually exclusive of each other, but can accumulate and interact with the marine environment receptors to result in cumulative environmental change. Section 5 of the EA has assessed the cumulative effects within the Project and any remaining residual effects therefore include potential cumulative effects.

In addition to this, it is necessary to assess the cumulative effects from likely future projects (outside of the current Project) and activities in the Study Area. These comprise any reasonably foreseeable future projects or activities whose effects on the VEC would likely overlap in space and time with those of the current Project and/or would affect the same populations, communities, etc., as the Project. Where the predicted residual environmental effects of the Project have the potential to accumulate or interact with potential future projects and activities, the potential cumulative effects are evaluated.

The VEC's within the Study Area are being and will continue to be affected by a variety of activities, including:

- Commercial fishing;
- Vessel traffic for transportation, defence etc.;
- Research surveys;
- Offshore oil and gas.

These activities have all collectively influenced the presence and distribution of species in particular areas, depths and seasons, as well as the overall population size and health of marine fish, birds, mammals and sea turtles, and the environmental characteristics of particular areas within and throughout the Study Area. Fisheries and other human activities in the marine environment may also be affected both individually and collectively by offshore oil and gas exploration and production activities, general vessel traffic, research surveys, and associated disturbances, with these effects possibly accumulating or interacting on a regional scale to bring about cumulative environmental effects.

6.1 Commercial Fisheries

Commercial fishing in the Study Area has been discussed and assessed in Sections 4.8 and 5.8.2, respectively.

Physical presence of commercial fishing vessels in the Study Area at the same time as the survey vessel has the potential to cause cumulative disturbance to feeding or migrating seabirds, fish, sea mammals and turtles. The potential for cumulative disturbance can be managed and mitigated through good communication and cooperation between industries.

Fishing activities cause mortality to fish populations and incidental mortality to seabirds, marine mammals and turtles. As discussed in Section 5.8.1, during seismic acquisition there is potential for the threshold for mortality or injury to fish both with swimbladders or no swimbladders to be reached within the immediate vicinity of the seismic source (80 metres and 40 metres of the seismic source respectively). However, there is no recorded evidence that energy sources have killed fish or caused injuries during seismic survey operations (*Turnpenny and Nedwell, 1994*). In addition, at levels above 200 dB re 1 µPa, fish make active efforts to avoid the noise source and attempt to distance themselves from the source.

It is therefore predicted that the seismic survey will not cause any mortality to these VECs (with the potential exception of small number of bird species that may become stranded on the seismic vessel) and thus, there will be either no or negligible cumulative mortality effect.

6.2 Vessel Traffic and Research Surveys

The seismic vessel will also spatially and temporally avoid DFO research vessels during trawl surveys. The survey stations of the post-season snow crab survey which occurs in the fall will also be avoided until the survey stations are complete. Any cumulative effect should it occur is predicted to be not significant.

The Eastern Newfoundland region has 17 shipping ports covering domestic and international shipping and numerous shipping lanes. The seismic survey vessels are not significant in number in comparison and will not add much marine traffic. 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. In addition, this avoidance will mean cumulative shipping noise within the Study Area is minimized. Thus, potential for cumulative effects with other shipping is predicted to be low and not significant.

6.3 Offshore Oil and Gas Activities

As described in Section 5, offshore oil and gas exploration activities such as the seismic survey being proposed as part of this Project may affect marine biota through direct and indirect influences. This includes possible behavioural effects, injury, and even mortality in some cases to fish, birds, mammals or sea turtles due to noise or other disturbances in the marine environment, possible contamination resulting from routine activities (discharges) or unplanned events (oil spills), and through the alteration of marine habitats.

There are three existing offshore production developments on the Grand Banks, in the southwestern part of the Study Area, namely Hibernia, Terra Nova, and White Rose. A fourth development in the same area, Hebron, is anticipated to commence installation in 2017. These developments are at fixed locations and do not create the same types and levels of underwater noise as seismic programs. Any cumulative effects are not predicted to be significant.

Fixed platforms are either steel or concrete structures and their size is dependent upon the field properties and amount of machinery required to process production fluids. Underwater noise produced from platforms would be expected to be relatively low given the small surface area for sound transmission and given that all the machinery is located above the waterline. Sound from production platforms (drilling, production, and water injection) is characteristically broadband noise, with maximum sound levels in the region of 162 dB (rms) re 1µPa@1m (*Hannay, et al., 2004*), as opposed to the multi-pulse underwater noise levels associated with the seismic survey (estimated at 246 dB re 1 µPa).

A number of potential offshore oil and gas exploration programs in the regional area were recently proposed or approved or are currently subject to Environmental Assessment review by the C-NLOPB. These programs are all listed on the C-NLOPB website and include:

- MKI Newfoundland and Labrador Offshore Seismic Program 2017-2026;
- Seitel's East Coast Offshore 2D 3D 4D Seismic Program 2016-2025;
- CGG Newfoundland Offshore 2D 3D 4D Seismic Program 2016-2025;
- ExxonMobil Canada Eastern NL Geophysical Program 2015-2024;
- WesternGeco Canada Eastern Newfoundland Offshore Seismic Program, 2015 to 2024;
- WesternGeco Canada Southeastern Newfoundland Offshore Seismic Program, 2015 to 2024;
- Suncor Energy’s Eastern Newfoundland Offshore Area 2D/3D/4D Seismic Program, 2014-2024;
- Bridgeporth Holdings Ltd. and JEBCO Seismic Company North Flemish Pass Gravity Survey, 2015 to 2019; and

- MKI Southern Grand Banks Seismic 2014-2018.

There is potential for cumulative effects with other seismic programs proposed during the period, if different surveys are operating in close proximity to each other. During such periods, the VECs may be exposed to noise from more than one of the seismic survey programs. As discussed in Section 5, negative effects on key sensitive VECs, such as marine mammals, appear unlikely beyond a localized area from the sound source.

Contributions towards cumulative impacts will be minimised by the mitigation measures expected to be implemented by each operator associated with these projects. Cumulative effects on marine mammals are only likely to be felt by a small proportion of the biogeographic population. This, in combination with the restricted duration of the survey, suggests that cumulative impacts on marine mammals will be limited.

Good communication and coordination between the survey companies (and the operators) to avoid spatial and temporal overlaps or at least maintain sufficient buffer zones should minimize acoustic interference. Assuming this is the case, the predicted cumulative impacts on the sensitive VECs would not be significant.

6.4 Summary

Although the proposed Project will have the potential to interact with the VECs within the Study Area, as described in Section 5 any potential effects will be of a short term, localized and transient nature. With the implementation of the various mitigation measures outlined in Section 5.6 of this EA, the Project is not likely to result in significant adverse effects to any VEC. The localized and transient nature of the Project activities will reduce the potential for particular individuals, populations, areas or other environmental components to be affected through multiple interactions with this Project and other activities in the marine environment, and for any one environmental receptor to be affected simultaneously and repeatedly by multiple projects and activities. As part of the planning and implementation of its survey activities over the course of this Project, Polarcus will also continue to communicate and consult with relevant industry stakeholders. This will also include oil and gas exploration companies operating in the area, to plan and coordinate activities to ensure appropriate spatial and temporal separation is maintained, for technical, safety and environmental reasons.

It can therefore be concluded that the proposed Project is unlikely to result in significant adverse cumulative environmental effects in combination with other projects and activities that are currently occurring or will be carried out in the future.

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7 Assessment Summary and Conclusions

Polarcus is proposing to conduct 2D, 3D and/or 4D seismic surveys in the Newfoundland Offshore Area over one or more years between 2016 and 2022, within the months of May to November.

The Project will require authorizations from the C-NLOPB, pursuant to:

- Section 138 (1)(b) of the Canada – Newfoundland Atlantic Accord Implementation Act; and
- Section 134(1)(b) of the Canada – Newfoundland and Labrador Atlantic Accord Implementation Newfoundland and Labrador Act (the Accord Acts).

This document provides an Environmental Assessment of the proposed marine seismic exploration program in accordance with the requirements and processes of the C-NLOPB and the Scoping Document. Included within this assessment document is a summary of the following:

- Project purpose and rationale;
- The activities and equipment that constitute the Project;
- The existing physical and biological environment;
- The potential environmental issues identified through scoping and consultation activities;
- The predicted environmental effects of the Project on the identified VECs;
- The proposed mitigation measures to avoid / reduce any adverse environmental effects;
- The Project's predicted residual environmental effects and their significance; and
- Cumulative environmental effects.

The potential environmental issues and effects that could be associated with the proposed Project can be avoided or otherwise mitigated through the use of good planning, tried and tested operational practices and procedures, supported by Project-specific and industry standard mitigation measures. These mitigation measures are well established and outlined in relevant regulatory procedures and guidelines, and have been identified by Polarcus as part of this Environmental Assessment.

Overall, a localized, short-term and transient disturbance in the marine environment at any one location and time throughout the operational life of the seismic program is expected to occur. It is therefore not anticipated to displace or otherwise affect marine fish, birds, mammals, turtles, fisheries or other marine activities in such a way that causes significant adverse effects to populations, species at risk or human activities in the region.

The proposed Project is therefore not likely to result in significant adverse environmental effects.

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References

8.1 Project Description References

Davies R. J., Stewart S. A., Cartwright J. A., Lappin M., Johnston R., Fraser S. I. and Brown A. R., (2004). *3D Seismic Technology: Are We Realising Its Full Potential?* Geological Society, London, Memoirs 2004, v.29; p1-10.

Hunt, T., (2007). *Investigating high frequency underwater vessel noise and potential masking of killer whale echolocation clicks.* www.beamreach.org/071dir/props/finprop_tim.pdf.

Mjelde, R. (2006). General Geophysics. http://folk.uio.no/hanakrem/svalex/E-learning/geophysics/3D-Seismic.swf.

Oil and Gas Producers (OGP), (2004). *Seismic Surveys & Marine Mammals.* Joint OGP / IAGC Position Paper. September 2004.

Oil and Gas Producers (OGP), (2011). *An overview of marine seismic survey operations.* Report No. 448. April 2011.

Richardson, W.J., Greene, C.R. Jr., Malme, C.I. & Thomson, D.H., (1995). *Marine mammals and noise.* Academic Press, San Diego. Section 2.11.4.

Senior, B., Bailey, H., Lusseau, D., Foote A., & Thompson, P.M., (2008). *Anthropogenic noise in the Moray Firth SAC*; potential sources and impacts on bottlenose dolphins. Scottish Natural Heritage Commissioned Report No.265 (ROAME No.F05LE02).

Simmonds, M., Dolman, S. & Weilgart, L., (2003). *Oceans of Noise: A WDCS Science report*. Whale and Dolphin Conservation Society.

Swan, J., Neff, J. & Young, P., (1994). *Environmental implications of offshore oil and gas development in Australia: The findings of an independent scientific review.* Australian Petroleum Exploration Association, Sydney.

8.2 Physical Environment References

Canada-Newfoundland and Labrador Offshore Petroleum Board (C-NLOPB), (2014). *Eastern Newfoundland Strategic Environmental Assessment.* Prepared by AMEC Environmental & Infrastructure. Report Reference ISBN: 978-1-927098-50-9.

CBC News, (2016). Hurricane Alex first January hurricane since 1938. Retrieved from; http://www.cbc.ca/news/canada/nova-scotia/january-hurricane-rare-occurance-1.3405785

CIS (Canadian Ice Service), (2011). *Sea ice climatic atlas, East Coast, 1981-2010.* Retrieved from http://www.ec.gc.ca/Publications/default.asp?lang=Enandxml=8DFED3F9-4BD6-49F3-9ACA-F9AA9F52A96D.

DFO (Department of Fisheries and Oceans Canada), (2013a). *Oceanographic Databases, Ocean Data Inventory.* Retrieved from http://bluefin2.dfo-mpo.gc.ca/odiqry/servlet/MainServlet

DFO (Department of Fisheries and Oceans Canada), (2012a). *The Newfoundland Shelf - Climatology.* Retrieved from http://www2.mar.dfo-mpo.gc.ca/science/ocean/nfld/nfld_hydro.html.

Gregory, D. N., (2004). Ocean Data Inventory (ODI): *A Database of Ocean Current, Temperature and Salinity Time Series for the Northwest Atlantic (Report no. 2004/097).* Canadian Science Advisory Secretariat, Department of Fisheries and Oceans Canada.

ICOADS, (1950-2012). *International Comprehensive Ocean-Atmosphere Data Set (ICOADS). (National Center for Atmospheric Research, USA)*. Retrieved from http://rda.ucar.edu.

King, L.H. and Fader, G.B., (1985). *Geological setting and age of the Flemish Cap granodiorite, east of the Grand Banks of Newfoundland.* Canadian Journal of Earth Sciences. 22(9):1286-1298.

King, L.H., Fader, G.B.J., Jenkins, W.A.M., and King, E.L., (1986). *Occurrence and regional geological setting of Paleozoic rocks on the Grand Banks of Newfoundland.* Canadian Journal of Earth Sciences. (23):504–526.

NCDC (National Climatic Data Center), 1960 – 2015.

NCDC (National Climatic Data Center/NESDIS/NOAA/U.S), (2016). Department of Commerce, Data Support Section/Computational and Information Systems Laboratory/National Center for Atmospheric Research/University Corporation for Atmospheric Research, Earth System Research Laboratory/NOAA/U.S. Department of Commerce, and Cooperative Institute for Research in Environmental Sciences/University of Colorado. 1984, updated monthly. International Comprehensive Ocean-Atmosphere Data Set (ICOADS) Release 2.5, Individual Observations. Research Data Archive at the National Center for Atmospheric Research, Computational and Information Systems Laboratory.

Seaconsult Ltd., (1998) *Physical Environmental Data for Production Systems at Terra Nova.* Report prepared for Petro-Canada Inc.

8.3 Biological Environment References

Allen, J.A. (1963). *Observations on the biology of Pandalus montagui (Crustacea: Decapoda).* Journal of the Marine Biological Association of the United Kingdom. 43: 665-682.

Andersen, J.M., Wiersma, Y.F., Stenson, G B., Hammill, M.O., Rosing-Asvid, A., and Skern-Maurizen M., (2012). *Habitat selection by hooded seals (Cystophora cristata) in the Northwest Atlantic Oce*an – ICES Journal of Marine Science, 69: 1–13.

Anderson, J.T. and Gardner, G.A., (1986). *Plankton communities and physical oceanography observed on the Southeast Shoal Region, Grand Bank of Newfoundland. Journal of Plankton Research*. 8:1111-1135.

Anderson, J.T. and Gardner, G.A., (1986). *Plankton communities and physical oceanography observed on the Southeast Shoal Region, Grand Bank of Newfoundland*. Journal of Plankton Research. 8:1111-1135.

Baillon, S., Hamel, J.-F. , Wareham, V.E. and Mercier, A., (2012). *Deep cold-water corals as nurseries for fish larvae. Frontiers in Ecology and the Environment.* 10:351-356. Baker *et al.,* 2012

Baker, K.D., Haedrich, R.L., Snelgrove, P.V.R., Wareham, V.E., Edinger, E.N. and Gilkinson K.D., (2012). *Small-scale patterns of deep-sea fish distributions and assemblages of the Grand Banks, Newfoundland continental slope. Deep Sea Research Part I: Oceanographic Research Papers.* 65:171-188.

Bartol, S.M. and Ketten D., (2006). *Tuna and Turtle Hearing. in Swimmer Y. and Brill R. (eds) Sea Turtle and Pelagic Fish Sensory Biology: Developing Techniques to Reduce Sea Turtle Bycatch in Longline Fisheries, NOAA Technical Memorandum NMFS-PIFSC-7.*

Beazley, L. I., Kenchington E. L., Murillo, F. J., and Sacau, M., (2013). *Deep-sea sponge grounds enhance diversity and abundance of epibenthic megafauna in the Northwest Atlantic.*– ICES Journal of Marine Science, doi:10.1093/icesjms/fst124.

Bluhm, B.A., Piepenburg, D. and von Juterzenka, K., (1998). *Distribution, standing stock, growth, mortality and production of Strongylocentrotus pallidus (Echinodermata: Echinodea) in the northern Barents Sea*. Polar Biology. 20:325-334.

Bowering, W.R. and Chumakov, A.K., (1989). *Distribution and relative abundance of greenland halibut (Reinhardtius hippoglossoides (Walbaum)) in the Canadian Northwest Atlantic from Davis Strait to the northern Grand Bank. Fisheries Research.* 7:301-327.

Bowman, R.E., Stillwell, C.E., Michaels, W.L., and Grosslein, M.D., (2000). *Food of Northwest Atlantic fishes and two common species of squid.* NOAA Technical Memorandum. NMFS-NE-155. xiv + 16 pp. + appendices.

Breeze, H., Fenton, D.G. Rutherford, R.J. and Silva, M.A., (2002). *The Scotian Shelf: An ecological overview for ocean planning*. Canadian Technical Report of Fisheries and Aquatic Sciences, 2393.

Bruno, I., Costas, G., Gonzalez Iglesias, C. and Paz, X., (2000). *Feeding Chronology of yellowtail flounder (Limanda ferruginea) and American plaice (Hippoglossoides platessoides) on Grand Bank (NAFO Division 3N).* NAFO Science Council Studies. 33: 103-116.

Canada-Newfoundland and Labrador Offshore Petroleum Board (C-NLOPB), (2014). *Eastern Newfoundland Strategic Environmental Assessment.* Prepared by AMEC Environmental & Infrastructure. Report Reference ISBN: 978-1-927098-50-9.

Canadian Coast Guard, (2016). Marine Communications and Traffic Services MCTS. Retrieved from; http://www.ccg-gcc.gc.ca/Marine-Communications/Home

Carscadden, J., Nakashima, B.T, and Frank, K.T., (1997). *Effects of fish length and temperature on the timing and peak spawning in capelin (Mallotus villosus).* Canadian Journal of Fisheries and Aquatic Sciences. 54:781-787.

Christian, J.R., Grant, C.G.J., Meade, J.D., and Noble, L.D., (2010). *Habitat Requirements and Life History Characteristics of Selected Marine Invertebrate Species Occurring in the Newfoundland and Labrador Region (Report no. 2925).* Canadian Manuscript Report of Fisheries and Aquatic Sciences.

Collette, B., A. Acero, A.F. Amorim, A. Boustany, C. Canales Ramirez, G. Cardenas, K.E. Carpenter, S.-K. Chang, N. de Oliveira Leite Jr., A. Di Natale, D. Die, W. Fox, F.L. Fredou, J. Graves, A. Guzman-Mora, F.H. Viera Hazin, M. Hinton, M. Juan Jorda, C. Minte Vera, N. Miyabe, R. Montano Cruz, E. Masuti, R. Nelson, H. Oxenford, V. Restrepo, E. Salas, K. Schaefer, J. Schratwieser, R. Serra, C. Sun, R.P. Teixeira Lessa, P.E. Pires Ferreira Travassos, Y. Uozumi, and E. Yanez., (2011). *Thunnus alalunga. In: IUCN 2013. IUCN Red List of Threatened Species.* Version 2013.1. <www.iucnredlist.org>.

Corey, S., (1981). *Comparative fecundity and reproductive strategies in seventeen species of the Cumacea (Crustacea: Peracarida).* Marine Biology. 62:65-72.

COSEWIC (Committee on the Status of Endangered Wildlife in Canada), (2009). *COSEWIC assessment and status report on the American Plaice Hippoglossoides platessoides, Maritime population, Newfoundland and Labrador population and Arctic population, in Canada.* Committee on the Status of Endangered Wildlife in Canada. Ottawa. x + 74 pp. (www.sararegistry.gc.ca/status/status_e.cfm).

COSEWIC (Committee on the Status of Endangered Wildlife in Canada), (2010). *COSEWIC assessment and status report on the Deepwater Redfish/Acadian Redfish complex Sebastes mentella and Sebastes fasciatus in Canada.* Committee on the Status of Endangered Wildlife in Canada. Ottawa. X + 80pp. (www.sararegistry.gc.ca/status/status_e.cfm).

COSEWIC (Committee on the Status of Endangered Wildlife in Canada), (2012a). *COSEWIC assessment and status report on the Smooth Skate Malacoraja senta in Canada.* Committee on the Status of Endangered Wildlife in Canada. Ottawa. xix + 77 pp. (www.registrelep-sararegistry.gc.ca/default_e.cfm).

COSEWIC (Committee on the Status of Endangered Wildlife in Canada), (2012b). *COSEWIC assessment and status report on the Leatherback Sea Turtle Dermochelys coriacea in Canada.* Committee on the Status of Endangered Wildlife in Canada. Ottawa. xv + 58 pp.

Dalley, E.L. and Anderson, J.T. (1998). *Plankton and nekton of the northeast Newfoundland Shelf and Grand Banks in 1997.* Canadian Stock Assessment Secretariat Research Document 98/121.

Department of National Defence (DND) (2016) *Geospatial data for UXOs and legacy sites*. Personal communication 14.01.2016.

DFO (Department of Fisheries and Oceans Canada), (1998). *Canadian Atlantic integrated fisheries management plan. Bigeye (Thunnus obesus), Yellowfin (Thunnus albacares), Albacore tunas (Thunnus alalunga)* 1998-1999. 46 pp.

DFO (Department of Fisheries and Oceans Canada), (2007). *Placentia Bay-Grand Banks Large Ocean Management Area Conservation Objectives.* DFO Can. Sci. Advis. Sec. Sci. Advis. Rep. 2007/042.

DFO (Department of Fisheries and Oceans Canada), (2008). *Assessment of Newfoundland and Labrador snow crab.* Canadian Science Advisory Secretariat 2008/009.

DFO (Department of Fisheries and Oceans Canada), (2010). *Aquatic species: Details for shortfin mako shark. Species Information.* Retrieved from http://www.dfo-mpo.gc.ca/species-especes/aquatic-aquatique/shortfin-mako-shark-requin-taupe-bleu-eng.htm.

DFO (Department of Fisheries and Oceans Canada), (2011). *2011 – 2015 Integrated Fisheries Management Plan for Atlantic Seals*. Retrieved from: http://www.dfo-mpo.gc.ca.

DFO (Department of Fisheries and Oceans), (2012). *Proceedings of the Newfoundland and Labrador Regional Advisory Process for the Recovery Potential Assessment of American Plaice (Hippoglossoides platessoides), Newfoundland and Labrador Designatable Unit; January 24-26, 2011*. DFO Canadian Science Advisory Secretariat Proceeding Series. 2011/042.DFO (Department of Fisheries and Oceans Canada), (2013a). *Angler's Guide 2013-14.* Retrieved from: http://www.dfo-mpo.gc.ca.

DFO (Department of Fisheries and Ocean Canada), (2013b). *Satellite tagging uncovers surprising birthing ground of porbeagle sharks.* Retrieved from http://www.dfo-mpo.gc.ca/science/publications/article/2011/01-24-11-eng.html.

DFO (Department of Fisheries and Ocean Canada), (2013c). *Identification of Additional Ecologically and Biologically Significant Areas (EBSAS) within the Newfoundland and Labrador Shelves Bioregion. DFO Canadian Science Advisory Secretariat Proceedings Series 2013/048.*

DFO (Department of Fisheries and Oceans Canada), (2013d). Marine Protected Areas. Retrieved from: http://www.dfo-mpo.gc.ca. October 2, 2013.

DFO, (2015). *2011-2015 Integrated Fisheries Management Plan for Atlantic Seals*. Retrieved from: http://www.dfo-mpo.gc.ca/fm-gp/seal-phoque/reports-rapports/mgtplan-planges20112015/mgtplan-planges20112015-eng.htm.

DFO, (2015). *Atlantic Cod (Newfoundland and Labrador population)* Retrieved from; http://www.dfo-mpo.gc.ca/species-especes/profiles-profils/atlanticcod-morue_nl-tnl-eng.html.

Djiman. R and Sohou B., (2013). Influences of climate variability on coastal oceanography of Benin. [Online] Available from ftp://ftp.wmo.int/Documents/PublicWeb/amp/mmop/documents/JCOMM-TR/J-TR-22-CLIMAR-II/DOCUMENTS_JCOMM_22/004_Poster_presentations/P3_Session_III/P_III_01_Djiman.pdf Accessed 26.02.2015.

Duffy, J.E., and Hay, M.E. (1991). *Food and shelter as determinants of food choice by an herbivorous marine amphipod. Ecology*. 72:1286-1298.

Dutil, J.-D., Proulx, S., Hurtubise, S., and Gauthier, J., (2010). *Recent findings on the life history and catches of wolffish (Anarhichas sp.) in research surveys and in the Sentinel Fisheries and Observer Program for the Estuary and Gulf of St. Lawrence.* Canadian Science Advisory Secretariat. Research Document 2010/126. 81 pp.

EC (Environment Canada), (2012). *Migratory Bird Sanctuaries*. Retrieved from http://www.ec.gc.ca/ap-pa.

EC-CWS (Environment Canada-Canadian Wildlife Service), (2013). *Atlantic Canada Colonial Waterbird Database.* Environment Canada, Canadian Wildlife Service.

EC-CWS (Environment Canada – Canadian Wildlife Service) (2016). *Atlantic Canada Colonial Waterbird Database.* Information provided by EC-CWS in response to data request, 26 April 2016.

ECSAS (Eastern Canada Seabirds at Sea), (2013). *Eastern Canada Seabirds at Sea sightings database.* Environment Canada - Canadian Wildlife Service, Atlantic Canada.

ECSAS (Eastern Canada Seabirds at Sea), (2015). *Eastern Canada Seabirds at Sea sightings database.* Environment Canada – Canadian Wildlife Service, Atlantic Canada. Information provided by EC-CWS in response to data request, 16 December 2015.

Edinger, E.N., Wareham, V.E., and Haedrich, R.L., (2007). *Patterns of groundfish diversity and abundance in relation to deep-sea coral distributions in Newfoundland and Labrador waters.* Bulletin of Marine Science. 81(Supplement 1): 101-122.

Emson, R.H., Mladenov, P.V., and Barrow, K., (1991). *The feeding mechanism of the basket star Gorgonocephalus articus. Canadian Journal of Zoology*. 69(2):449-455.

FAO (Food and Agriculture Organization of the United Nations), (2013). *Species fact sheets: Thunnus obesus* (Lowe, 1839). Retrieved from http://www.fao.org/fishery/species/2498/en.

Fifield, D.A., Baker, K.D., Byrne, R., Robertson, G.J., Burke, C., Gilchrist, H.G., Hedd, A., Mallory, M.L., McFarlane Tranquilla, L., Regular, P.M., Smith, A., Gaston, A.J., Montevecchi, W.A., Elliot, K.H., Phillips, R., (2009). Modelling *Seabird Oil Spill Mortality Using Flight and Swim Behaviour.* Environmental Studies Research Funds Report No. 186. Dartmouth, 46 p.

Frank, K.T., Loder, J.W., Carscadden, J.E., Leggett, L.C. and Taggart, C.T., (1992). *Larval flatfish distributions and drift on the southern Grand Bank.* Canadian Journal of Fisheries and Aquatic Sciences. 49:467-483.

Frank, K.T., Loder, J.W., Carscadden, J.E., Leggett, L.C. and Taggart, C.T., (1992). *Larval flatfish distributions and drift on the southern Grand Bank.* Canadian Journal of Fisheries and Aquatic Sciences. 49:467-483.

Gascon, D. (ed.), (2003). *Redfish multidisciplinary research zonal program (1995-1998):* Final report. Canadian Technical Report of Fisheries and Aquatic Sciences. 2462: xiii + 139 p.

Gilkinson, K.D., Gagnon, J.M., and Schneider, D.C., (1998). *The sea urchin Strongylocentrotus pallidus (G.O.Sars) on the Grand Bank of Newfoundland*. In Echinoderm Biology, Balkema, Rotterdam. pp. 467-473.

Goff, G.P. and Lien, J., (1988). *Atlantic leatherback turtles, Dermochelys coriacea, in cold water off Newfoundland and Labrador.* Canadian Field Naturalist. 102(1):1-5.

Gomes, M.C., Haedrich, R.L., and Rice, J.C., (1992). *Biogeography of groundfish assemblages on the Grand Bank*. Journal of Northwest Atlantic Fishery Science. 14:13-27.

Gosner, K.L., (1979). Petersen field guides: Atlantic seashore from the Bay of Fundy to Cape Hatteras. Houghton Mifflin Company: Boston. 329 pp.

Gregory, R. S. and Anderson, J.T., (1997). Substrate selection and use of protective cover by juvenile Atlantic cod Gadus morhua in inshore waters of Newfoundland. Marine Ecology Progress Series. 146:9–20.

Han, G. and Kulka, D., (2009). *Dispersion of eggs, larvae and pelagic juveniles of White Hake (Urophycis tenuis) in relation to ocean currents of the Grand Bank: A modelling approach.* Journal of Northwest Atlantic Fisheries Science 41: 183–196. doi:10.2960/J.v41.m627.

Harrison, G.W., Børsheim, K.Y., William, K.W.L., Maillet, G.L., Pepin, P., Sakshaug, E., Skogen, M.D., and Yeats, P.A., (2013). *Phytoplankton production and growth regulation in the Subarctic North Atlantic: A comparative study of the Labrador Sea-Labrador/Newfoundland shelves and Barents/Norwegian/Greenland seas and shelves.* Progress in Oceanography 114: 26–45.

Hays, G.C., (1996). *Large-scale patterns of diel vertical migration in the North Atlantic.* Deep-Sea Res. I, 43: 1601-1615.

Healey, B. P., Murphy, E.F., Stansbury, D.E. and Brattey, J., (2003). *An Assessment of the Cod Stock in NAFO Divisions 3NO. NAFO SCR Doc. No. 03/59.*

Houston, K.A. and Haedrich, R.L., (1984). *Abundance and biomass of macrobenthos in the vicinity of Carson Submarine Canyon, northwest Atlantic Ocean*. Marine Biology. 82:301-305.

Hudon, C., Parsons, D.G., and Crawford, R., (1992). *Diel pelagic foraging by a pandalid shrimp (Pandalus montagui) off resolution island (Eastern Hudson Strait).* Canadian journal of Fisheries and Aquatic Sciences. 49(3):565-576.

Husky Energy, (2000). *White Rose Development Environmental Assessmen*t - Comprehensive Study, Part I. St. John's, NL: Husky Energy.

Husky Energy, (2010). *White Rose Environmental Effects Monitoring (EEM) program - 2010. Submitted to the Canada-Newfoundland and Labrador Offshore Petroleum Board.* Report No. WR-HSE-RP-2261. vii + 184 + appendices.

Hutchings, J.A., Myers R.A., and Lilly, G.R., (1993). *Geographic variation in the spawning of Atlantic cod, Gadus morhua, in the Northwest Atlantic*. Canadian Journal of Fisheries and Aquatic Sciences. 50:2457-2467.

IBA, (2013). *Important Bird Areas of Canada.* Retrieved from: http://www.ibacanada.ca/.

IBA, (2016). *Important Bird Areas of Canada*. Available online at: http://www.ibacanada.ca/. Accessed 22 January 2016.

Jacoby, D.M.P., Croft, D.P. and Sims, D.W., (2012). *Social behaviour in sharks and rays: analysis, patterns and implications for conservation.* Fish and Fisheries. 13:399-417.

Jessop, B.M., Shiao, J.C., Iizuka, Y. and Tzeng, W.N., (2002). *Migratory behaviour and habitat use by American eels Anguilla rostrata as revealed by otolith microchemistry*. Marine Ecology Progress Series. 233:217–229.

Kelly, J.T. and Hanson, J.M., (2013). *Maturity, size at age and predator-prey relationships of winter skate Leucoraja ocellata in the southern Gulf of St. Lawrence: potentially an undescribed endecmic facing extirpation*. Journal of Fish Biology. 82: 959-978.

Kenchington, E.L.R., Prena, J., Gilkinson, K.D., Gordon Jr., D.C., MacIsaac, K., Bourbonnais, C., Schwinghamer, P.J., Rowell, T.W., McKeown, D.L., and Vass, W.P., (2001). *Effects of experimental otter trawling on the macrofauna of a sandy bottom ecosystem on the Grand Banks of Newfoundland.* Canadian Journal of Fisheries and Aquatic Sciences. 58: 1043-1057.

Kilada, R.W., Campana, S.E., and Roddick, D., (2009). *Growth and sexual maturity of the northern propellorclam (Cyrtodaria siliqua) in Eastern Canada, with bomb radiocarbon age validation*. Marine Biology. 156:1029-1037.

Koen-Alonso M., Pepin, P., and Mowbray, F., (2010). *Exploring the role of environmental and anthropogenic drivers in the trajectories of core fish species of the Newfoundland and Labrador marine community*. NAFO Scientific Council Research Document. 10/37. 16 pp.

Kulka, D.W., (2006). *Abundance and distribution of demersal sharks on the Grand Banks with particular reference to the NAFO Regulatory Area.* NAFO SCR Doc. 06/20, N5237, 41p.

Kulka, D.W. and Miri, C.M., (2001). *The status of Monkfish (Lophius americanus) in NAFO Divisions 2J, 3K, 3L, 3N, 3O and Subdivision 3Ps. DFO Atlantic Fisheries Research.* 2001/004 42 p.

Kulka, D.W., Simpson, M.R. and Hooper, R.G., (2004). *Changes in Distribution and Habitat Associations of Wolffish (Anarhichidae) in the Grand Banks and Labrador Shelf. Atlantic Fisheries* Research Document 04/113 44 pp.

Kulka, D.W., Simpson, M.R., and Inkpen, T.D., (2003). *Distribution and biology of blue hake (Antimora rostrata Gunther 1878) in the Northwest Atlantic with comparison to adjacent areas.* Scientific Council Meeting NAFO SCR Doc. 01/185.

Kulka, D.W., Swain, D., Simpson, M.R., Miri, C.M., Simon, J., Gauthier, J., McPhie, R. Sulikowski, J., and Hamilton R., (2006). *Distribution, Abundance, and Life History of Malacoraja senta (Smooth Skate) in Canadian Atlantic Waters with Reference to its Global Distribution. Canadian Science Advisory Secretariat Research Document*. 06/93 140 p.

Lacalli, T., (1981). *Annual spawning cycles and planktonic larvae of benthic invertebrates from Passamaquoddy Bay, New Brunswick.* Canadian Journal of Zoology. 59: 433-440.

Lawson, J.W. and Gosselin, J.F., (2009). *Distribution and preliminary abundance estimates for cetaceans seen during Canada's marine megafauna survey - a component of the 2007 TNASS.* DFO Can. Sci. Advis. Sec. Res. Doc. 2009/031. VI + 28 pp.

Lear, W.H., (1976). *Migrating Atlantic salmon (Salmo salar) caught by otter trawl on the Newfoundland Continental Shelf.* Journal of the Fisheries Research Board of Canada 33:1202-1205.

Lear, W.H. and Green, J.M., (1984). *Migration of "Northern" Atlantic cod and the mechanisms involved. Mechanisms of Migration in Fishes*. NATO Conference Series 14: 309-315.

Lesage, V., Gosselin, J.-F., Hammill, M., Kingsley, M.C.S., and Lawson, J., (2007). *Ecologically and Biologically Significant Areas (EBSAs) in the Estuary and Gulf of St. Lawrence – A marine mammal perspective(Sci. Adv. Rep. 2007/046).* Canadian Science Advisory Secretariat, Department of Fisheries and Oceans.

LGL Limited, (2003). *Orphan Basin Strategic Environmental Assessment*. Prepared for Canada-Newfoundland Offshore Petroleum Board.

LGL Limited, (2012). *Orphan Basin Exploration Drilling Program Environmental Assessment: Update 2012*. LGL Rep. SA1160. Rep. by LGL Limited, St. John's, NL, for Chevron Canada Limited, Calgary, AB. 53 p. + appendix.

LGL Limited, (2013). *Environmental Assessment of HMDC's 2D/3D/4D Seismic Projects 2013-Life of Field, Newfoundland Offshore Area.* LGL Rep. SA1207. Prepared by LGL Limited for Hibernia Management and Development Company Ltd., St. John's, NL. 228 p. + appendices.

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

Maillet, G.L., Pepin, P., and Craig, J.D.C., (2004). *Assessing phytoplankton and zooplankton taxa from the CPR survey in NAFO Subareas 2 and 3 in the Northwest Atlantic*. Northwest Atlantic Fisheries Organization, NAFO SCR Doc. 04/30.

McMahon, K.W., Ambrose, W.G., Johnson, B.J., Sun, M.-Y., Lopez, G.R., Clough, L.M., and Carroll, M.L., (2006). *Benthic community response to ice algae and phytoplankton in Ny Alesund, Svalbard.* Marine Ecology Progress Series. 310:1-14.

McPhie, R.P., and Campana, S.E., (2009). *Reproductive characteristics and population decline of four species skate (Rajidae) off the eastern coast of Canada.* Journal of Fish Biology. 75: 223-246.

Morgan, M.J. and Brodie, W.B., (1991). *Seasonal distribution of American plaice on the northern Grand Banks*. Marine Ecology Progress Series. 75: 101-107.

Morgan, M.J., Garabana, D., Rideout, R.M., Román, E., Pérez-Rodriguez, A., and Saborido-Rey, F., (2013). *Changes in distribution of Greenland halibut in a varying environment*. ICES Journal of Marine Science, 70: 352–361.

Murillo, F.J., Munoz, P.D., Cristobo, J., Rios, P., Gonzalez, C., Kenchington, E., and Serrano, A., (2012). *Deep-sea sponge grounds of the Flemish Cap, Flemish Pass and the Grand Banks of*

Newfoundland (Northwest Atlantic Ocean): Distribution and species composition. Marine Biology Research. 8:842-854.

NAFO (Northwest Atlantic Fisheries Organization), (2011). *New VME indicator species (excluding corals and sponges) and some potential VME elements of the NAFO Regulatory Area*. NAFO SCR Doc. 11/73.

NAFO (Northwest Atlantic Fisheries Organization), (2014). *NAFO Response to the C-NLOPB SEA* Draft Report. April 16, 2014.

NAFO (Northwest Atlantic Fisheries Organization), (2014). *SC Working Group on Ecosystem Science and Assessment.* NAFO SCS Doc. 14/023

NAFO (Northwest Atlantic Fisheries Organization), (2015). *NAFO Conservation and Enforcement Measures.* NAFO/FC Doc. 15/1.

Neilson, J.D., Paul, S.D., and Smith, S.C., (2006). *Stock Structure of Swordfish (Xiphias gladius) in the Atlantic: A review of the non-genetic evidence*. Collective Volume of Scientific Papers ICCAT. 61: 25-60.

NLDEC (Newfoundland and Labrador Environment and Conservation), (2013). *Wilderness and Ecological Reserves*. http://www.env.gov.nl.ca/env/parks/wer/index.html. Accessed 03 October 2013.

NLDFA (Newfoundland and Labrador Department of Fisheries and Aquaculture), (2013). *Aquaculture.* Retrieved from: http://www.fishaq.gov.nl.ca. October 8, 2013.

Ollerhead L.M.N., Morgan, M.J., Scruton, D.A., and Marrie, B., (2004). *Mapping spawning times and locations for 10 commercially important fish species found on the Grand Banks of Newfoundland.* Canadian Technical Reports in Fisheries and Aquatic Sciences 2522: iv + 45 p.

Parks Canada, (2008). *National Marine Conservation Areas of Canada*. Retrieved from: http://www.pc.gc.ca. October 2, 2013.

Parks Canada, (2009). *National Historic Sites of Canada*. Retrieved from: http://www.pc.gc.ca.

Parks Canada, (2013). *Terra Nova National Park Management Plan*. Retrieved from: http://www.pc.gc.ca.

Piatt, J. F., Methven, D.A, Burger, A.E., McLagan, R.L., Mercer, V., and Creelman, E., (1989). *Baleen whales and their prey in a sub-arctic coastal environment.* Canadian Journal Zoology 67:1523-1530.

Pitt, T.K., (1973). *Food of American plaice (Hippoglossoides platessoides) from the Grand Bank,* Newfoundland. Journal of the Fisheries Research Board of Canada. 30(9):1261-1273.

Pitt, T.K., (1976). *Food of Yellowtail flounder on the Grand Bank and a comparison with American Plaice*. International Commission for the Northwest Atlantic Fisheries Research Bulletin. 12:23-27.

Prena, J., Schwinghamer, P., Rowell, T., Gordon, D., Gilkinson, K., Vass, W.P. and McKeown, D.L., (1999). *Experimental otter trawling on a sandy bottom ecosystem of the Grand Banks of Newfoundland: analysis of trawl bycatch and effects on epifauna.* Marine Ecology Progress Series. 181:107-124.

Pusineri, C., Vasseur, Y., Hassani, S., Meynier, L., Spitz, J., and Ridoux, V., (2005). *Food and feeding ecology of juvenile albacore, Thunnus alalunga, off the Bay of Biscay: A case study.* ICES Journal of Marine Science. 62(1):116-122.

Ramsar Sites Information Service (Ramsar), (2016). *The Ramsar Sites Database.* Retrieved from: http://ramsar.wetlands.org.

Reddin, D.G., (1985). *Atlantic salmon (Salmo salar) on and east of the Grand Bank. Journal of Northwest Atlantic Fishery Science*. 6:157-164.

Reid, R.N., Cargnelli, L.M., Griesbach, S.J., Packer, D.B., Johnson, D.L., Zetlin, C.A., Berrien, P.L., (1999). *Essential fish habitat source document: Atlantic herring, Clupea harengus, life history and habitat characteristics* (NOAA Tech. MEM. NMFS-NE-126).

Rose, G.A., Rowe, S., and King, G., (2013). *The amazing journey of cod 017.* The Osprey 44(1):12-16.

Rosenberg. R., Dupont, S., Lundalv, T., Skold, H.N., Norkko, A., Roth, J., Stach, T., and Thorndyke, M. (2005). *Biology of the basket star Gorgonocephalus caputmedusae* (L.) Marine Biology. 148:43-50.

Russell, J. and Fifield, D., (2001a). *Marine Bird Important Areas on the Northeast Coast of Newfoundland: Conservation Concern and Potential Strategies.* Canadian Nature Federation, Bird Studies Canada, Natural History Society of Newfoundland and Labrador, 124 pp.

Russell, J. and Fifield, D., (2001b). *Marine Bird Important Areas in Southeast Newfoundland: Conservation Concern and Potential Strategies*. Canadian Nature Federation, Bird Studies Canada, Natural History Society of Newfoundland and Labrador, 160 pp.

Saïdi, B., Bradaï, M.N., Bouaïn, A., Guélorget, O., Capapé, C. (2005). *Capture of a pregnant female white shark, Carcharodon carcharias (Lamnidae) in the Gulf of Gabès (southern Tunisia, central Mediterranean) with comments on oophagy in sharks*. Cybium. 29(3): 303-307.

SARA, (2016). The Canadian *Species at Risk Act* (SARA) http://laws-lois.justice.gc.ca/eng/acts/S-15.3/.

Schneider, D.C., Gagnon, J.M., and Gilkinson, K.D. (1987). *Patchiness of epibenthic megafauna on the outer Grand Banks of Newfoundland.* Marine Ecology Progress Series. 39: 1-13.

Scott, W.B., and Scott, M.G., (1988). *Atlantic fishes of Canada.* Canadian Bulletin of Fisheries and Aquatic Sciences. 219: 731 p.

Shackell, N.L., Carscadden, J.E., and Miller, D.S., (1994). *Migration of pre-spawning capelin (Mallotus villosus) as related to temperature on the northern Grand Bank, Newfoundland*. ICES Journal of Marine Science. 51:107-114.

Sheader, M., (1983). *The reproductive biology and ecology of Gammarus duebeni (Crustacea: Amphipida) in southern England.* Journal of the Marine Biological Association of the United Kingdom. 63(3):517-540.

Simpson, M.R., Chabot, D., Hedges, K., Simon, J., Miri, C.M., and Mello, L.G.S., (2013). *An update on the biology, population status, distribution, and landings of wolffish (Anarhichus denticulatus, A. minor, and A. lupus) in the Canadian Atlantic and Arctic Oceans.* Canadian Science Advisory Secretariat Research Document 2013/089. v + 82 p.

Simpson, M.R., Mello, L.G.S, Miri, C.M., and Treble, M., (2012). *A pre-COSEWIC assessment of three species of Wolffish (Anarhichas denticulatus, A. minor, and A. lupus) in Canadian waters of the Northwest Atlantic Ocean.* Canadian Science Advisory Secretariat Research Document 2011/122. iv + 69 pp.

Spetland, F., Rapp, H.T., Hoffmann, F., and Tendal, O.S., (2007). *Sexual reproduction of Geodia barretti Bowerbank, 1858 (Porifera, Astrophorida) in two Scandinavian fjords. Porifera research: biodiversity, innovation and sustainability*. Museu Nacional, Rio de Janeiro 28: 613-620.

Suncor Energy, (2010). *Terra Nova 2010 Environmental Effects Monitoring Program Year 7 (Volume 1).* Submitted to the Canada-Newfoundland and Labrador Offshore Petroleum Board. xiv + 237.

Templeman, N.D., (2007). *Placentia Bay-Grand Banks Large Ocean Management Area Ecologically and Biologically Significant Areas.* DFO Canadian Science Advisory Secretariat Research Document 2007/052.

Wareham, V.E. and Edinger, E.N., (2007). *Distribution of deep-sea corals in the Newfoundland and Labrador region, Northwest Atlantic Ocean*, Bulletin of Marine Science 81: 289–313.

Wiese, F.K. and W.A. Montevecchi., (1999). *Marine Bird and Mammal Surveys on the Newfoundland Grand Bank from Offshore Supply Vessels*. Contract Report for Husky Oil Company, St. John's, Newfoundland.

8.4 Assessment References

(DFO website, accessed February 2016 and statement last updated 2013) http://www.dfo-mpo.gc.ca/oceans/management-gestion/integratedmanagement-gestionintegree/seismic-sismique/statement-enonce-eng.asp

AMEC, (2015). ExxonMobil Eastern Newfoundland Exploration Programs (2015-2024) Environmental Assessment.

Amoser, S., and Ladich, F., (2003). *Diversity in noise-induced temporary hearing loss in otophysine fishes*. J. Acoust. Soc. Am. 113, 2170–2179.

Amoser, S., Wyoscki, L. E., and Ladich, F., (2004). *Noise emission during the first powerboat race in an Alpine lake and potential impact on fish communities*. J. Acoust. Soc. Am. 116, 3789–3797.

Bartol, S.M., Musick, J.A. and Lenhardt, M.L., (1999). *Auditory evoked potentials of the loggerhead sea turtle (Caretta caretta).* Copeia 3: 836–840.

Bramford, A.R., Davies, S.J.J.F., and Van Delft, R., (1990). *The effects of model power on boats on waterbirds at Herman Lake, Perth, Western Australia*. Emu. 90:260-265.

CEAA (Canadian Environmental Assessment Agency), (1994). Reference Guide: *Determining Whether a Project is Likely to Cause Significant Adverse Environmental Effects.* In http://www.ceaa.gc.ca/.

CEAA, (2007). Operational Policy Statement: *Addressing Cumulative Environmental Effects under Canadian Environmental Assessment Act*. Original Published March 1999 and Updated in November 2007. In http://www.ceaa.gc.ca/.

CEAA, (2015). Operational Policy Statement: *Determining Whether a Designated Project is Likely to Cause Significant Adverse Environmental Effects under the Canadian Environmental Assessment Act, 2012*. In http://www.ceaa.gc.ca/.

C-NLOPB (Canada-Newfoundland Offshore Petroleum Board), (2012). Geophysical, Geological, Environmental and Geotechnical Program Guidelines (January 2012).

COSEWIC (Committee on the Status of Endangered Wildlife in Canada), (2010). *COSEWIC assessment and status report on the Loggerhead Sea Turtle Caretta caretta in Canada*. Committee on the Status of Endangered Wildlife in Canada. Ottawa. viii + 75 pp.

Davis, R.A., Thomson, D. H., and Malme, C.I., (1998). *Environmental Assessment of Seismic Exploration on the Scotian Shelf*. Prepared for Mobil Oil Canada Properties Ltd., Shell Canada Ltd. and Imperial Oil Ltd. Submitted to the Canada - Nova Scotia Offshore Petroleum Board, Halifax, NS.

Department of Energy & Climate Change (DECC), (2011). *Review and Assessment of Underwater Sound Produced from Oil and Gas Sound Activities and Potential Reporting Requirements under the Marine Strategy Framework Directive.*

DeRuiter, S.L., and Larbi Doukara, K., (2010). *Loggerhead turtles dive in response to airguns [presentation]*. Joint 159th Acoustical Society of America Meeting and Noise-Con 2010. Baltimore, Maryland: 19-23 April 2010.

DFO (Department of Fisheries and Oceans Canada), (2004). *Review of Scientific Information on Impacts of Seismic Sound on Fish, Invertebrates, Marine Turtles and Marine Mammals*. DFO Can. Sci. Advis. Sec. Habitat Status Report 2004/002.

DFO, (2004). *Potential Impacts of Seismic Energy on Snow Crab*. DFO Can. Sci. Advis. Sec. Habitat Status Report 2004/003.

Dooling, R.R. and Therrien, S.C., (2012). *Hearing in Birds: What Changes From Air to Water*. Chapter in: The Effects of Noise on Aquatic Life. Popper, A.N. and A. Hawkins, eds. Advances in Experimental Medicine and Biology, Springer, New York. pp. 77-82.

Dow Piniak W. E., Eckert, S. A., Harms, C. A. and Stringer, E. M., (2012). *Underwater hearing sensitivity of the leatherback sea turtle (Dermochelys coriacea): Assessing the potential effect of anthropogenic noise.* U.S. Dept. of the Interior, Bureau of Ocean Energy Management, Headquarters, Herndon, VA. OCS Study BOEM 2012-01156. 35pp.

Ellis, D.H., Ellis, C.H., and Mindell, D.P., (1991). *Raptor Responses to Low-Level Jet Aircraft and Sonic Booms.* Environmental Pollution. 74:53-83.

Engås. A., Løkkeborg, S., Ona, E. and Soldal, A.V., (1996). *Effects of seismic shooting on local abundance and catch rates of cod (Gadus morhua) and haddock (Melanogrammus aeglefinus).* Canadian Journal of Fisheries and Aquatic Sciences.

Evans, M.I., Symens, P. and Pilcher, C., (1993). *Short-term damage to coastal bird populations in Saudi Arabia and Kuwait following the 1991 Gulf War.* Marine Pollution Bulletin. 22: 157-161.

Gjerdrum, C., Fifield, D.A., and Wilhelm, S.I., (2012). *Eastern Canada Seabirds at Sea (ECSAS) standardized protocol for pelagic seabird surveys from moving and stationary platforms*. Canadian Wildlife Service Technical Report Series No. 515. Atlantic Region. vi + 37 pp. Finneran, J. J. and Jenkins, A. K. (2012). *Criteria and Thresholds for US Navy Acoustic and Explosive Effects Analysis.* Technical Report.

Godley, B.J., Almeida, A., Barbosa, C., Broderick, A.C., Catry, P.X., Hays, G.C. and Indjai, B., (2003). *Using satellite telemetry to determine post-nesting migratory corridors and foraging grounds of green turtles nesting at Poilao, Guinea Bissau: Report to project donors.* Unpublished Report, Marine Turtle Research Group, School of Biological Sciences, University of Wales Swansea, Swansea SA2 8PP, UK. www.seaturtle.org/mtrg.

Hawkins A.D., Roberts L., Cheesman S., (2014). *Responses of free living coastal pelagic fish to impulsive sounds*. Journal of the Acoustic Society of America. 135:3101–3116. doi:10.1121/1.4870697.

Hawkins, A.D., (1993). *Underwater sound and fish behaviour.* In: Pitcher, T.J. (Ed). The behaviour of teleost fish, 2nd Edition. Groom Helm Ltd, Kent. 114 – 149.

Hegmann, G., Lloyd, K. and Donihee, J., (1999). *Review of Policy Issues for the Practice of Cumulative Effects Assessments in Canada's North: A Discussion Paper (preliminary draft)*. Ottawa: Natural Resources Canada, 1999.

Kenchington, E.L.R., Prena, J., Gilkinson, K.D., Gordon Jr., D.C., MacIsaac, K., Bourbonnais, C., Schwinghamer, P.J., Rowell, T.W., McKeown, D.L., and Vass, W.P., (2001). *Effects of experimental otter trawling on the macrofauna of a sandy bottom ecosystem on the Grand Banks of Newfoundland.* Canadian Journal of Fisheries and Aquatic Sciences. 58: 1043-1057.

Komenda-Zehnder, S., Cevallos, M., Bruderer, B., (2003). *Effects of Disturbance by aircraft overflight on waterbirds – an experimental approach* (ISSC26/WP-LE2). Warsaw, Poland: International Bird Strike Committee.

Lacroix, D.L., Lanctot, R.B., Reed, J.A., and McDonald, T.L., (2003). *Effect of underwater surveys on molting male Long-tailed Ducks in the Beaufort Sea, Alaska*. Canadian Journal of Zoology. 81:1862-1875.

Ladich F. and Fay R. R. (2012). *Auditory evoked potential audiometry in fish*. Rev Fish Biol Fisheries (2013) 23:317–364.

Lenhardt, M.L., (1994). *Seismic and very low frequency sound induced behaviours in captive loggerhead marine turtles (Caretta caretta).* Pages 238-241 in K.A. Bjorndal, A.B. Bolten, D.A.

Johnson, and P.J. Eliazar, eds. Proceedings of the Fourteenth Annual Symposium on Sea Turtle Biology and Conservation. NOAA Technical Memorandum NMFS-SEFSC-351.

LGL (LGL Limited), (2013). Suncor Energy's Eastern Newfoundland Offshore Area 2D/3D/4D Seismic Program, 2014-2024 Environmental Assessment. Report Prepared for Canada-Newfoundland Offshore Petroleum Board, St. John's, NL.

Løkkeborg, S., Fernö, A., Humborstad, O. B., (2010) *Fish behaviour in relation to longlines. In: He P (ed) Behavior of marine fishes: capture processes and conservation challenges.* Wiley, Oxford, pp 105–141

McCauley, R.D. Fewtrell, J., Duncan, A.J., Jenner, C., Jenner, M-N., Penrose, J. D., Prince, R.I.T., Adhitya, A., Murdoch, J and McCabe, K., (2000). *Marine seismic surveys — a study of environmental implications.* APPEA 40:692–708.

McCauley, R.D., Fewtrell, J. and Popper, A.N., (2003). High intensity anthropogenic sound damages fish ears. J. Acoust. Soc. Am. 113(1): 638-642.

National Environmental Research Institute (NERI), (2011). *Underwater noise from the drillship Stena Forth in Disko West, Baffin Bay, Greenland*. NERI Technical Report, No. 838.

National Science Foundation. (2011). Programmatic Environmental Impact Statement/ Overseas Environmental Impact Statement for Marine Seismic Research Funded by the National Science Foundation or conducted by the U.S Geological Survey.

NDE, (2016). In https://www.nde-ed.org/EducationResources/CommunityCollege/Ultrasonics/Physics/attenuation.htm.

Oil and Gas Producers (OGP), (2011). *An overview of marine seismic survey operations.* Report No. 448. April 2011.

Pearson, W.H., Skalski, J.R., Malme, C.I., (1992). *Effects of sounds from a geophysical survey device on behaviour of captive rockfish (Sebastes sp).* Canadian Journal of Fisheries and Aquatic Sciences. 49: 1343–56.

Peña, H., Handegard, N.O., and Ona, E., (2013). *Feeding herring schools do not react to seismic airgun surveys*. – ICES Journal of Marine Science, doi.10.1093/icesjms/fst079.

Popper, A. N., and Clarke, N. L., (1976). *The auditory system of the gold- fish Carassius auratus: Effects of intense acoustic stimulation.* Comp. Biochem. Physiol. A 53A, 11–18.

Popper, A.N. and M.C. Hastings. (2005). *Effects of sound on fish*. Prepared for Jones & Stokes, Sacramento, CA, for California Dept. Transportation, Sacramento, CA.

Popper, A.N. and Hastings M.C.,(2009). *The effects of human-generated sound on fish*. Integrated Zoology 4(1): 43-52.

Popper, A.N., Hawkins A.D., Fay, R.R., Mann, D.A. Bartol, S., Carlson, T.J., Coombs, S., Ellison, W.T., Gentry, R.L. Halvorsen, M.B., Lokkebeborg, S., Rogers, P.H., Southall, B.L, Zeddies, D.G., Tavolga, W.N., (2014). ASA S3/SC1.4 TR-2014 *Sound Exposure Guidelines for Fishes and Sea Turtles,* SpringerBriefs in Oceanography, DOI 10.1007/978-3-319-06659-2_1, Acoustical Society of America 2014.

Richardson, W.J., Greene, C.R. Jr., Malme, C.I. & Thomson, D.H., (1995). *Marine mammals and noise. Academic Press, San Diego. Section 2.11.4.*

Ridgway, S. H., Wever, E. G., McCormick, J. G., Palin, J. and Anderson, J. H., (1969). *Hearing in the giant sea turtle, Chelonia mydas.* Proc. Natl. Acad. Sci. 64, 884-890.

Saetre, R. and Ona, E., (1996). *Seismike undersøkelser og på fiskeegg og -larver en vurdering av mulige effecter pa bestandsniva. [Seismic investigations and damages on fish eggs and larvae; an evaluation of possible effects on stock level].* Fisken og Havet 1996:1-17, 1-8. (Norwegian, with English summary - full translation not published).

Scholik, A. R., and Yan, H. Y., (2001). *Effects of underwater noise on auditory sensitivity of a cyprinid fish*. Hear. Res. 152, 17–24.

Schummer, M.L. and Eddleman, W.R., (2003). *Effects of disturbance on activity and energy budgets on migrating waterbirds in south-central Oklahoma*. Journal of Wildlife Management, 67 (4), 789.

Henrik, S. and Durinck, J., (2001). *Seabird attraction to fishing vessels is a local process*. Marine Ecology Progress Series. 214, 289 -298

Slabbekoorn, H., Bouton, N., van Opzeeland, I., Coers, A., Cate, C., and Popper, A.N., (2010). *A noisy spring: the impact of globally rising underwater sound levels on fish.* Trends Ecol. Evol. 25, 419 –427. (doi:10. 1016/j.tree.2010.04.005.

Slotte, A., Hansen, K., Dalen, J., and Ona, E., (2004). A*coustic mapping of pelagic fish distribution and abundance in relation to a seismic shooting area off the Norwegian coast*. Fisheries Research. 67:143-150.

Smith, M. E., Kane, A. S., and Popper, A. N., (2004a). *Noise-induced stress response and hearing loss in goldfish Carassius auratus.* J. Exp. Biol. 207, 427–435.

Smith, M. E., Kane, A. S., and Popper, A. N., (2004b). *Acoustical stress and hearing sensitivity in fishes: Does the linear threshold shift hypothesis hold water?* J. Exp. Biol. 207, 3591–3602.

Southall, B.L., Bowles, A.E., Ellison, W.T., Finneran, J.J., Gentry, R.L., Greene, C.R. Jr. and Tyack, P.L., (2007). *Marine mammal noise exposure criteria: Initial scientific recommendations.* Aquatic Mammals. 33(4):411-521.

Stemp, R., (1985). *Observations on the effects of seismic exploration on seabirds. In Proceedings of the Workshop on the Effects of Explosives Use in the Marine Environment, 29–31 January 1985.* Edited by G.D. Greene, F.R. Engelhardt, and R.J. Paterson. Tech. Rep. 5, Canada Oil and Gas Lands Administration, Environmental Protection Branch, Ottawa, Ont. pp. 217–231.

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

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

Swan, J., Neff, J. & Young, P., (1994). *Environmental implications of offshore oil and gas development in Australia: The findings of an independent scientific review.* Australian Petroleum Exploration Association, Sydney.

The Engineering Toolbox, (2016). In http://www.engineeringtoolbox.com/sound-frequency-wavelength-d_56.html.

Turnpenny, W.H. & Nedwell J. R., (1994). *The Effects on Marine Fish, Diving Mammals and Birds of Underwater Sound Generated by Seismic Surveys.* Consultancy Report proposed for UKOOA by Fawley Aquatic Research Laboratories Ltd.

UNSW, (2016). In http://www.animations.physics.unsw.edu.au/jw/dB.htm.

Webb, J. F., Popper, A. N and Fay, R. R., (2008). *Fish Bioacoustics.*

Weilgart, L.S., (2007). *The impacts of anthropogenic ocean noise on cetaceans and implications for management.* Canada Journal of Zoology, 85, 1091 – 1116.

Weir, C.R., (2007). *Observations of marine turtles in relation to seismic airgun sound off Angola.* Marine Turtle Newsletter 116:17-20. Internet website: http://www.seaturtle.org/mtn/archives/mtn116/mtn116p17.shtml.

Wright, A.J., Aguilar Soto, N., Baldwin, A.L., Bateson, M., Beale, C.M., Clark, C., Deak, T., Edwards, E.F., Fernandez, A., Godinho, A., Hatch, L.T., Kakuschke, A., Lusseau, D., Martineau, D., Romero, L.M., Weilgart, L.S., Wintle, B.A., Notarbartolo-di-Sciara, G. & Martin, V. (2007). *Do Marine*

Mammals Experience Stress Related to Anthropogenic Noise? International Journal of Comparative Psychology. **20:** 74 – 316.

8.5 Cumulative Effects References

Hannay, D., MacGillivary, A., Laurinolli, M., and Racca, R., (2004). *Source Level Measurements from 2004 Acoustics Programme.* p66, Sakhalin Energy, 2004.

Contents

Appendix A – Supporting Environmental Baseline Data

The following environmental baseline data provides the background ecological and distribution information relating to key species within the Project Area to support Section 4.

Table A.1. Overview of Some Key Invertebrate Species in the Study Area (Christian et al., 2010, and individually noted sources). Summarised from the Offshore Newfoundland SEA (C-NLOPB, 2014)

Species	Ecology	Distribution and Importance in Study Area
Amphipods (*Amphipoda*)	• Spawning occurs throughout the year (*Sheader, 1983*). • Feeding modes vary and include scavenging, predation and grazing (*Duffy and Hay, 1991*). • Preyed upon by commercially important groundfish species including American plaice and yellowtail flounder (*Pitt, 1976*).	• Distributed on silt, sand and gravel substrates on the Grand Bank (*Houston and Haedrich, 1984*). • Not commercially significant in the region. • Important prey for larval fish species.
Atlantic surf clam (*Spisula solidissima*)	• Spawns in summer to early fall when water temperatures reach 12-15 degrees Celsius. • Larvae settle on sand substrates. • Suspension feeders. • Preyed upon by rock crabs, seastars, hermit crabs, moon snails, whelks and various groundfish including cod, flounder, sculpin and ocean pout.	• Distributed in the northwest Atlantic Ocean along the continental shelf from southern Gulf of St. Lawrence to North Carolina. • Occurs at depths from the subtidal zone to less than 50 metres. • High abundance along the eastern edge of the Grand Banks (*Ollerhead et al., 2004*). • Commercially significant species (refer to Section 4.9.1).
Basket star (*Gorgonocephalus arcticus*)	• Primarily feeds on euphausiids (*Emson et al., 1991).* • Associated with deep sea corals (*Rosenberg et al., 2005*).	• Dominated otter trawl sampling on sandy areas of the Grand Bank (*Prena et al., 1999*). • At subtidal depths greater than 1200 metres. (*Gosner. 1979*). • Not commercially significant in region.
Brittlestar (*Ophiuroidea*)	• Undergo asexual and sexual reproduction. • Larvae settle during late July to early August. • Feeds on small crustaceans, polychaetes and detritus. • Important prey species for lobster and American plaice.	• Comprised of several species of brittle star. • Generally occurs from the Arctic to Cape Cod in the intertidal zone to depths greater than 300 metres. • Not commercially significant in region.

Species	Ecology	Distribution and Importance in Study Area
Hooded shrimp (*Cumacea*)	• Preyed upon by American plaice, yellowtail flounder and cod (*Bruno et al., 2000; Pitt, 1973).* • Spawning varies depending on the species. As a group spawning times range from February to December (*Corey, 1981*).	• Distributed from Newfoundland to Cape Cod (*Gosner, 1979*). • Common on gravel and sand substrates on the Grand Bank (*Houston and Haedrich, 1984*). • Not commercially significant in the region.
Icelandic scallops (*Chlamys islandica*)	• Spawning in Newfoundland from April to May. • Planktonic larvae remain in the water column for ten weeks before settling. • Spat settle primarily between August and November at depths of 10 to 15 metres. • Spat settle in deep offshore areas. • Suspension feeders on phytoplankton.	• Distributed in the northwest Atlantic Ocean. • Occurs in depth ranges from subtidal depths to 180 metres. • Occur generally in depths greater than 55 metres on variable hard substrates. • Icelandic scallops are associated with gravel and cobble substrates on the Grand Bank. • Commercially significant species (refer to Section 4.9.1
Jellyfish (*Scyphozoa*)	• Planulae larvae appear during early to mid spring. • Major predator of fish eggs and larvae.	• Occur inshore and offshore. • Commonly captured during plankton tows on the Grand Bank (*LGL., 2012*). • Main species captured include *Cyanea capillata* and *Aurelia aurita*. • Not commercially significant in region.
Northern shrimp (*Pandalus borealis*)	• Spawns once a year around late June or early July. • During late summer, fertilized eggs are attached to the female's abdomen. • The eggs hatch the following spring and summer. • Feeds on polychaetes, small crustaceans, detritus, marine plants, copepods and euphausiids. • Prey for Greenland halibut, Atlantic halibut, cod redfish and harp seals.	• Most abundant shrimp species in Newfoundland. • Concentrated in the northeast portions of the Study Area, at the edge of the continental shelf and in the Flemish Pass. • Distributed from west Greenland to Georges Bank. • Occupies areas with mud and silt substrates in temperature ranges from one to six degrees Celsius. • Northern shrimp was the most commonly observed species in 3NLOPs area from RV surveys. • Northern Shelf Assemblage. • Commercially significant species (refer to Section 4.9.1). • Important forage species.
Pale sea urchin (*Strongylocentrotus pallidus*)	• Feeds on epibiotics on stones, infaunal meiobenthos and detritus (*Bluhm et al., 1998*). • Preyed upon by commercially important groundfish species including American plaice (*Gilkinson et al., 1998*).	• High abundance on sandy bottoms of the Grand Bank (*Kenchington et al., 2001*). • Distributed in deep waters up to depths of 1600 metres (*Bluhm et al., 1998).* • Found on a mixture of cobble and sand substrates (*Gilkinson et al., 1998).* • Dominant sea urchin at depths greater than 60 metres (*Gilkinson et al., 1998).* • Not commercially significant in the region.
Polychaete worms (*Polychaeta*)	• Spawning for *P. steenstrupi* occurs between May-August (*Lacalli, 1981*). • Polychaetes are important prey species for a variety of invertebrates and	• Important component of marine benthic communities on the Grand Bank (*Kenchington et al., 2001*). • Most common polychaete species

Species	Ecology	Distribution and Importance in Study Area
	groundfish.	observed at 120-146 metres on the Grand Bank was *Prionospio steenstrupi* (*Kenchington et al., 2001*). • Distributed throughout the North Atlantic including the Grand Banks at depths greater than 50 metres. • Common on silt substrates on the Grand Bank (*Houston and Haedrich, 1984*). • Not commercially significant in region.
Propellor clam (*Cyrtodaria siliqua*)	• Population dominated by older individuals to ages exceeding 100 years (*Kilada et al 2009*). • Prey species of American plaice and Atlantic wolfish (*Templeman, 2007*).	• High abundance on sandy bottoms of the Grand Bank (*Kenchington et al., 2001*). • Commercially significant species (refer to Section 4.9.1).
Sand dollar (*Echinarachnius parma*)	• Spawning occurs in late spring to early summer. • Preyed upon by American plaice (*Bruno et al., 2000*). • Stomach gut contents include diatoms, sand grains, sponge spicules and detritus.	• Distributed in the northwest Atlantic Ocean from Labrador to North Carolina. • Occurs mainly on sandy substrates at depths ranging from shallow waters to greater than 800 metres. • Burrows in soft substrates and reaches densities of 100 individuals per square metre. • High abundance on sandy bottoms of the Grand Bank (*Kenchington et al., 2001*). • Important food source for commercially important groundfish species.
Sea anemones (*Actiniaria*)	• Feed on echinoderms and other invertebrates. • Have planktonic larvae.	• Commonly observed during the 2005-2011 DFO RV surveys of the Orphan Basin (*LGL, 2012*). • Variety of species found on the Grand Bank. • Not commercially significant in Region.
Sea scallop (*Placopecten magellanicus*)	• Sea scallops spawn from September to October in Newfoundland triggered by a rise in water temperature. • Large females are able to produce over a hundred million eggs each. • Planktonic larvae remain in the water column for four weeks before settling. • Suspension feeders on phytoplankton.	• Distributed in the northwest Atlantic Ocean from Labrador to North Carolina. • Occurs in shallow depths of greater than 20 metres in the northern part of its range on sand, gravel and pebble substrates. • Commercially significant species (refer to Section 4.9.1).
Sipunculan worms (*Sipuncula*)	• Many species are generally deposit feeders (*McMahon et al., 2006*). • Spawning times vary between species. • Preyed upon by groundfish and other invertebrates.	• Common on sand substrates on the Grand Bank *(Houston and Haedrich, 1984*). • Burrowing worms found on sandy-mud to coral-rock substrates (*Gosner, 1979*). • Not commercially significant in Region.
Snow crab (*Chionoecetes opilio*)	• Fertilized eggs are attached to the hairs on the female's pleopods. • Eggs are carried for 12 to 27 months. • Eggs hatch during the peak phytoplankton bloom between April and June. • Larvae feed on microplankton. • Feeds on polychaetes, bivalves, echinoderms and fish carcasses.	• Concentrations occur in the colder waters of the northern slopes of the Grand Banks and Flemish Pass as well as in northern portions of the Newfoundland Shelf. • Distributed in the northwest Atlantic Ocean from Greenland to the Gulf of Maine. • Occupies on soft bottoms at depth

Species	Ecology	Distribution and Importance in Study Area
	• Various groundfish, other snow crabs and seals prey on snow crabs.	ranges from 60-400 metres and temperature ranges from -1 to 6 degrees Celsius. • Commonly observed species in 3NLOPs from RV surveys. • Commonly observed during the 2005-2011 DFO RV Surveys of the Orphan Basin (*LGL, 2012*). • Dominated otter trawl sampling on sandy areas of the Grand Bank (*Prena et al., 1999*). • Cold Shelf Assemblage. • Commercially significant species (refer to Section 4.9.1).
Sponges (*Geodia* sp.)	• In Scandinavia, *G. barretti* undergoes sexual reproduction and releases gametes 1-2 periods per year (*Spetland et al., 2007*). • Gamete release coincides with phytoplankton blooms (*Spetland et al., 2007).*	• Commonly observed during the 2005-2011 DFO RV Surveys of the Orphan Basin (*LGL, 2012*). • Variety of species found on the Grand Bank. • The most dominant species observed on sponge grounds on the Grand Bank, Flemish Cap and Flemish Pass (*Murillo et al., 2012*). • Not commercially significant in region.
Striped pink shrimp (Pandalus *montagui)*	• Eggs are laid between November and January and hatch by the end of April (*Allen, 1963*). • In pelagic waters, it feeds mainly on copepods. At benthic depths, it feeds on polychaetes and foraminiferans (*Hudon et al., 1992*). • Prey for Greenland halibut, Atlantic halibut, cod, redfish and harp seals.	• Striped pink shrimp are distributed primarily in the northern parts of the Study Area, but compared to Northern shrimp they are found in greater abundance in coastal areas and on the Grand Banks. • Undergoes vertical migrations in association with pelagic feeding (*Hudon et al., 1992*). • Northern Shelf Assemblage. • Commercially significant species (refer to Section 4.9.1). • Important forage species.
Whelk (*Buccinum* sp.)	• Copulates from May to July. • Fertilized eggs are laid approximately two to three weeks after copulation. • Eggs are enclosed in masses that may contain about 340,000 developing embryos. • Feeds on urchins, polychaetes, amphipods, crustaceans and fish eggs. Also known to feed on animal carcasses. • Preyed upon by lobsters, cod, crabs, seastars and dogfish.	• Distributed throughout the northwest Atlantic Ocean from Labrador to New Jersey. • Common in cold waters from tidal levels to depths of 180 metres. • Common in otter trawl sampling on sandy areas of the Grand Bank (*Prena et al., 1999*). • Commercially significant species (refer to Section 4.9.1).
Sponges (*Geodia sp.)*	• Commonly observed during the 2005 to 2011 DFO RV Surveys of the Orphan Basin (*LGL, 2012*). • In Scandinavia, *G. barretti* undergoes sexual reproduction and releases gametes 1-2 periods per year (*Spetland et al., 2007*). • Gamete release coincides with phytoplankton blooms *(Spetland et al.,*	• Variety of species found on the Grand Bank. • The most dominant species observed on sponge grounds on the Grand Bank, Flemish Cap and Flemish Pass (*Murillo et al., 2012*).

Species	Ecology	Distribution and Importance in Study Area
	2007).	
Jellyfish *(Scyphozoa)*	• Main species captured include Cyanea capillata and Aurelia aurita. Major predator of fish eggs and larvae	• Planulae larvae appear during early to mid spring. Occur inshore and offshore. • Commonly captured during plankton tows on the Grand Bank *(LGL, 2012*).
Brittlestar *(Ophiuroidea)*	• Comprised of several species of brittle star. • Undergo asexual and sexual reproduction. • Larvae settle during late July to early August. • Feeds on small crustaceans, polychaetes and detritus.	• Important prey species for lobster and American plaice. • Generally occurs from the Arctic to Cape Cod in the intertidal zone to depths greater than 300 metres.
Basket star *(Gorgonocephalus arcticus)*	• Primarily feeds on euphausids *(Emson et al., 1991).* • Associated with deep sea corals *(Rosenberg et al., 2005*).	• Dominated otter trawl sampling on sandy areas of the Grand Bank (*Prena et al., 1999).* • At subtidal depths to greater than 1200 metres. (*Gosner, 1979*).
Sand dollar *(Echinarachnius parma)*	• Burrows in soft substrates and reaches densities of 100 individuals per square metre. • Spawning occurs in late spring to early summer. • Preyed upon by American plaice (*Bruno et al., 2000*). • Stomach gut contents include diatoms, sand grains, sponge spicules and detritus.	• High abundance on sandy bottoms of the Grand Bank *(Kenchington et al., 2001*). • Distributed in the northwest Atlantic Ocean from Labrador to North Carolina. • Occurs mainly on sandy substrates at depths ranging from shallow waters to greater than 800 metres.
Sea anemones *(Actiniaria)*	• Feed on echinoderms and other invertebrates. • Have planktonic larvae.	• Commonly observed during the 2005 to 2011 DFO RV surveys of the Orphan Basin (*LGL, 2012*). • Variety of species found on the Grand Bank.

Table A.2. Overview of the Key Groundfish Species in the SEA Area (Scott and Scott, 1988, and individually noted sources). Summarised from the Offshore Newfoundland SEA (C-NLOPB, 2014)

Species	Ecology	Distribution and Importance in Study Area
American plaice *(Hippoglossoides platessoides*)	• Spawning occurs in spring, beginning early April on the Flemish Cap and Late April on the Grand Bank. • Eggs float near the surface and drift widely from their point of origin. • Time to hatching depends on water temperature in the surface layers, but at five degrees Celsius hatching occurs in 11 to 14 days. • EBSA sites Southeast Shoal and Tail of the Banks and Virgin Rocks are spawning areas for American plaice (*Templeman, 2007*). • Feeds on polychaetes, echinoderms, molluscs, crustaceans and fish.	• Usually considered a coldwater species, with a preference for temperatures from just below 0 to 1.5 degrees Celsius and a depth range of 90 to 250 metres. • Occurs on both sides of the Atlantic, can tolerate lowered salinities and have been reported in salinities as low as 20 to 22 ppt. • Commonly observed species in 3NLOPs from RV surveys. • Widely distributed on the shelf. • Widespread Shelf Assemblage. • Applicable Designatable units: Division 3LNO, Division 3Ps and Division 2J3K (*DFO, 2012*). • Has COSEWIC status (Newfoundland and

Species	Ecology	Distribution and Importance in Study Area
		Labrador Population). • Commercially significant species (refer to Section 4.9.1).
Atlantic cod (*Gadus morhua*)	• Over the whole Canadian Atlantic region, spawning begins in the north as early as February and ends in the south as late as December. • Due to the fact that cod spawn over such a large area, it is difficult to generalize about specific conditions. • The depth at which cod spawn varies according to the particular stock, locality, and temperature and can vary from 110 to 182 metres. • Cod are broadcast spawners and fertilized eggs drift toward nursery areas in surface currents. • EBSA sites Southeast Shoal and Tail of the Banks and Virgin Rocks are spawning areas for Atlantic cod (*Templeman, 2007*).	• Occurs on both sides of the North Atlantic. • Found in cool-temperature to subarctic waters from inshore regions to the edge of the continental shelf. • Depth of habitat is usually related to temperature; cool temperatures are preferred, in 0.5 to10 degrees Celsius range. • Cod occur throughout the Canadian Atlantic Area, and each region has unique stocks. • Juveniles are found in greater abundance in inshore areas (*Gregory and Anderson, 1997*). • Commonly observed species in 3NLOPs from RV surveys. • Widespread Shelf Assemblage. • Applicable Designatable unit: Newfoundland and Labrador • Has COSEWIC (Newfoundland and Labrador Population) status. • Commercially significant species (refer to Section 4.9.1). • Culturally and ecologically important species.
Atlantic halibut (*Hippoglossus hippoglossus*)	• Spawning grounds of the Atlantic halibut are not clearly defined. • Fertilized eggs are slightly positively buoyant so that they naturally disperse and only gradually float toward the ocean's surface. • Once hatched, the developing larvae live off their yolk for the next six to eight weeks while their digestive system develops so they can begin feeding on zooplankton. • Feeds on polychaetes, molluscs, crustaceans and fish.	• The largest of the flat fishes, and typically found along the slopes of the continental shelf. • Atlantic halibut move seasonally between deep winter waters and the shallow waters of the Gulf where they feed. • The migration allows them to avoid temperatures below 2.5 degrees Celsius. • Found almost exclusively in the spring in the Southwest Shelf Edge and Slope EBSA. • Warm Southern Shelf Assemblage. • Commercially significant species (refer to Section 4.9.1).
Atlantic wolffish (*Anarhichas lupus*)	• Shows a wide variability in time and place of spawning. • Demersal eggs. • Feeds mainly on bottom invertebrates including crustaceans and echinoderms (*Simpson et al 2012; 2013).* • Spring surveys indicated that Atlantic wolffish are concentrated in EBSA site Southeast Shoal and Tail of the Banks (*Templeman, 2007).*	• Occurs on both sides of the North Atlantic Ocean. • Commonly an inhabitant of deep water along the shelf (*Dutil et al., 2010*). • In the Newfoundland area, it occurs over a variety of substrates at depths of less than 100-400 metres and bottom temperatures of -0.5 to 6.5 degrees Celsius *(Kulka et al., 2004; Simpson et al., 2012).* • Warm Southern Shelf Assemblage. • Has SARA and COSEWIC status. • Not commercially significant in the region, however may be retained and sold in some areas.
Barndoor skate (*Dipturus laevis*)	• Spawning likely takes place during winter months. • Eggs are laid in large yellowish egg capsules. • Feeds on bivalves, squid, rock crabs, lobster,	• Found on a variety of substrates from shoals to depths of 750 metres. Common at depths of 50-150 metres *(COSEWIC, 2010).* • Preferred temperature range is 3-13

Species	Ecology	Distribution and Importance in Study Area
	shrimp and polychaetes.	degrees Celsius. • Migrates offshore to seek cool temperatures • High catch rates of this species in Southeast Shoal and Tail of the Banks EBSA (*Kulka et al., 2002; Templeman, 2007*). • Warm Southern Shelf Assemblage.
Black dogfish (*Centroscyllium fabricii*)	• Fertilized eggs develop within the brood chamber of the female. • Feeds mainly on squid, crustaceans, jellyfish and small redfish.	• Small, deepwater shark occurring near bottom, at times forming schools. • Usually occurring at depths of 350 to 500 metres in Canadian waters (*Kulka, 2006*). • Bottom temperatures where most captures have occurred were 3.5 to 4.5 degrees Celsius. • Deep Demersal Assemblage. • Not commercially significant in the region.
Blue hake (*Antimora rostrata*)	• Little is known about the reproductive phase of this species. Blue hake may spawn in Canadian waters though it has not been confirmed *(Kulka et al., 2003).* • Feeds on benthic invertebrates including crustaceans and squids.	• Benthopelagic species associated with mud bottoms. • Distributed in slope waters along the eastern Grand Bank at depths greater than 1400m (*Kulka et al .,2003*). • Bottom temperatures where most captures have occurred were three to 4.5 degrees Celsius (*Kulka et al., 2003*). • Deep Demersal Assemblage. • Not commercially significant in the region.
Cusk (*Brosme brosme*)	• Reproductive biology not known for the northwest Atlantic. • Larvae are pelagic until they reach about 50 mm, after which they seek bottom areas. • Feeds on fish, crustaceans, molluscs and echinoderms (*Bowman et al., 2000*). • Monotypic species.	• Lives on hard, rough or rocky bottom, preferring relatively warm water and intermediate depths. • Found in moderately deep water on both sides of the North Atlantic. • In the Canadian region more common on southwestern Scotian Shelf and Slope and Fundian Channel. • Warm Southern Shelf Assemblage • Has COSEWIC status. • Not commercially significant in the region.
Greenland halibut (*Reinhardtius hippoglossoides)*	• These halibut are believed to spawn in Davis Strait during the winter and early spring at depths ranging from 650 to 1,000 metres. • The large fertilized eggs are benthic but the hatched young move upwards in the water column and remain at about 30 metres below surface until they attain an approximate length of 70 millimetres. • As they grow, the young fish move downward in the water column and are transported by the currents in the Davis Strait southward to the continental shelf and slopes of Labrador and Newfoundland. • Bathypelagic predator that feeds on capelin, Atlantic cod, polar cod, roundnose grenadier, redfishes, sand lance, shrimp, squid and other benthic invertebrates.	• A deepwater flatfish species that occurs in water temperatures ranging from -0.5 to six degrees Celsius but appears to have a preference for temperatures of 0 to 4.5 degrees Celsius. • Occupies an extensive depth range from 200m to 2200 metres. • Unlike many flatfishes, the Greenland halibut spends considerable time in the pelagic zone (*Morgan et al., 2013*). • Distributed across areas of the Grand Bank and Flemish Pass (*Morgan et al., 2013).* • Aggregates in Northeast Shelf and Slope EBSA in the spring (*Templeman, 2007*). • Deep Demersal Assemblage. • Commercially significant species (refer to Section 4.9.1).
Haddock (*Melanogrammus aeglefinus*)	• Generally haddock spawning on the Grand Banks begins in March and continues through to August or September. Spawning peaks in March.	• Found in southwest Newfoundland and St. Pierre Bank. • High concentrations observed in the Southwest Slope of the Grand Banks EBSA

Species	Ecology	Distribution and Importance in Study Area
	• Pelagic eggs and larvae. Larvae seek the bottom once they reach about 50 mm. • Haddock on the Grand Banks primarily spawn in Southwest Shelf Edge and Slope EBSA (*Templeman, 2007*). • Bottom feeding fishes that consume crustaceans, molluscs, echinoderms, polychaetes and fish.	(*Templeman, 2007*). • Found in water depths of 27 to 366 metres and prefer temperatures of one to 13 degrees Celsius. • Occurs in a variety of habitats; juveniles have higher survival rates when they settle on sand or gravel bottoms. • Commercially significant species (refer to Section 4.9.1).
Longfin hake (Physis chesteri)	• On the Grand Bank and Flemish Pass, spawning is estimated to take place between fall and winter. • Larvae and juveniles remain pelagic during winter and spring. • Juveniles and larvae are preyed upon by white hake and cod. • Feeds mainly on shrimp, euphausiids and amphipods. Also known to feed on vertically migrating fishes including lanternfish and hatchetfish.	• Deepwater species that occupies a depth range of 160-1290 metres. • Occurs along Labrador to the southern edge of the Grand Bank. • Commonly observed species in 3NLOPs from RV surveys. • Warm Deep Offshore Shelf Assemblage. • Not commercially significant in the region.
Longnose eel (*Synaphobranchus kaupi*)	• Spawns during summer months.	• Occurs on both sides of the North Atlantic Ocean to South Atlantic Ocean, in the Pacific Ocean and Gulf of Mexico. • Bottom-dwelling fish occurring in deep water between 240-3650 metres. • Commonly observed in the Grand Bank and Eastern Offshore SEA Area (*Baker et al., 2012; LGL, 2012*). • Deep Demersal Assemblage. • Not commercially significant in the region.
Marlin-spike (*Nezumia bairdi*)	• Information on reproduction is sparse, but the species most likely spawns in summer and autumn. • Assumed to be a long-lived, slow growing species. • Feeds on benthic euphausiids and amphipods. • Preyed upon by swordsfish.	• A benthic species, usually living on mud bottoms. • It has been caught at depths of 16 to 2285 metres but was found to be most abundant off Newfoundland in 183 to 732 metres. • Its distribution in the western Atlantic occurs in deeper parts of the Gulf of St. Lawrence; in the Bay of Fundy; from the southwestern Grand Bank; banks of the Scotian Shelf; and southward along the continental slope of the West Indies. • Bottom temperatures where marlin-spike have been found range between three and eight degrees Celsius. • Commonly observed species in 3NLOPs from RV surveys. • Deep Demersal Assemblage. • Not commercially significant in the region.
Monkfish (*Lophius americanus*)	• Spawning occurs from June to September in Canadian waters. • Larvae hatch on the surface and descend to the bottom where they seek protection among algae-covered rocks. • Feeds on fish including herring, sand lance, smelt, cod, haddock, cunner, sculpin, flounder, skates and invertebrates including crab, squid, molluscs, echinoderms and polychaetes.	• Bottom-dwelling sluggish fish living over a variety of substrates, from tideline down to 668 metres. • Tolerates a wide variety of temperature, 0 to 21 degrees Celsius. Common in areas greater than four degrees Celsius (*Kulka and Miri, 2001*). • Research shows that they invade shallow waters of the banks in summer and migrate to deeper waters in winter. Associated with deep waters along the western Grand Bank

Species	Ecology	Distribution and Importance in Study Area
		(*Gomes et al., 1992*). • High concentrations observed in the Southwest Shelf Edge and Slope EBSA (*Templeman, 2007*). • Warm Southern Shelf Assemblage • Commercially significant species (refer to Section 4.9.1).
Northern Sand Lance (*Ammodytes dubius*)	• On the Scotian Shelf spawning occurs from November to March. Spawning peaks from December to January. • Aggregate on the Southeast Shoal and Tail of the Banks EBSA to spawn. • Larvae are planktonic until they reach 35 mm, after which they seek bottom areas. • Burrows in substrate during part of the day and undertakes short vertical feeding migrations. • Feeds mainly on copepods and other planktonic organisms. • Important forage species that are prey for a variety of fish, birds and mammals.	• Occurs on sandy or fine gravel bottoms at offshore depths less than 91 metres. • Inhabit localized areas. • High densities observed on the eastern and South East Shoal of the Grand Bank. • Shelf Edge Assemblage. • Not commercially significant in the region. • Important forage fish species.
Northern wolffish (*Anarhichas denticulatus*)	• Information on reproduction is limited. • Critical spawning habitats have not been identified. • Pelagic larvae. • Feeds mainly on euphausiids, shrimp, and American plaice and redfish *(Simpson et al., 2012; 2013).*	• Occurs in Arctic and Atlantic Oceans. • The preferred temperature of wolffish is less than -0.8 to seven degrees Celsius (*Simpson et al., 2012*). • Found in deep waters (150 to 1000 metres) on the Grand Bank and Flemish Cap in the spring and fall (*Simpson et al., 2012*). • Grand Bank Shelf Assemblage. • Has SARA and COSEWIC status. • Not commercially significant in the region. • Mandatory live-release when captured as bycatch.
Pollock (*Pollachius virens*)	• On Burgeo and St. Pierre Banks, pollock of various stages of maturity are encountered during surveys indicating spawning. • An average female produces approximately 225 000 pelagic eggs. • Feed mainly on copepods.	• Juveniles are common in shallow inshore waters, while adults live in deeper inshore waters or on offshore banks. • Adults prefer a depth range of 110 to 181 metres. • Can withstand a range of temperatures, from 0 to 18 degrees Celsius, but prefer a range of 7.2 to 8.6 degrees Celsius. • Distributions mainly restricted to the slope waters of the Burgeo and St. Pierre Banks. • Congregates mainly in Southwest Shelf Edge and Slope EBSA (*Templeman, 2007*). • Warm Southern Shelf Assemblage. • Not commercially significant in the region.
Redfish (*Sebastes mentella*, *Sebastes fasciatus)*	• Ovoviviparous, the fertilized eggs develop within the brood chamber of the female. • Mating occurs in the fall months and the larvae subsequently hatch from the eggs inside the female. • The larvae feed exclusively on energy stored in the yolk, develop inside the female and eventually are released as young fish sometime between April and July (*Gascon, 2003; Ollerhead et al., 2004*). • Redfish larvae have dominated the	• Redfish typically occur in cool waters (3.0 to 8.0ºC) along the slopes of fishing banks and deep channels in depths of 100 to 700 metres. • In the western Atlantic, redfish species range from Baffin Island in the north to the waters off New Jersey in the south. • The three redfish species that occur in the Northwest Atlantic include *Sebastes mentella, S. fasciatus,* and *S. marinus.* The latter species is relatively uncommon except

Species	Ecology	Distribution and Importance in Study Area
	ichthyoplankton within the SEA area. • Southwest Shelf Edge and Slope EBSA is an important spawning area for redfish.	in the area of the Flemish Cap. • *S. mentella* is typically distributed deeper than *S. fasciatus* (*Gascon, 2003*). • *S. mentella* a commonly observed species in 3NLOPs from RV surveys. • Redfish larvae have been found in association with sea pen fields (*Baillon et al., 2012)*. • Warm Deep Offshore Shelf Assemblage. • Applicable designatable unit: 2+3KLNO; Northern Population Designatable Unit. • Has COSEWIC (Atlantic Population and Northern Population) status. • Commercially significant species (refer to Section 4.9.1).
Roughhead grenadier (*Macrourus berglax*)	• Little is known about spawning habits. • Spawning is predicted to occur between winter and early spring on the southern and southeastern slopes of the Grand Banks. • Slow growing species with late maturation. • Feeds on benthic invertebrates including bivalves, shrimp, echinoderms and some fish.	• Mainly inhabits deep water between 600 - greater than 1,000 metres (*Edinger et al., 2007).* • Abundant at 200-400 metres in association with large gorgonian and antipatharian corals (*Edinger et al., 2007)* • Abundant at 400-1000 metres in association with soft corals (*Edinger et al., 2007).* • On the Grand Banks, greatest catches occur in areas between 2.0 to 3.5 degrees Celsius and depths of 183 to 503 metres. • Deep Demersal Assemblage. • Has COSEWIC status. • Commercially significant species (refer to Section 4.9.1).
Roundnose grenadier (*Coryphaenoides rupestris*)	• Little is known about spawning habits. • Spawning is predicted to occur in late autumn and spring. • Vertically distributed by maturity. Percentage of mature fish captured increases with depth. • Feeds on small crustaceans, euphausiids, squid and small fishes.	• Mainly Inhabits deep water between 600 - greater than 1,000 metres (*Edinger et al., 2007*). • Abundant at 400-600 metres in association with gorgonian corals (*Edinger et al., 2007*). • In Newfoundland waters greatest catches occurred at depths greater than 500 metres at temperatures between 3.5 to 4.5 degrees Celsius. • Deep Demersal Assemblage. • Has COSEWIC status. • Commercially significant species (refer to Section 4.9.1).
Sculpin (*Triglops* sp.)	• Spawning generally occurs from late summer to late fall. • Feeds on small crustaceans including mysids and amphipods. • Preyed upon by cod and thick-billed murres.	• Boreal cool-water benthic marine group of species that occur from shallow to deep depths. • Commonly observed species in 3NLOPs from RV surveys. • Grand Bank Shelf Assemblage. • Not commercially significant in the region • Important forage fish species.
Smooth skate (*Malacoraja senta*)	• Slow to reproduce with 40 to 100 large egg capsules per year (*COSEWIC, 2012a*). • Hatching takes one to two years and have been found on the bottom at various times of the year (*COSEWIC, 2012a*). • Egg capsules are eaten by gastropods, halibut, monkfish and Greenland sharks	• Distributed between depths of 70 to 480 metres (*Kulka et al., 2006*). • Generally occur on soft mud and clay substrates over a range of depths (*COSEWIC, 2012a*). • Densest concentrations of this species are in waters between three to ten degrees

Species	Ecology	Distribution and Importance in Study Area
	(*COSEWIC, 2012a*). • Feed mainly on crustaceans, euphausiids, mysids and some fish.	Celsius (*COSEWIC, 2012a; Kulka et al., 2006*). • Widespread Shelf Assemblage • Has COSEWIC (Funk Island Deep Population) status. • Not commercially significant in the region.
Spiny dogfish (*Squalus acanthias*)	• Ovoviviparous, developing young are in the brood chamber of the female. • Gestation period is long, about 22 months, one of the longest for any vertebrate animal. • Spiny dogfish is slow-growing and long-lived. • Opportunistic feeder that consumes mainly small fishes. • Juvenile dogfish are prey to various fish and sharks.	• Widely distributed in coastal waters of temperate seas throughout the world. • Small, schooling shark frequenting coastal and inshore waters in cold to warm temperate oceans. Usually found at temperatures of six to 15 degrees Celsius. Tolerant at low salinities and may ascend estuaries. • Preferred depth of 100 to 250 metres (*Kulka, 2006*). • Warm Southern Shelf Assemblage. • Has COSEWIC (Atlantic Population) status. • Commercially significant species (refer to Section 4.9.1).
Spotted wolffish (*Anarhichas minor*)	• Information on reproductive activities in western North Atlantic Ocean is minimal. • Studies have shown that wolffish in the Newfoundland area spawn in mid to late summer from July to September (*Templeman, 2007).* • Feeds mainly on invertebrates including shrimp and echinoderms (*Simpson et al., 2012; 2013*).	• Occurs on both sides of the North Atlantic. • Mainly captured in deeps waters of less than 500 but large catches have occurred at depths of less than 350 metres (*Simpson et al., 2012*). • Usually occurs at temperatures of one to six degrees Celsius (*Simpson et al., 2012*). • Tagging studies indicated that migrations are local and limited. • Greatest proportion of this species aggregates in the Northeast Shelf and Slope EBSA in the spring (*Templeman, 2007*). • Warm Deep Offshore Shelf Assemblage. • Has SARA and COSEWIC status. • Not commercially significant in the region. • Mandatory live-release required when captured as bycatch.
Thorny skate (*Amblyraja radiata*)	• Spawning on the Scotian Shelf peaks in May and October. • Feeds mainly on polychaetes, amphipods, decapods and fishes. • Egg cases are eaten by Greenland sharks and halibut.	• A boreal to arctic species living offshore on hard and soft bottoms at depths of about 18 to 966 metres and at temperatures of -1.4 to 14 degrees Celsius. • Occurs in eastern and western North Atlantic. • Widespread Shelf Assemblage. • Has COSEWIC status. • Commercially significant species (refer to Section 4.9.1).
Vahl's eelpout (*Lycodes vahlii*)	• Feeds on polychaetes, small crustaceans and molluscs. • Has large eggs and low fecundity.	• Occurs of Newfoundland in depths of 200 to 600 metres in temperatures from 2.0 to 4.5 degrees Celsius. • Captured at average depths of 410 metres in the Orphan Basin during the spring and fall respectively (*LGL 2012*). • Occurs on both sides of the Atlantic Ocean. • Northern Shelf Assemblage. • Not commercially significant in the region.

Species	Ecology	Distribution and Importance in Study Area
White hake (*Urophycis tenuis*)	• Spawning is thought to occur in spring and early summer. • Eggs, larvae and early juveniles are pelagic and remain close to the surface (*Han and Kulka, 2009*). • Juveniles are commonly observed in inshore areas. • Sand-hiding behaviour has been observed in young hake (*Han and Kulka, 2009*). • Feeds mainly on fish including herring, other hake species, and mackerel	• Prefer temperatures 4.0 to 8.0 degrees Celsius (*Kulka et al., 2005*) • Occurs at depths between 200 to 1,000 metres over mud bottoms however common at depths of less than 300 metres (*Han and Kulka, 2009*) • Occurrence on the Grand Bank mainly along the southwest slope (*Templeman, 2007).* • Warm Southern Shelf Assemblage. • Commercially significant species (refer to Section 4.9.1).
Winter skate (*Leucoraja ocellata*)	• Mating most likely occurs throughout the year and peaks offshore in the summer. • Slow to reproduce with 40 to 70 egg capsules per year (*McPhie and Campana, 2009; Kelly and Hanson, 2013*). • Feeds mainly on amphipods, polychaetes, squid and some fish (e.g. sand lance are an important prey item).	• Restricted to the northwest Atlantic. • A benthic species living over sand or gravel bottoms usually in depths less than 110 metres. • Warm Southern Shelf Assemblage. • Has COSEWIC (Georges Bank-Western Scotian Shelf-Bay of Fundy Population) status. • Not commercially significant in the region.
Witch flounder (*Glyptocephalus cynoglossus*)	• Spawning occurs between March and September and peaks in July and August on the Grand Bank Region. • Eggs and larvae are pelagic. • Young flounder remain in a pelagic state for about a year before settling on the bottom. • Slow growing, long lived species. • Feeds mainly on polychaetes, amphipods, molluscs and small fishes.	• Inhabits mud or mud-sand bottoms. • Mainly occurs at depths of 185 to 366 metres in areas associated with deep holes and channels between banks. • Captured at average depths of 432 and 487 metres in the Orphan Basin during the spring and fall respectively (*LGL 2012*). • Deep Demersal Assemblage. • Commercially significant species (refer to Section 4.9.1).
Yellowtail flounder (*Limanda ferruginea*)	• Spawning occurs between spring and summer with peaks from mid- late June on the Grand Banks. • Eggs are deposited near the bottom and float to the surface where they drift during development. • Aggregates in Virgin Rocks EBSA to spawn (*Templeman, 2007).* • Southeast Shoal and Tail of the Banks EBSA is an important nursery area for this species (*Templeman, 2007).* • Feeds mainly on polychaetes and amphipods and some small fish.	• Inhabits mud or mud-sand bottoms. • On the Grand Banks mainly found at depths between 57 to 64 metres and temperatures between 3.1 to 4.8 degrees Celsius. • Commonly observed species in 3NLOPs from RV surveys. • Grand Bank Shelf Assemblage. • Commercially significant species (refer to Section 4.9.1).

Table A.3. Overview of the Key Pelagic Species in the SEA Area (Scott and Scott, 1988), and individually noted sources). Summarised from the Offshore Newfoundland SEA (C-NLOPB, 2014)

Species	Ecology	Distribution and importance in Study Area
Atlantic bluefin tuna (*Thunnus thynnus*)	• Bluefin tuna do not reproduce in Canadian waters. Two major spawning areas in the western Atlantic are the Straits of Florida and the Gulf of Mexico. • Spawning occurs during April, May, and June in subsurface waters • At temperatures of 24.9 to 29.5 degrees Celsius in the Straits of Florida, hatching of eggs occurs in a few days. • Feed on pelagic and bottom fishes including capelin, saury, herring, mackerel and lanternfishes. Around Newfoundland, squid and capelin are important food sources.	• Moves northward into Canadian waters in summer and southward again in late fall. • They occur over the continental shelf, off Newfoundland, and in the Gulf of St. Lawrence, at depths of 27 to 183 metres, often in schools of less than 50 fish. • Bluefin tunas undertake extensive migrations, moving from the waters off Florida and the Gulf of Mexico as far as Newfoundland and the Gulf of St. Lawrence. • Pelagic Assemblage. • Has COSEWIC status. • Commercially significant species (refer to Section 4.9.1).
Albacore tuna (*Thunnus alalunga*)	• Spawns during spring and summer in sub-tropical waters (*DFO, 1998*). • Spawning occurs at surface temperatures of less than 24 degrees Celsius (*Collette et al., 2011*). • Feeds on pelagic fish, crustaceans and squid *(Pusineri et al., 2005*).	• Albacore tuna is a cosmopolitan species and has been captured on the Grand Banks. • Epipelagic and mesopelagic oceanic species. • Abundant in surface waters at 15.6 to 19.4 degrees Celsius (*Collette et al., 2011).* • Pelagic Assemblage. • Commercially significant species (refer to Section 4.9.1).
American eel (Anguilla *rostrata)*	• The eel is unique to other fish in that it breeds at sea and the young move into fresh water where they feed and grow. • After a number of years in freshwater they return to the sea to spawn, and presumably die. • The larvae feed on plankton. • Larvae are preyed upon by predaceous fishes.	• Found in the western North Atlantic. • Abundant in many tributaries of the St. Lawrence River and Gulf, and rivers of Newfoundland and the Maritime Provinces. It occurs in estuaries, lakes and rivers (*Jessop et al., 2002*) that have access to the sea. • During the freshwater phase of their life, eels move into streams, rivers, and muddy or silt-bottomed lakes. • Has COSEWIC status. • Recreational and commercial significance (refer to Section 4.9.1).
Atlantic herring *(Clupea harengus harengus)*	• Atlantic herring are demersal spawners depositing their adhesive eggs on stable bottom substrates (*Reid et al., 1999*). • The species is known to spawn in coastal and offshore areas • Spawning times are stock specific. • Feeds mainly on plankton. • Important food source for other fishes, marine birds and marine mammals.	• Primarily pelagic, and often in schools, occurring in the shallow inshore waters, or offshore from surface to depths of 200 metres. • Observed at 450 metres depths in multispecies surveys. • Research has demonstrated that Atlantic Herring has annual migratory patterns, such as movements to spawning grounds and feeding and wintering areas. • Occurs on both sides of the North Atlantic. It occurs in commercial quantities along the coast of southern Labrador, around the coast of Newfoundland and offshore banks, in the Gulf of St. Lawrence, along the coast of Nova Scotia and offshore banks, and the Bay of Fundy. • Pelagic Assemblage. • Commercially significant species (refer to Section 4.9.1).

Species	Ecology	Distribution and importance in Study Area
Atlantic mackerel *(Scomber scombrus)*	• Usually spawn in coastal waters between Cape Cod and Cape Hatteras. • Larval hatching generally occurs within five to seven days at water temperatures of 11 to 14 degrees Celsius. • Strong schooling species. • Filter and selectively feeds on planktonic organisms. • Preyed upon by porbeagles, dogfish, Atlantic cod, bluefin tuna, swordfish, and marine mammals.	• A pelagic fish common to the temperate waters of the open sea and is one of the most active and migratory fishes. • Occurs on both sides of the Atlantic Ocean. Mackerel are seen in Canadian coastal and inshore waters only during summer and fall. • Pelagic Assemblage. • Commercially significant species (refer to Section 4.9.1).
Atlantic salmon (*Salmo salar*)	• Atlantic salmon spawn in October and November in Canadian waters. • Eggs are buried in gravel by females and development continues over the winter. • The time required for the eggs to hatch varies with water temperature but is about 110 days at 3.9 degrees Celsius. • Atlantic salmon at sea consume amphipods and euphausiids, and fish including herring, alewives, smelt, capelin, mackerel, sand lance and cod.	• Occurs on both sides of the North Atlantic Ocean. • An anadromous species, living in fresh water and estuaries for at least the first two to three years of life before migrating to sea. • Cool rivers with extensive gravelly bottom headwaters are important habitat. • When about 15 centimetres long, young salmon migrate to sea, where they may live for 1, 2, or more years before returning to freshwater. • Salmon from various designated populations migrate through the Study Area. • Has COSEWIC (Northwestern Newfoundland, Southern Newfoundland, and Southwestern Newfoundland Populations) status. • Important recreational fishery. • Historically commercially important species but no longer fished commercially in the area.
Basking shark (*Cetorhinus maximus*)	• Considered ovoviviparous with about six pups born at a time during summer (*DFO, 2008*). • Aggregates from September to October for mating (*Jacoby et al., 2012*). • Filter feeds on planktonic organisms.	• Highly migratory. • Pelagic shark occurring in coastal warm waters around Newfoundland during the summer and fall. • Mainly caught in waters ranging from 8 to 12 degrees Celsius. • Distributed mainly off southern Newfoundland, on the Scotian Shelf and in the Gulf of Maine (*DFO, 2008*). • Pelagic Assemblage. • Has COSEWIC (Atlantic Population) status. • Not commercially significant in the region.
Bigeye tuna (*Thunnus obesus*)	• Spawning takes place approximately twice a year in inter-tropical waters (*FAO, 2013; DFO, 1998*). • Approximately 2.9 million to 6.3 million eggs released per spawning (*FAO, 2013*).	• Distributed worldwide in Atlantic, Indian and Pacific Oceans (*FAO, 2013*). • Pelagic species occurring from the surface to 250 metres depth in temperatures ranging from 13 to 29 degrees Celsius (*FAO, 2013*). • Young fish school near the surface with other tuna species (*DFO, 1998*). • Migrates through temperate waters such as the Eastern Study Area after spawning. • Pelagic Assemblage. • Has COSEWIC status. • Commercially significant species (refer to Section 4.9.1).

Species	Ecology	Distribution and importance in Study Area
Blue shark (*Prionace glauca*)	• As with all sharks, fertilization is internal. After eggs are fertilized, gestation requires nine to 12 months, and birth usually occurs during March to July. • Feeds mainly on fish and squids. Species consumed include herring, hake, cod, haddock, pollock, mackerel, butterfish, sea raven and flounders.	• A wide-ranging pelagic species in temperate waters, often occurring near the surface, preferring temperatures of seven to 16 degrees Celsius. • Occurs worldwide in both inshore and offshore waters. In the western Atlantic from Newfoundland and the Gulf of St. Lawrence southward to Argentina. Most occurrences in Canadian waters are during summer months. • Pelagic Assemblage. • Has COSEWIC (Atlantic Population) status. • Commercially significant species (refer to Section 4.9.1).
Capelin (*Mallotus villosus*)	• In the Northwest Atlantic spawning is typically conducted on beaches though some deepwater spawning sites are known (e.g. Southeast Shoal) • Spawning is marked by an intensive migration inshore in early spring to spawn on beaches throughout the spring-summer and return to offshore waters in autumn. • Where substrate conditions are suitable spawning beaches may be found in exposed, moderately exposed, and sheltered locations throughout the region. • Beach spawning is demersal with the eggs being deposited in the intertidal zone. Larvae are dispersed passively via currents. • Feeds mainly on planktonic organisms. • Major food source for other fish, marine birds and marine mammals. Preyed upon heavily by Atlantic cod.	• A marine fish of cold, deep waters, found in the Atlantic Ocean on the offshore banks and in coastal areas. • The largest concentrations in Canadian waters are found off Newfoundland and the Labrador Coast. • Commonly observed species in 3NLOPs from spring RV surveys and in 3K2J in fall RV surveys. • Pelagic Assemblage. • Commercially significant species (refer to Section 4.9.1). • Important forage fish species.
Greenland shark (*Somniosus microcephalus*)	• Ovoviviparous, with more than ten pups at a time. • Feeds on a variety of fishes including herring, Atlantic salmon, Arctic char, capelin, redfish, sculpin, lumpfish, cod, haddock, halibut, and skate.	• Inhabits cool northern waters from 0.6 to 12 degrees Celsius. • Occupies near surface areas in winter months in estuaries, shallow bays and coastal waters. • Occupies deep (600 to 1,200 metres) cool waters during summer months. • Pelagic Assemblage. • Not commercially significant in the region.
Lantern fish (*Myctophidae*)	• Generally spawns during the spring to summer in the northwest Atlantic. • This group of fish are opportunistic planktivores that feed on copepods, euphausiids, ostracods and occasionally fish eggs and larvae.	• Commonly observed species in 3NLOPs from RV surveys. • Deep sea pelagic fish. • Generally occur at depths of 300 to 1,200 metres during the day and may migrate to surface waters at night. • Deep Pelagic Assemblage. • Not commercially significant in the region. • Important forage fish species.
Porbeagle shark (*Lamna nasus*)	• Ovoviviparous, developing young are in the brood chamber of the female. Young sharks are born alive. • Mating grounds South of Newfoundland (*DFO, 2013a*). • Little information on the rate of growth. • Feeds mainly on pelagic fish including herring, mackerel, cod, hake, haddock, and	• A pelagic, epipelagic, or littoral shark usually more common on continental shelves but occurring sometimes well offshore. • Occurs in Atlantic, Pacific, and Indian Oceans. • More common in the Canadian region during spring, summer, and fall, usually found in temperatures below 16 degrees Celsius. • Pelagic Assemblage.

Species	Ecology	Distribution and importance in Study Area
	cusk. Squid are also eaten.	• Has COSEWIC status. • Commercially significant species (refer to Section 4.9.1).
Shortfin mako shark (*Isurus oxyrinchus*)	• Females mature at lengths of 2.7 to three metres (corresponding to an age of about 17 years) and give birth to a litter size of four to 25 pups after a gestation period of approximately 15 to 18 months. • Lifespan has been estimated at 24 years with a maximum life expectancy of up to 45 years (*DFO, 2010*). • Feeds on fish including squid, mackerel, tuna, swordfish and bonitos.	• Extremely active, the shortfin mako shark is the fastest shark and one of the swiftest fishes. • The species is circumglobal in temperate and tropical waters. Individuals found in Atlantic Canada are considered part of a larger North Atlantic population. • Highly migratory with distribution apparently dependent on water temperatures (between 17 and 22 degrees Celsius). • They migrate to the Atlantic coast of • Canada generally in the late summer and fall where they are usually associated with the warm waters of the Gulf Stream (*DFO, 2010*). • Pelagic Assemblage. • Has COSEWIC (Atlantic Population) status. • Commercially significant species (refer to Section 4.9.1).
Swordfish (*Xiphias gladius*)	• Spawning occurs in the area of the Gulf of Mexico, Florida, the Caribbean Sea, south of the Sargasso Sea and waters off Brazil (*Neilson et al., 2006).* • Eggs are buoyant. • Opportunistic feeders that feed on squid, mackerel, barracudinas, hake, redfish, herring and lanternfishes. • Young swordfish are consumed by blue shark, tunas and marlins.	• Occurs in Canadian waters between June to November. • Distributed throughout a variety of depths from surface to over 500 metres. • Pelagic Assemblage. • Commercially significant species (refer to Section 4.9.1).
White shark (*Carcharodon carcharias*)	• Reproduction is via internal fertilization with development characterized as ovoviviparous (*Saïdi et al., 2005).* • Feeds on salmon, hake, halibut, mackerel, and tunas. Also known to consume other sharks, sea turtles, seabirds and marine mammals.	• Occurs in coastal and offshore waters of continental shelves, from surface waters to depths of 1,280 metres. • Widespread in warm and cool temperate seas of all oceans, antitropical in Atlantic and Pacific oceans and contiguous waters. • Has SARA (Atlantic Population) status. • Not commercially significant in the region.

Table A.4. Summary of Key Birds Species in the Survey Area. Summarized from the Offshore Newfoundland SEA (C-NLOPB, 2014).

Species	Ecology	Distribution / Habitat
Seabirds		
Cormorants *(Phalacrocoracidae)*	*Description* • Large-bodied, long-necked black seabirds with colourful bare facial patches. • Long-lived colonial seabirds. • Two species found in SEA Area: Double-crested Cormorant and Great Cormorant. • Great cormorants are widespread along the eastern coast of North America, while	• Coastal species; typically found in shallow (less than eight metres) waters. • Arrive at breeding territory in early spring • North Atlantic populations of Double-crested Cormorants migrate south in late fall • Great Cormorants are partial migrants, with some individuals remaining within the breeding range year round.

Species	Ecology	Distribution / Habitat
	double-crested ones are found on east and west coasts as well as inland. • Both species are secure in Canada. Double-crested Cormorant populations have increased significantly since 1970. *Reproduction* • Nests may be constructed on cliffs, artificial platforms, rocky ground, shrubs or trees. • Begin to breed at three (sometimes two) years of age. • Mean clutch size: four eggs (range one to seven). • Great Cormorant: Egg-laying begins in mid-April. Chick rearing takes place from mid-May until mid-August. • Double-crested Cormorant: Egg-laying begins in early May. Chick rearing is from early June until late August. • Number of fledglings per breeding pair for populations in eastern Canada range from 0.98 to 2.35 (Double-crested) and 1.2 to 1.97 (Great). *Food Sources* • Feed by pursuit diving to depths of up to 35 m, though typically ten metres or shallower • Prey on a wide variety of small fish (typically less than 20 centimetres) and invertebrates, predominantly marine bottom species.	• Double-crested Cormorants have a wide breeding distribution in Newfoundland, however the breeding range of great cormorants is restricted to the south and southwest coast of the Island • A coastal species seldom found in deep waters, cormorants were only rarely observed in the ECSAS surveys in the waters off Eastern Newfoundland (*ECSAS, 2013*).
Gannets *(Sulidae)*	*Description* • Northern Gannet is a large-bodied seabird with long neck and large, bluish bill. Adult plumage is white with yellowish-buff wash on head and neck, black wing tips. Long-lived colonial seabird. • Entire Northwest Atlantic breeding population is confined to six colonies in eastern Newfoundland and Québec. Winter range extends along the eastern coast of the United States, as far as northern Mexico. • Gannets are secure in Canada, with a steadily increasing population of between 200,000 and 300,000 breeding adults. *Reproduction* • Nests in dense colonies on cliff ledges, typically on islands, but occasionally inaccessible mainland areas. • Age at first breeding between four and seven years.	• Gannets typically inhabit continental shelf waters at all times of the year. • Adults arrive at breeding territory in mid-March, followed a few weeks later by sub-adults. • Juvenile gannets begin a southward migration in September. Adults and older immatures may travel north from the breeding colonies in order to feed along the Labrador Coast before beginning southward migration. • Winter range is south of the SEA Area, extending from the Gulf of Maine as far south as Mexico. • Gannets are common off Eastern Newfoundland in the spring, summer and fall, and are absent in winter (*Husky Energy, 2000*). • The largest concentrations of gannets are found near the breeding colonies in the spring and summer months. • In September and October, gannets are more

Species	Ecology	Distribution / Habitat
	• Clutch size: one egg. • Egg-laying begins in mid-May. Chick rearing takes place from late June until early October. • Number of fledglings per year per breeding pair: 0.81. *Food Sources* • Feeds by deep plunge diving from a height of ten to 40 metres above the surface. • Large flocks (up to 1000 birds) may congregate over shoals of food fish. • Descends to depths of up to 15 metres. • During breeding season, may travel up to 180 kilometres from breeding colony to forage. • Preys on shoaling fish, predominantly herring, mackerel and capelin, as well as invertebrates such as squid.	common in the southern portion of the Study Area.
Phalaropes *(Scolopacidae)*	*Description* • Two species occur offshore in the SEA Area, the Red Phalarope and the Red-necked Phalarope. • Among the smallest seabirds, phalaropes are unusual in that they display reverse sexual dimorphism, females being larger and more brightly coloured than males. • Both species breed throughout the Arctic and winter in offshore waters, mostly in tropical and sub-tropical regions. • Red-necked Phalarope populations have decreased slightly, while insufficient data exists to determine population trends for Red Phalaropes. Both species are estimated to have a population of over 1,000,000 adults in Canada. *Reproduction* • Ground nester, lays eggs in short vegetation (e.g. sedges, mossy hummocks) typically close to fresh water. • Male is sole provider; female leaves shortly after egg laying. • Typically breed in first year. • Clutch size: typically 4. • Egg-laying begins in late May to early June. Chick rearing takes place from mid-July until early September.	• Phalaropes spend most of the year offshore, coming on land only during the summer months to breed. • Found in Arctic tundra during breeding season. • Typically spend winter along offshore ocean fronts, where upwellings are associated with higher prey densities. • Both phalarope species are absent from the region in winter, and uncommon or scarce in all other seasons.

Species	Ecology	Distribution / Habitat
	• Number of fledglings per year highly variable depending on predator populations; average believed to be approximately ten percent in Canada for the Red Phalarope. *Food Sources* • Phalaropes employ a unique surface feeding strategy whereby they spin in tight circles on the water surface, churning prey upwards to within reach. • Feed on zooplankton and small aquatic invertebrates.	
Gulls (*Laridae*)	*Description* • Nine species occur in the SEA Area: Herring Gull, Iceland Gull, Glaucous Gull, Great Black-backed Gull, Ring-billed Gull, Black-headed Gull, Sabine's Gull, Ivory Gull and Black-legged Kittiwake. • One species, the Ivory Gull, is considered at risk at the federal and provincial level. This species has suffered a large decrease in numbers since 1970, with an estimated population of 500 to 1000 pairs in Canada. • There are insufficient data to estimate Sabine's gull population trends. Glaucous Gulls are in global decline and are known to occur in the Eastern Newfoundland offshore area. Regional data concerning Glaucous Gulls are sparse, but it is likely that this species is in decline in the SEA Area as well. Further research is required. However, all other species are considered secure. *Reproduction* • Most species are ground nesters, although Black-legged Kittiwake breeds on cliffs. • Typically begin to breed at between three and seven years of age. • Clutch size: typically two to three. • Egg-laying begins in late May to early June. Chick rearing takes place from mid-June to late August for Herring and Great Black-backed Gulls, and to late September for Black-legged Kittiwakes. *Food Sources* • Surface feeders. • Feed on invertebrates (cephalopods and crustaceans) and fish, as well as offal. • Large gulls including herring and great black-backed also prey on eggs, young, and occasionally adults of other seabird species.	• Iceland, Glaucous, Ivory and Sabine's breed in the Arctic; Iceland and glaucous occur in offshore and coastal areas outside the breeding season, while Ivory and Sabine's are restricted to offshore waters the rest of the year. • Herring, Great Black-backed, Ring-billed and Black-headed Gulls, as well as Black-legged Kittiwakes, are found in temperate areas year-round.

Species	Ecology	Distribution / Habitat
Terns (*Sternidae*)	*Description* • Three species occur in the SEA Area: common tern, Arctic Tern and Caspian Tern. • Widely distributed throughout North America, although the Caspian tern is locally uncommon. • Populations are considered stable in Canada, with little change since the 1970s, at between 100,000 and 200,000 individuals for Common and Arctic Terns. Caspian Tern populations are somewhat smaller. *Reproduction* • Ground nester. • Begin to breed at two to four years of age. • Clutch size: one to three eggs. • Egg-laying begins in early June. Chick rearing takes place from mid-July until early August. • Number of chicks fledged per pair varies between 0.59 and 2.0 in different studies. *Food Sources* • Surface feeding and pursuit plunging. • Feed on fish and small crustaceans.	• Breed in northern North America, often on islands and typically in areas with sand or low vegetation. • Found in coastal and offshore waters. • Arctic terns undertake long migrations to the waters off of Antarctica, while Common and Caspian Terns winter in Central and South America.
Alcids (*Alcidae*)	*Description* • Six species occur in the SEA Area: Dovekie, Razorbill, Common Murre, Thick-billed Murre, Atlantic Puffin and Black Guillemot. • Alcids are heavy-bodied and proportionately small winged black-and-white birds of the northern hemisphere. • Distribution of alcids in eastern North America is from the high Arctic to north of the Carolinas. • Alcid populations are considered secure, with many species showing slight increases in number in recent years. *Reproduction* • Cliff nesters and cavity nesters in inaccessible (typically island) colonies. • Typically breed at two years or older. • Clutch size: one for most species; two for Black Guillemot. • Egg-laying begins in May to early June. Chick rearing takes place from mid-June until late August. • For Razorbills and the two Murre species, instead of “fledging” in the typical sense,	• Breed on offshore islands or inaccessible cliffs, away from terrestrial predators. • Typically found in offshore waters outside the breeding season; however, Black Guillemot tends to prefer more coastal environments, often close to breeding colonies. • Dovekie is a largely arctic species that ranges into offshore eastern Canada only in winter. • In the waters of the SEA Area, black guillemots are considered common year-round, while Common Murre and Atlantic Puffin are scarce in winter and common the rest of the year

Species	Ecology	Distribution / Habitat
	the chick departs the colony with the male parent; father and offspring remain together for several weeks before the chick attains independence. • Number of fledglings per breeding pair varies from 0.26 to 0.72 for Black Guillemot, and from around 0.40 to 0.60 for Atlantic Puffins (in eastern Newfoundland studies). Successful nest departures per breeding pair range from 0.65 to 0.75 for the Razorbill, from 0.35 to 0.85 for Common Murres (the algae subspecies found in Newfoundland), and 0.48 to 0.79 for Thick-billed Murres in the Atlantic. Factors affecting breeding success include food availability, weather and parental experience. *Food Sources* • Feed by pursuit diving. • Primary food source for alcids in Newfoundland is small fish such as capelin and sand lance; also take some invertebrates such as copepods.	
Jaegers and Skuas *(Stercorarii-dae)*	*Description* • Five species occur in SEA Area: Pomarine Jaeger, Parasitic Jaeger, Long-tailed Jaeger, Great Skua and South Polar Skua. • High arctic breeders which are found in offshore waters the rest of the year. • Great and South Polar Skuas do not breed in Canada, but are occasionally seen in offshore waters of the northwest Atlantic. • Insufficient data exist to determine population trends for jaegers. All three species are estimated to have a population of over 100,000 to 200,000 adults in Canada. *Reproduction* • Age at first breeding believed to be typically four years. • Clutch size: typically two. • Egg-laying begins in late May to early June. Chick rearing takes place from mid-July until early September. • Number of fledglings per pair varies with factors such as parental experience and prey density; range is between approximately 0.5 and 1.5. *Food Sources* • Frequently engage in kleptoparisitism, stealing food items from other seabirds, especially in winter; Long-tailed and	• Jaegers and skuas spend most of the year offshore, coming on land only during the summer months to breed. • Breed in Arctic tundra. • Jaegers and skuas are scarce or rare in the waters off Eastern Newfoundland, and with the exception of the Great Skua, they are absent in winter.

Species	Ecology	Distribution / Habitat
	Pomarine Jaegers largely predatory during breeding, feeding on lemmings and voles.	
Fulmars and Shearwaters *(Procellariidae)*	*Description* • Northern Fulmar and three shearwater species, Great Shearwater, Sooty Shearwater and Manx Shearwater, occur in the SEA Area. Cory's Shearwater is also known to occur off the southern Grand Banks. • Wide-ranging at sea outside of the breeding season. • Only the Northern Fulmar and Manx Shearwater nest in Canada; the other three shearwater species breed in the Southern hemisphere. • Fulmar populations have shown little change in recent years, with a stable population of 300,000 to 400,000 individuals in Canada. • Manx Shearwaters breed in one small colony of less than 20 pairs in southern Newfoundland. *Reproduction* • Most shearwaters are burrow nesters, while fulmars nest on cliffs. • Typically start to breed at five to eight years, female fulmars generally older at first breeding. • Northern Fulmar: egg laying begins in mid June, and chick rearing is from mid July to end of September. Manx Shearwater: egg laying begins in mid April; chick rearing is from mid June to end of October. • Clutch size: one. • Number of fledglings per pair per season ranges from 0.28 to 0.62. *Food Sources* • Shearwaters feed by pursuit plunging, while fulmars are typically surface feeders. • Feed on fish, offal, squid.	• Spend most of the year in coastal and offshore waters, primarily along the continental shelf in temperate to cold water environments. • Breed on islands, often on cliffs. • Northern Fulmar is considered common in the waters off Eastern Newfoundland year-round (*Husky, Energy, 2000*).
Storm-petrels *(Hydrobatidae)*	*Description* • Two species in SEA Area, Leach's Storm-petrel and Wilson's Storm-petrel. • Among the smallest of seabirds, both species are dark in colour with a white rump and with a decidedly bat-like flight. • Only Leach's breeds in Canada; Wilson's is an Antarctic breeder.	• Breed on offshore islands. • Nocturnal at the breeding colony, and are seldom seen from land. • Highly pelagic; even during breeding season, returns to land only at night. Wilson's Storm-petrels are rare to uncommon spring and summer visitors to Eastern Newfoundland and are absent in fall and winter.

Species	Ecology	Distribution / Habitat
	• While there are insufficient data to assess population trends, there are over ten million breeding Leach's Storm-petrels in Canada. *Reproduction* • Nests in burrows in offshore islands. • Age at first breeding typically breed in fifth year. • Clutch size: One. • Egg-laying begins in early June. Chick rearing takes place from mid-July until late October. • Fledging success in Newfoundland estimated at 48 percent. *Food Sources* • Surface feeders, hovering over the surface while gleaning prey items. • Often follow ships and fishing boats (particularly Wilson's). • Feed on zooplankton, small crustaceans.	
Coastal Birds		
Waterfowl *(Anatidae),* *Loons (Gaviidae), Grebes (Podicipedidae)*	*Description* • The Common Loon, Pied-billed Grebe and at least fourteen species of waterfowl breed in Newfoundland, and over twenty species occur in the SEA Area during at least part of the year. • Populations of inland-breeding duck species surveyed by CWS (American Black Duck, Mallard, Green-winged Teal and Ring-necked Duck) are considered stable throughout Eastern Canada. Available information indicates that sea duck populations are stable; however, because most sea ducks breed in remote areas, population trends are relatively poorly known. • The Common Eider is the most abundant waterfowl species in all seasons in coastal Newfoundland. *Reproduction* • Loons, grebes and sea ducks typically have lower reproductive rates compared with inland duck species. *Food Sources* • The main foraging strategies of this group are diving and dabbling (surface-feeding).	• Most nest inland on freshwater lakes and rivers; some (e.g. American Wigeon, Blue-winged Teal, northern shoveler, pied-billed grebe) nest in estuaries. Common Eider breeds in colonies on coastal islands. • In the fall, many species aggregate at staging areas • Many species spend winter months offshore in the Study Area (e.g. scoters, mergansers, Common Goldeneye, Long-tailed Duck, Common Eider).
Shorebirds		

Species	Ecology	Distribution / Habitat
Shorebirds *(Scolopacidae, Charadriidae)*	*Description* • At least 28 species of shorebirds pass through Eastern Newfoundland during fall migration. Commonly seen migrants include White-rumped Sandpiper, Greater Yellowlegs, Semipalmated plover, Sanderling, American Golden-plover, Semipalmated Sandpiper, Whimbrel and Black-bellied Plover. Other species reported less frequently in the area include Dunlin, Hudsonian Godwit, Ruddy Turnstone, Least Sandpiper, Buff-breasted Sandpiper and the endangered rufa subspecies of Red Knot. Purple Sandpiper and Ruddy Turnstone are present in the winter months. • Small numbers of shorebirds breed in Newfoundland, including the Least Sandpiper, Spotted Sandpiper, Greater Yellowlegs, Semipalmated Plover, Piping Plover and Killdeer. The endangered Piping Plover's nesting range is concentrated in the western and southwestern portions of the Island, but they have recently been found breeding in Eastern Newfoundland. *Reproduction* • Most species typically lay four eggs. Incubation lasts approximately three weeks. • Chicks are relatively precocious, leaving the nest within 24 hours of hatching, although they are unable to fully thermoregulate for the first few days. *Food Sources* • Most shorebirds feed in tidal mudflats, probing the sand with their long bills. • Some species (e.g. Whimbrel) feed on berries in coastal barrens. The Purple Sandpiper feeds on small invertebrates (e.g. molluscs) along rocky shorelines and offshore ledges and islands.	• Shorebirds are generally long distance migrants, and most species that occur in the Study Area nest in the far north. • Most species that do nest in Newfoundland tend to breed close to inland freshwater bodies; the greater yellowlegs will nest in estuaries and tidal flats. • Spring and fall migration routes differ; in Atlantic Canada, greater numbers of most species are seen during fall migration.

Table A.5. Summary of Marine Mammal Species in the Study Area (C-NLOPB, 2014). Summarised from the Offshore Newfoundland SEA (C-NLOPB, 2014)

Species	Ecology	Distribution / Habitat
Mysticetes		
North Atlantic Right Whale *(Eubalaena glacialis)*	*Description* • Adult North Atlantic right whales average 13 to 16 metres in length and 40,000 to 70,000 kilogrammes in weight. • Concentrated in the western North Atlantic, but may occur further east to Europe. • Considered to be the most endangered large whale in the world, with	• Generally found in waters with surface temperatures ranging from 8 to 15 degrees Celsius, in areas that are 100 to 200 metres deep. • Shifts in the distribution and abundance of their primary prey items can dramatically affect right whale distribution within their range.

Species	Ecology	Distribution / Habitat
	approximately 300 to 350 individuals remaining. • Endangered (SARA Schedule 1). *Reproduction* • Mean age at first reproduction is ten years for females and is likely similar for males. • Gestation period is unknown; may be greater than 12 months. • Interval between births typically three to five years (mean: 3.7). *Food Sources* • Plankton feeders. The primary prey item of the North Atlantic right whale is the copepod *Calanus finmarchicus*, which they capture by filtering seawater through the baleen plates in their mouths.	• Right whales are only rarely sighted in the SEA Area.
Humpback Whale *(Megaptera novaeangliae)*	*Description* • Adult humpback whales average 13 to 16 metres in length with females growing larger than the males. • It has unusually long pectoral flippers. • Known for its surface displays and breaching acrobatics. • Western North Atlantic Population: Special Concern (SARA, Schedule 3). *Reproduction* • Average age at sexual maturity is nine years. • Calving occurs between January and April after a gestation of approximately 12 months. • Inter-calving interval of two years. *Food Sources* • Humpback whales feed on small schooling fishes and krill. • They often feed cooperatively in groups and have been observed using specialized feeding techniques such as bubble net feeding.	• Highly migratory, with seasonal movements between temperate to arctic feeding areas and low-latitude breeding areas. • In the North Atlantic, six distinct feeding areas: Gulf of Maine, Gulf of St Lawrence, Newfoundland and Labrador, West Greenland, Iceland and North Norway. • One common breeding area located in the West Indies. • Often sighted singly or in groups of two or three, except during breeding and feeding times, where groups can be as large as 15 individuals. • Humpback whales are considered to be relatively common within the SEA Area.
Blue Whale *(Balaenoptera musculus)*	*Description* • The largest animal ever known to live, an adult blue whale can reach up to 30 metres in length. • All populations have been exploited commercially. It is estimated the western North Atlantic stock to be on the order of a few hundred individuals. • Widely distributed throughout the world's oceans and occurs in coastal, shelf and oceanic waters. • Atlantic Population: Endangered (SARA Schedule 1). *Reproduction* • Mate and calve from late fall to mid-winter in Northern hemisphere. • Age at sexual maturity: five to 15 years for both sexes. • Gestation period ten to 11 months. • Interval between births is two - three years.	• In the western North Atlantic, blue whales occur in the Gulf of St. Lawrence and east of Nova Scotia in spring, summer and fall and off southern Newfoundland in winter. • Usually occur alone or in small groups. • Distribution during feeding seasons is largely dependent on the areas of high concentrations of their primary food item. • The North Atlantic population of blue whales was severely depleted by whaling, and sightings of this species anywhere within its range are quite uncommon.

Species	Ecology	Distribution / Habitat
	Food Sources • The primary prey item of the blue whale is euphausiids.	
Fin Whale *(Balaenoptera physalus)*	*Description* • Adult fin whales average 18 to 20 metres in length. • Lower jaw is white on the right side while the left side is gray or black. • One of the fastest whales on earth and nicknamed "the greyhound of the sea", the fin whale can sustain speeds of up to 37 kilometres per hour and burst speeds of over 40 kilometres per hour. • Atlantic population: Special Concern by SARA (Schedule 1) and COSEWIC. *Reproduction* • Average age of sexual maturity: six to seven years for males and seven to eight years for females. • Conception and calving typically in winter. • Average 2.7 years between births. *Food Sources* • The primary prey of the fin whale is small schooling fishes such as capelin, as well as krill.	• Widely distributed in all the world's oceans but typically occur in temperate and polar regions. • Appear to have complex seasonal movements and are likely seasonal migrants. • Mate and calve in temperate waters during winter but migrate to northern latitudes during the summer to feed. • Occur in coastal and shelf waters, as well as in oceanic waters. • Observed alone or in pairs but groups of up to 20 individuals are often seen on feeding grounds. • The fin whale is common in the Grand Banks, particularly during the summer months, and its distribution is associated with the presence of abundant food supply (e.g. capelin).
Sei Whale *(Balaenoptera borealis)*	*Description* • Adult sei whales can reach up to 18 metres in length. • A relatively tall sickle shaped dorsal fin that may appear simultaneously as the blow, as seen from the surface. • Atlantic population considered Data Deficient by COSEWIC. *Reproduction* • Reach sexual maturity at five to 15 years of age; mean age at first reproduction has apparently decreased since the 1930s. • Gestation period 10.5 to 12 months. Conception and birth typically occur in winter months. • Calving interval of two - three years. *Food Sources* • Diet includes copepods, euphausiids and small fish.	• Migrate between tropical to subtropical latitudes in winter and temperate and subpolar latitudes in summer, staying mainly in water temperatures of eight to 18 degrees Celsius. • Winter distribution seems to be widely dispersed and is not fully mapped; summer distribution is highly variable, but in the western North Atlantic, generally north of southern Nova Scotia. • Typically occur in offshore, pelagic habitats; appear to be associated with the continental shelf edge in the northwest Atlantic. • Highly mobile and are known to make unpredictable movements. • Not considered deep divers. • Although it has a relatively wide distribution overall, this species is considered uncommon in the Eastern Newfoundland Offshore Area.
Minke Whale *(Balaenoptera acutorostrata)*	*Description* • Adult minke whales average seven to ten metres in length, the smallest of the baleen whales. • Like most whale species, females are larger. • White band on each flipper is diagnostic. • Assessed as Not at Risk by COSEWIC; populations are considered to be more secure than other baleen whales. *Reproduction* • Both sexes reach sexual maturity at about seven to eight years.	• Cosmopolitan distribution that spans ice-free latitudes. Prefer colder waters. • Very little information on winter distribution; have been reported along the western North Atlantic south of 40 degrees latitude. • Migrate northward from calving grounds during spring and summer. • Appear to prefer shallow water (less than 200 metres). • Relatively solitary; usually seen individually or in small groups of two or three. • Larger groups have been observed in areas of

Species	Ecology	Distribution / Habitat
	• Gestational period of 10 to 11 months. • Produce calves every two years on average. *Food Sources* • The preferred prey items of the minke whale are sand lance and capelin, although other small schooling fishes likely make up a large part of their diet as well. Copepods and krill are also taken.	concentrated feeding. • Minke whales are commonly observed on the Grand Banks in the summer, associated with the presence of their prey species (*Piatt et al., 1989*).
Odontocetes		
Sperm Whale *(Physeter macrocephalus)*	*Description* • Largest of the toothed whales, growing to a length of approximately 20.5 metres with a worldwide distribution. • Routinely dive to depths of hundreds of meters and may occasionally dive as deep as 3000 metres. • Considered to be Not At Risk by COSEWIC. *Reproduction* • Females reach reproductive maturity at seven to 13 years, males somewhat later. • Gestation is 14 to 16 months. • Interval between births is typically three to six years. *Food Sources* • The primary prey item of the sperm whale is squid.	• Range as far north and south as the edges of the polar pack ice, although they are most abundant in tropical and temperate waters where temperatures are higher than 15 degrees Celsius. • Distribution is linked to social structure; adult females and juveniles generally occur in tropical and subtropical waters, whereas adult males are commonly alone often occurring in higher latitudes outside of the breeding season. • Generally distributed over large areas that have high secondary productivity and steep underwater topography. • Sperm whales were observed in small numbers in the waters off Eastern and Southern Newfoundland during aerial surveys conducted in the summer of 2007 (two and nine individuals, respectively; *Lawson and Gosselin, 2009*).
Northern Bottlenose Whale *(Hyperoodon ampullatus)*	*Description* • Adult northern bottlenose whales grow to approximately ten metres in length. • Pronounced beak that is white on males and grey on females. • Davis Strait-Baffin Bay-Labrador Sea population listed by COSEWIC as a species of Special Concern, while localized Scotian Shelf population considered endangered by SARA (Schedule 1) and COSEWIC. • Scotian Shelf population is believed to be non-migratory, while the Labrador population migrates north to south seasonally. *Reproduction* • Mate and give birth in April in the Labrador population. • Females reach reproductive age at eight to 13 years, males somewhat earlier. • Single offspring produced every two years. *Food Sources* • The primary prey item of the Northern bottlenose whale is deep water squid.	• Live in deep water areas of the North Atlantic and are rarely found in waters less than 800 metres deep. • Capable of remaining submerged for over an hour. • Can be found in groups ranging in size from one to 20 individuals. • Two areas of abundance in the western North Atlantic: Davis Strait off northern Labrador and “the Gully” on the Scotian Shelf. • Northern bottlenose whales are known to occur in the Grand Banks, and were sighted in the waters off Eastern and Southern Newfoundland during aerial surveys conducted in 2007 (*Lawson and Gosselin, 2009*).
Killer Whale *(Orcinus orca)*	*Description* • Killer whales, also known as orcas, are large members of the dolphin family. They are black with distinct white patches on the chest, sides and above the eye. • Adult male killer whales can reach a length	• Cosmopolitan and globally fairly abundant; have been observed in all oceans of the world. • Prefer warm waters but have been reported in cold waters as well. Not known to be reliably migratory.

Species	Ecology	Distribution / Habitat
	of 6-8 metres while females can reach a length of 5-7 metres. • Have tall dorsal fins that can reach a height of two metres. • Northwest Atlantic / Eastern Arctic population assessed as Special Concern by COSEWIC. *Reproduction* • Males reach sexual maturity at about 13 years, females at 14 to 15 years. • Calving peaks from fall to spring. • Average period between calving is approximately five years. *Food Sources* • Prey on a diverse variety of items including marine mammals, fish and squid.	• The greatest abundance of killer whales is found within 800 kilometres of major continents. • Often travel in close-knit matrilineal groups of a few to tens of individuals. • Killer whales occur year round in small numbers within the SEA Area (*Lien et al., 1988*).
Long-finned Pilot Whale *(Globicephala melas)*	*Description* • Members of the dolphin family. • Adult long-finned pilot whales reach a length of approximately 3.5 to 4.5 metres, with males somewhat larger than females. • Bulbous forehead and sickle shaped dorsal fin. • Population considered Not At Risk by COSEWIC. *Reproduction* • Gestation period is 12 to 15 months. • Age at first breeding: six to seven years. • Calving occurs every three to five years. • Calving may occur year round, but typically in summer. *Food Sources* • Long-finned pilot whales feed primarily on squid but known to consume octopus, cuttlefish and some fish species as well.	• Widely distributed throughout the world's oceans, and abundant throughout the North Atlantic as far north as 70 degrees north. • No evidence for marked north-south migration, but may migrate inshore-offshore seasonally in response to prey availability. • Pods are known to strand frequently en masse. • Typically only found in cold waters. • During aerial surveys conducted in summer of 2007, ten observations totalling 65 individual long-finned pilot whales were recorded off Southern Newfoundland, although none were observed in the Eastern Newfoundland Offshore Area (*Lawson and Gosselin, 2009*).
Sowerby's Beaked Whale *(Mesoplodon bidens)*	*Description* • Up to 5.5 metres long and dark grey in colour. • Small head with a long, narrow beak, and a small triangular dorsal fin and relatively long dorsal fins. Tail flukes lack center notch. • Species of special concern according to COSEWIC and SARA (Schedule 1). *Reproduction* • Poorly known. Females apparently sexually mature when they attain a length of between 4.6 and 4.8 m, while males are apparently sexually mature at 5.0 metres. *Food Sources* • Based on stomach contents and isotope analysis, diet appears to consist primarily of mid- to deep-water fishes and squid.	• Most northerly of the beaked whales; has been found on the eastern and western side of the North Atlantic. • No data on seasonal movements of the species. • Social structure poorly known, but most sightings and strandings have been of small groups of fewer than ten individuals. • During aerial surveys conducted in summer of 2007, Sowerby's beaked whales were not observed in the areas off Eastern and Southern Newfoundland *(Lawson and Gosselin, 2009*).
Small Dolphin Species	*Description* • In addition to killer whale and long-finned pilot whale, five dolphin species may be found in SEA Area: 1) Atlantic white-sided dolphin, 2) White-beaked dolphin, 3) Common bottlenose dolphin, 4) Risso's dolphin and 5) Short-beaked common	• All species occur in temperate to warm waters in the North Atlantic. The Atlantic white-sided dolphin and white-beaked dolphin also inhabit sub-Arctic portions of the North Atlantic. The short-beaked dolphin also inhabits southern waters off the coast of Venezuela and the Gulf of Mexico.

Species	Ecology	Distribution / Habitat
	dolphin. • All five species have been assessed by COSEWIC and populations were considered Not at Risk. Atlantic white-sided dolphins are considered abundant throughout their range. *Reproduction* • Reach sexual maturity at three to four years. • Gestation lasts from ten to 14 months. *Food Sources* • Diet for most species consists of a variety of small schooling fishes and squid; Risso's dolphin feeds almost exclusively on squid.	• Seasonal migration patterns for these species are poorly understood. • Most commonly found in groups of 30 to 70 individuals; however, larger groups numbering several hundred individuals are also observed. • Often associate and feed with large baleen whales, and are known to form mixed dolphin species groups. • Atlantic white-sided dolphins may be found throughout the SEA Area, and have been recorded within 30 kilometres of the White Rose site during vessel-based surveys (*Wiese and Montevecchi, 1999*).
Harbour Porpoise *(Phocoena phocoena)*	*Description* • The harbour porpoise is a small compared to other cetaceans, growing to a length of 1.2 to 1.4 metres. • Most commonly observed near the coast and will enter small bays and estuaries. • Harbour porpoises in the Western North Atlantic Population have been divided into three different subpopulations: the Bay of Fundy/Gulf of Maine, the Gulf of St. Lawrence and the Newfoundland populations. The boundaries between these sub-populations are not well defined as there is some genetic overlap. *Reproduction* • Most mature females become pregnant each year. Gestational period is ten to 11 months. • Mean age at sexual maturation is 3.5 years. *Food Sources* • Feed on small schooling fishes.	• Found in shelf waters throughout the northern hemisphere, usually in waters colder than 17 degrees Celsius. • Usually seen in small groups of one to three animals often including at least one calf. Occasionally they form larger groups. • Present in northern coastal waters only during the summer months. • Off Eastern Newfoundland, harbour porpoises are most likely to be found in the shallower waters of inshore areas.
Pinnipeds		

Species	Ecology	Distribution / Habitat
Harp Seal *(Pagophilus groenlandicus)*	*Description* • Adults may reach a length of approximately 1.7 to 2.0 metres, with both sexes similar in size. • The most abundant pinniped in the northwest Atlantic, estimated population size was 7.7 million in 2012. • Populations are considered secure in the region, having increased by 400 percent since the 1970s. *Reproduction* • Harp seal pups are born on the ice and females will nurse their pups for approximately 12 days, then mate and disperse. • Give birth in late February or March on medium to thick first year pack ice. *Food Sources* • Diet includes a variety of fish species, predominantly capelin, sand lance, Arctic cod, and flatfish such as halibut. Other fish and invertebrates such as crustaceans, krill, squid, shrimp are also taken. • Diet varies considerably with age and season.	• Older harp seals form large moulting concentrations on the sea ice off northeastern Newfoundland and in the northern Gulf of St. Lawrence during April and/or May. • Following the moult, seals disperse and eventually migrate northward. • Small numbers of harp seals may remain in southern waters throughout the summer while a portion of the population remains in the Arctic. • Whelping occurs in the spring in an area off southern Labrador and northeastern Newfoundland known as the 'Front,' as well as in Gulf of St. Lawrence. • Harp seals are relatively common in the SEA Area in the winter months, although small numbers remain in southern waters in the summer.
Hooded Seal *(Cystophora cristata)*	*Description* • Adults reach a length of approximately 2.0 metres for females and 2.6 metres for males. • Populations are considered secure in the region; a recent study estimated the population at approximately 592,100 individuals. • Assessed by COSEWIC as Not At Risk. *Reproduction* • Congregate to breed on pack ice in mid March. • Very short breeding season, including the shortest lactation period for any mammal with most pups being weaned in four days. *Food Sources* • Diet includes a variety of fish species, including cod, haddock, herring and mackerel. Crustaceans, krill, squid, shrimp and other invertebrates are also taken.	• Feed in the Canadian Arctic and Greenland during the summer months, migrating to the Gulf of St. Lawrence in December and January and leaving the area in April to May. • Highly pelagic; it is not uncommon to see them outside of their normal range. • The largest whelping concentration in the Northwest Atlantic occurs off the coast of southern Labrador or northern Newfoundland (the 'Front'), as well as in the Davis Strait and the Gulf of St. Lawrence. • After breeding, they move to moulting areas off Greenland. • Hooded seals are relatively common in the SEA Area in the winter and spring, and small numbers may be found in the summer as well (*Andersen et al., 2012; Lesage et al., 2007*).
Grey Seal *Halichoerus grypus*	*Description* • Adults can grow to a length of approximately 1.6 to 2.0 metres for females and 2.5 to 3.3 metres for males. • Populations considered secure in the region; grey seals have been assessed by COSEWIC as Not At Risk. • Canadian population estimated at 250,000 individuals. *Reproduction* • The largest colony of grey seals is found off Nova Scotia. • Grey seals give birth between September	• Inhabit cold temperate to sub-Arctic areas in North Atlantic waters over the continental shelf. • Year round residents in the SEA Area. • Grey seals are found in the SEA Area primarily in the summer months (*Lesage et al., 2007*).

Species	Ecology	Distribution / Habitat
	and March, with peak pupping occurring in January. *Food Sources* • Diet includes a variety of fish species, including capelin, sand lance, herring and Atlantic cod. • Largely demersal and benthic feeders.	

Table A.6.. Summary of Turtle Species in the Survey Area (C-NLOPB, 2014). Summarised from the Offshore Newfoundland SEA (C-NLOPB, 2014)

Species	Ecology	Distribution / Habitat
Turtles	*Description* • There are three species of sea turtles that do or may occur within the SEA Area; Leatherback turtle, Loggerhead turtle and Kemp's ridley turtle. • The leatherback is the largest living turtle, measuring up to 2.19 metres in length. • The loggerhead is the largest hard-shelled turtle in the world, typically reaching 0.85 to 1.0 metres in length. • Kemp's ridley is the smallest sea turtle, at 0.6 to 0.7 metres in length. • Leatherback (Atlantic population) is listed as endangered under Schedule 1 of SARA, while the loggerhead is considered endangered by COSEWIC. • Kemp's ridley is only rarely found in Canadian waters (considered an accidental visitor), but is considered critically endangered by IUCN. *Reproduction* • Leatherbacks nest on open beaches in the tropics; females lay an average of six clutches per season. • Loggerheads nest in the southern United States and in tropical areas; they lay four clutches per season, and will go two to three years between breeding seasons. • Kemp's ridley turtles nest exclusively in the Gulf of Mexico where they lay an average of 2.5 clutches per season. • Sex determination of marine turtle hatchlings is temperature dependent. *Food Sources* • The preferred prey for leatherbacks is jellyfish and other gelatinous organisms. • Loggerheads and Kemp's ridleys consume crustaceans, molluscs and jellyfish.	• Leatherbacks range throughout the Atlantic, Pacific and Indian oceans. In Atlantic Canadian waters, present from April to December and most numerous from July to September. They are predominantly pelagic, typically inhabiting coastal shelf waters to a depth of less than 200 metres. • Loggerhead is the most abundant sea turtle in North American waters. Wander widely in their range from coastal areas to more than 200 kilometres from shore. In Eastern Canada, seldom found in nearshore waters. • Adult Kemp's ridley turtles rarely range beyond the Gulf of Mexico, but juveniles can be found as far north as Newfoundland. • Population estimates for leatherbacks in the North Atlantic range from 34,000 to 94,000 individuals, and they are thought to be a regular (albeit uncommon) part of the Newfoundland marine fauna in the summer and fall *(COSEWIC, 2012b; Goff and Lien, 1988).* The south coast of Newfoundland, in particular the Placentia Bay area, is a relatively high-use habitat for this species (*Templeman, 2007; COSEWIC, 2012b*). Loggerheads are less common than leatherbacks in Eastern Canadian waters (*Breeze et al., 2002*). • The number of Kemp's ridley turtles that visit the Eastern Newfoundland Offshore Area is unknown, but this species is likely to be extremely rare in the SEA Area.

Appendix B – Polarcus Environmental Management

Polarcus ensures its environmental footprint is minimized by managing all their operations responsibly through a process of measuring, monitoring and continuous improvement.

Environmental Management System

The Polarcus Management System is based on OGP 510 encompassing the 4 basic fundamentals of Leadership, Managing Risk, Continual Improvement and Implementation together with 10 Elements in a Plan, Do, Check and Act process. The Management System carries a hierarchic structure with Commitment and Accountability at the top, leading into the process flow encompassing our activities. Polarcus completed the 5-year ISO and ISM certification renewal process for the Company's Management System. The recertification included the ISM Document of Compliance, and the ISO 14001, OHSAS 18001, ISO 9001 (Environment, Health, Safety, and Quality) management system standards. With the renewal of these certificates, Polarcus remains the only marine seismic geophysical company with a Management System fully certified to the internationally recognized standards of ISM, ISPS, ISO and OSHA. These systems address the following:

- Pollution prevention policies and procedures;
- Fisheries liaison / interaction policies and procedures;
- Programme for compensation of affected parties and
- Emergency response plans.

The Polarcus organization also participate in the DNV GL Environment, Energy, and Efficiency (“Triple-E™”) voluntary rating initiative. Triple-E™ is a mechanism for ships to be certified based on quantifiable verification of their environmental performance. It also serves as a tool to help ship owners and operators benchmark and improve environmental performance.

It is comprised of four levels, from level 4 to level 1, with level 1 being the highest. The key elements of the Triple-E™ rating initiative are:

- Energy efficient ship design;
- Environmental management system;
- Onboard energy efficiency management;
- Supported IMO initiatives for pollution control and
- Verifiable measuring, monitoring and reporting.

The entire Polarcus fleet has obtained Level 1 Triple-E™.

Polarcus Commitment to the environment:

Our goal is “Zero Spills” with regards to oil pollution of the marine environment and we actively strive to reduce and recycle wherever possible in order to reduce the impact on our world and help preserve our environment for future generations.

We establish targets for minimizing our waste and reducing our emissions to ground, water and air. We monitor and measure the progress of our environmental stewardship and report our findings both in accordance with the applicable statutory requirements and beyond.

We have established procedures and practices to protect the environment during the course of our business activities, onshore and offshore, including the global application of a soft-start procedure for seismic sources as a minimum element in our marine mammal mitigation strategy.

So that we may further limit our environmental footprint, we make use of the latest technologies available in the geophysical and maritime industries including; The use of low sulphur fuels; SCR (Selective Catalytic Reduction) catalysts to reduce exhaust emissions; solid streamers; tail-buoys fitted with front guards to avoid harming turtles and by using an oil-free seismic source with an optimized array, specifically designed to minimize noise impact to the surrounding environment.

The Polarcus seismic fleet carries the stringent DNV Clean-Design notation. We are the first seismic company to hold the DNV BWM-T class notation which means these particular vessels operate a ballast water management system which is 100% chemical free, posing no threat for introducing harmful foreign ballast waters to local ecosystems.

We are the first and only seismic company to receive the DNV Vessel Emissions Qualification Statement which qualifies the methodology and accuracy of our emission measurements, verifying our ability to predict the exhaust emissions footprint for any project and then, post-project, to subsequently provide actual emissions measurements.

A copy of the Polarcus' Shipboard Oil Pollution Emergency Plan is provided in Appendix E. attached plan is for the Polarcus Alima but the same plan applies throughout the fleet and would apply to any vessel within the Polarcus fleet which is assigned to be deployed.

Appendix C – Consultation Report

Stakeholder Group	Attendees	Details of Engagement	Comments, Concerns and Requests	Responses and EA section where Comments, Concerns and Request are addressed
Fish, Food and Allied Workers Union (FFAW-Unifor)	Tony Doyle; VP Inshore Fishery FFAW-Unifor Bruce Button; Inshore Council FFAW-Unifor Johen Joensen; Former Petroleum Liaison Officer FFAW-Unifor Drew St. Peter; Arctic Sustainability Manager Polarcus Darlene Davis; Canadian Lead Consultant RPS Kent Simpson; GeoSpatial Strategy Group (RPS)	A face to face meeting held on February 11^{th}, 2016. The project description was provided to FFAW-Unifor well in advance of the scheduled meeting. Polarcus gave a presentation on their company and their vision. Maps illustrating the Project and Study Area (2016-2022), in relation to the Northwest Atlantic Fisheries Organization (NAFO) management areas, Shrimp Fishing Areas (SFA), and Crab Fishing Areas (CFA), were presented for discussions.	FFAW indicated that displaying fishing activity history as "heat maps" to illustrate areas of repeat activity, rather than "stacking" subsequent years when mapping 5 years of historic fisheries data would be helpful for fisher's interpretation. He said that when someone is fishing they do not want seismic vessels to go in and disturb their fishing. FFAW emphasized the importance of talking, working and communicating together. That must continue to guide the work for the least effect on harvesters. FFAW offered anything the FFAW can do to improve communication. FFAW expressed the importance of the end of season crab survey. FFAW advised, "that since the project is from 2016-2022, Cod Fishery is expected to improve around mid-term and he would like to see historical data on this activity as harvesting activity will change".	Fishing activity is discussed in Section 4.9 of the EA. Communication and Liaison is discussed in Section 5.6.2 of the EA. Polarcus committed to further communications with regards to the 2016 planned activities as the plans developed.
Association of Seafood Producers (ASP)	Derek Butler; Executive Director (ASP) Tom Scoulios; V P Multi-Client North & South America Polarcus Drew St. Peter; Arctic Sustainability Manager Polarcus Darlene Davis; Canadian Lead Consultant RPS	A face to face meeting held on February 10th, 2016. The project description was provided to ASP well in advance of the scheduled meeting. Polarcus gave a presentation on their company and their vision. Maps illustrating the Project and Study Area (2016-2022), in relation to the Northwest	ASP advised that communication between the Operator and the Fishers is key to working together. ASP expressed that Fishers need to get the information (e.g., 24 hour look-ahead seismic data acquisition plans) out to their Harvesters. ASP indicated that if this information could be posted on a website, Harvesters could be kept informed in this manner.	Polarcus was open to any discussion on methods to inform Harvesters that could improve communication between seismic vessels and fishing vessels. Polarcus will have an FLO onboard the vessel for the duration of the program- see Section 5.6.2 of the EA. Communication and Liaison is discussed in Section 5.6.2 of the EA. Polarcus committed to further

Stakeholder Group	Attendees	Details of Engagement	Comments, Concerns and Requests	Responses and EA section where Comments, Concerns and Request are addressed
	Kent Simpson; GeoSpatial Strategy Group (RPS)	Atlantic Fisheries Organization (NAFO) management areas, Shrimp Fishing Areas (SFA), and Crab Fishing Areas (CFA), were presented for discussions.		communications with regards to the 2016 planned activities as the plans developed.
Ocean Choice International (OCI)	Greg Viscount; General Manager OCI Rick Ellis; Director Fleet Operations OCI Tom Scoulios; VP Multi-Client North & South America Polarcus Drew St. Peter; Arctic Sustainability Manager Polarcus Kent Simpson; Geo Spatial Strategy Inc. (RPS) Darlene Davis; Canadian Lead Consultant RPS	A face to face meeting held on February 11th, 2016. The project description was provided to OCI well in advance of the scheduled meeting. Polarcus gave a presentation on their company and their vision. Maps illustrating the Project and Study Area (2016-2022), in relation to the Northwest Atlantic Fisheries Organization (NAFO) management areas, Shrimp Fishing Areas (SFA), and Crab Fishing Areas (CFA), were presented for discussions.	OCI advised that their vessels are equipped with AIS for position communication. The offshore component operates differently than the in-shore, they are operating 300 + days per year OCI advised that their fleet knows in October – November of each year where their vessels are going to be harvesting, because they review maps of historical catch rates. OCI advised there needs to be up-front planning. The unknown makes things difficult.	Polarcus committed to sharing more information once their plans were firmer. Polarcus advised that they were currently awaiting industry feedback on the planned 2016 season. Polarcus advised that they are committed to good communication. Polarcus further acknowledged that they are a visitor in the province and were not arriving to interfere in the fishery, that they would work together to establish communication in order for both the operations to be successful. Communication and Liaison is discussed in Section 5.6.2 of the EA. Polarcus will have an FLO onboard the vessel for the duration of the program- see Section 5.6.2 of the EA. Polarcus committed to further communications with regards to the 2016 planned activities as the plans developed.
Newfound Resources Ltd.	Tom Scoulios; VP Multi-Client North & South America Polarcus Drew St. Peter; Arctic	A face to face meeting held on February 10th, 2016. The project description was provided to Newfound	Joel Hickey, Operations Manager for Newfound Resources; shared information on Newfound Resources with regards to their vessel and operating season (year-round). The Study Area was reviewed for potential 2016 seismic operations, which do not conflict with Newfound	Polarcus will have an FLO onboard the vessel for the duration of the program- see Section 5.6.2 of the EA. Polarcus committed to further

Stakeholder Group	Attendees	Details of Engagement	Comments, Concerns and Requests	Responses and EA section where Comments, Concerns and Request are addressed
	Sustainability Manager Polarcus Kent Simpson; Geo Spatial Strategy Inc. (RPS) Darlene Davis; Canadian Lead Consultant RPS Joel Hickey (Newfound Resources, Operations Manager)	Resources Ltd. well in advance of the scheduled meeting. Polarcus gave a presentation on their company and their vision. Maps illustrating the Project and Study Area (2016-2022), in relation to the Northwest Atlantic Fisheries Organization (NAFO) management areas, Shrimp Fishing Areas (SFA), and Crab Fishing Areas (CFA), were presented for discussions.	Resources areas of operation. The Shrimp Fishery is closed in SFA7, and Newfound Resources May to November fishing season will be concentrated more to the north of SFA7. The key fisheries for Newfound Resources are shrimp and Greenland halibut. When asked by Polarcus, “What would Newfound Resources like to see from seismic operators for the 2016 season?” Newfound Resources advised again that communication and sharing of vessel position was essential to successful planning of concurrent seismic and fisheries operations.	communications with regards to the 2016 planned activities as the plans developed. Communication and Liaison is discussed in Section 5.6.2 of the EA.

Consultation Report Minutes

Company: Association of Seafood Producers (ASP)

Date: February 10th, 2016

Location: 10 Fort William Pl, St. John's, NL

Time: 10:00 am

Attendees: Derek Butler; Executive Director (ASP)
Tom Scoulios; V P Multi-Client North & South America Polarcus
Drew St. Peter; Arctic Sustainability Manager Polarcus
Darlene Davis; Canadian Lead Consultant RPS
Kent Simpson; GeoSpatial Strategy Group (RPS)

RPS Energy Canada (RPS) shared the Project Description with ASP, well in advance of the scheduled meeting.

The meeting opened with Tom Scoulios, VP Multi Client, Polarcus, giving a brief outline of "who Polarcus is" and what they are "about".

One of the key elements emphasized is the "Explore Green™" framework within Polarcus. Polarcus is an innovative Marine Geophysical company with an Environmental Agenda.

- It was explained that RPS were contracted for Canadian Lead Consultancy Services, to work with Polarcus to meet necessary regulations and expectations, while in Canada as an Operator.
- RPS has been supporting projects offshore Canada for the past 20+ years.
- Polarcus informed Stakeholders that a "Project Description" was filed with the C-NLOPB, December 2015, to trigger the process for an Environmental Assessment of the proposed area.
- It was explained that Kent Simpson, P. Geo., GIS Specialist, (GeoSpatial Strategy Group Inc.) is working closely with RPS for geospatial data analysis and environmental assessment mapping requirements, in particular historical fisheries landings data, to present in the stakeholder consultations with Fishers.
- Maps illustrating the Project and Study Area (2016-2022), in relation to the Northwest Atlantic Fisheries Organization (NAFO) management areas, Shrimp Fishing Areas (SFA), and Crab Fishing Areas (CFA), were presented for discussions.
- Polarcus illustrated the most likely area of operations for 2016 within the Project Area.
- Polarcus 2016 Plans have not been finalized nor confirmed
- Polarcus awaits industry interest and feedback for the 2016 season
- Polarcus understands the need for good communication with Stakeholders
- Polarcus believes good communication can be achieved by providing twice daily position and status information on the vessel to ASP to forward to their harvesters; weekly communication meetings between Polarcus and FFAW-UNIFOR, One Ocean, Ocean Choice, and to provide 24 hour look-ahead seismic data acquisition plans
- Point of Contact (SPOC) is referenced as a practice of mitigation under the C-NLOPB's Geophysical, Geological, Environmental and Geotechnical Program Guidelines:
- "A Single Point of Contact" for marine users that may be used to facilitate communication" will be established for the duration of the program

The following data sources were used for preparation of the maps presented during stakeholder consultations to show the 2010-2014 geographic trends of historical fisheries catch data.

- Fisheries Catch Landings, 2010-2014 (Fisheries and Oceans Canada, Economic Analysis and Statistics (EAS))
- Exploration, Significant Discovery, Production Licenses, and Sectors (C-NLOPB)
- Fisheries Management Divisions (Northwest Atlantic Fisheries Organization, NAFO)
- Exclusive Economic Zone boundaries (MarineRegions.org)
- Province and Territory boundaries (Statistics Canada)
- Shrimp and Crab Fishing Areas (DFO)

Derek Butler, Executive Director of ASP talked about ASP and what they do. the Association of Seafood Producers is a not-for-profit corporation representing the interests of seafood producers generally in the Province of Newfoundland & Labrador (NL), Canada.

Both ASP and Polarcus discussed the One Ocean Workshop that was held on the previous Monday (8th Feb, 2016), and how beneficial they thought it was for industry. It was pointed out that members of ASP are on the One Ocean board and that in future seismic operators will be invited to sit on the One Ocean board.

ASP advised that communication between the Operator and the Fishers is key to working together. ASP expressed that Fishers need to get the information (e.g., 24 hour look-ahead seismic data acquisition plans) out to their Harvesters. ASP indicated that if this information could be posted on a website, Harvesters could be kept informed in this manner. Polarcus was open to any discussion on methods to inform Harvesters that could improve communication between seismic vessels and fishing vessels.

Polarcus committed to having a Fisheries Liaison Officer onboard the vessel for the duration of the program.

Polarcus committed to further communication with ASP as plans for 2016 develop along further.

Meeting Adjourned at 11:00am

Company: Newfound Resources

Date: February 10th, 2016

Location: Quality Inn Harborview

Time: 1:45 pm

Attendees: Tom Scoulios; VP Multi-Client North & South America Polarcus
Drew St. Peter; Arctic Sustainability Manager Polarcus
Kent Simpson; Geo Spatical Strategy Inc. (RPS)
Darlene Davis; Canadian Lead Consultant RPS
Joel Hickey (Newfound Resources, Operations Manager)

RPS provided Newfound Resources with the Project Description well in advance of the scheduled meeting for discussions on February 10th.

Tom Scoulios, VP of Multi- Client for Polarcus provided Newfound Resources an overview of the company (Polarcus) and explained their interest in operating in Canada, offshore Newfoundland and Labrador.

Joel Hickey, Operations Manager for Newfound Resources; shared information on Newfound Resources with regards to their vessel and operating season (year-round). The Study Area was reviewed for potential 2016 seismic operations, which do not conflict with Newfound Resources areas of operation. The Shrimp Fishery is closed in SFA7, and Newfound Resources May to November fishing season will be concentrated more to the north of SFA7. The key fisheries for Newfound Resources are Shrimp and Greenland Halibut.

The current vessel operating for Newfound Resources is the Newfound Pioneer. Construction of an additional vessel for Newfound Resources is in progress. The Newfound Pioneer is equipped with AIS (Automatic Identification System), and Newfound Resources expressed that communication with seismic operators was key, adding that communications with seismic operators during 2015 was good, without issues. Newfound Resources pointed out that the larger vessels communicate better than smaller vessels as they are better equipped with a variety of communications equipment.

When asked by Polarcus, "What would Newfound Resources like to see from seismic operators for the 2016 season?" Newfound Resources advised again that communication and sharing of vessel position was essential to successful planning of concurrent seismic and fisheries operations.

Polarcus committed to further communications as plans for 2016 developed further.

Meeting Adjourned at 3:00pm

Company: Ocean Choice International (OCI)

Date: February 11th, 2016

Location: 1315 Topsail Road, St. John's, NL

Time: 10:00 am

Attendees: Greg Viscount; General Manager OCI
Rick Ellis; Director Fleet Operations OCI
Tom Scoulios; VP Multi-Client North & South America Polarcus
Drew St. Peter; Arctic Sustainability Manager Polarcus
Kent Simpson; Geo Spatial Strategy Inc. (RPS)
Darlene Davis; Canadian Lead Consultant RPS

The Project Description was provided to OCI well in advance of the scheduled meeting.

Drew St. Peter, Arctic and Sustainability Manager gave a presentation on Polarcus and their vision; "To be a pioneer in an industry where the frontiers of seismic exploration are responsibly expanded without harm to our world"

- Improving maritime energy efficiency
- DNV GL Triple-E™ environmental rating scheme
- Applicable for all ships
- An environmental performance monitoring and improvement tool.
- Triple-E™ has four levels with "Level 1" as the best

- Key elements of Triple-E™ :
- Energy efficient ship design
- Environmental management system
- Onboard energy efficiency management
- Verifiable measuring, monitoring and reporting
- Supported IMO initiatives for pollution control

- It was explained that RPS were contracted for Canadian Lead Consultancy Services to work with Polarcus to meet necessary regulations and expectations while in Canada as an Operator.
- RPS has been supporting projects offshore Canada for the past 20+years.
- They let Stakeholders be aware that in December of 2015 a "Project Description" was filed with the C-NLOPB to trigger the process for an Environmental Assessment of the proposed area.

- It was explained that Kent Simpson, P. Geo., GIS Specialist, (GeoSpatial Strategy Group Inc.) is working closely with RPS for geospatial data analysis and environmental assessment mapping requirements, in particular historical fisheries landings data, to present in the stakeholder consultations with Fishers.
- Maps illustrating the Project and Study Area (2016-2022), in relation to the Northwest Atlantic Fisheries Organization (NAFO) management areas, Shrimp Fishing Areas (SFA), and Crab Fishing Areas (CFA), were presented for discussions.
- Polarcus illustrated the most likely area of operations for 2016 operations within the Project Area.
- Polarcus 2016 Plans have not been finalized nor confirmed
- Polarcus awaits industry interest and feedback for 2016 season
- Polarcus understands the need for good communication with Stakeholders
- Polarcus believes good communication can be achieved by providing twice daily position and status information on the vessel to ASP to forward to their harvesters; weekly communication meetings between Polarcus and FFAW-UNIFOR, One Ocean, Ocean Choice, and to provide 24 hour look-ahead seismic data acquisition plans
- Point of Contact (SPOC) is referenced as a practice of mitigation under the C-NLOPB's Geophysical, Geological, Environmental and Geotechnical Program Guidelines:
- "A Single Point of Contact" for marine users that may be used to facilitate communication" will be established for the duration of the program

The following data sources were used for preparation of the maps presented during stakeholder consultations to show the 2010-2014 geographic trends of historical fisheries catch data.

- Fisheries Catch Landings, 2010-2014 (Fisheries and Oceans Canada, Economic Analysis and Statistics (EAS))
- Exploration, Significant Discovery, Production Licenses, and Sectors (C-NLOPB)
- Fisheries Management Divisions (Northwest Atlantic Fisheries Organization, NAFO)
- Exclusive Economic Zone boundaries (MarineRegions.org)
- Province and Territory boundaries (Statistics Canada)
- Shrimp and Crab Fishing Areas (DFO)

OCI advised that their vessels are equipped with AIS for position communication. The offshore component operates differently than the in-shore, they are operating 300 + days per year.

Polarcus expressed the need for open lines of communication before, during and after the project.

Polarcus pointed out the potential 2016 work area on the map within the assessed area for discussions.

OCI advised that their fleet knows in October – November of each year where their vessels are going to be harvesting, because they review maps of historical catch rates.

OCI advised there needs to be up-front planning. The unknown makes things difficult.

Polarcus committed to sharing more information once our plans become firm. Polarcus advised that they were currently awaiting industry feedback on the planned 2016 season.

Polarcus advised that they are committed to good communication. Polarcus further acknowledge that they are a visitor in the province and were not arriving to interfere in the fishery, that they would work together to establish communication in order for both the operations to be successful.

Polarcus committed to the Fisheries Liaison Officer being onboard the vessel for the duration of the project.

Polarcus committed to further communications with regards to the 2016 planned activities as the plans developed.

Meeting adjourned at 11:30am

Company: FFAW / UNIFOR Fish, Food & Allied Workers (FFAW)

Date: February 11th, 2016

Location: FFAW-UNIFOR
368 Hamilton Avenue
St. John's, NL

Time: 1:30pm

Attendees: Tony Doyle; VP Inshore Fishery FFAW / UNIFOR
Bruce Button; Inshore Council FFAW / UNIFOR
Johen Joensen; Former Petroleum Liaison Officer FFAW / UNIFOR
Drew St. Peter; Arctic Sustainability Manager Polarcus
Darlene Davis; Canadian Lead Consultant RPS
Kent Simpson; GeoSpatial Strategy Group (RPS)

The Project Description was provided to FFAW-UNIFOR well in advance of the scheduled meeting.

Drew St. Peter, Arctic and Sustainability Manager gave a presentation on Polarcus and their vision;

The Polarcus Vision:

"To be a pioneer in an industry where the frontiers of seismic exploration are responsibly expanded without harm to our world".

- Improving maritime energy efficiency
- DNV GL Triple-E™ environmental rating scheme
- Applicable for all ships
- An environmental performance monitoring and improvement tool.
- Triple-E™ has four levels with "Level 1" as the best
- Key elements of Triple-E™ :
- Energy efficient ship design
- Environmental management system
- Onboard energy efficiency management
- Verifiable measuring, monitoring and reporting
- Supported IMO initiatives for pollution control

- It was explained that RPS were contracted for Canadian Lead Consultancy Services to work with Polarcus to meet necessary regulations and expectations while in Canada as an Operator.
- RPS has been supporting projects offshore Canada for the past 20+years.

- They let Stakeholders be aware that in December of 2015 a "Project Description" was filed with the C-NLOPB to trigger the process for an Environmental Assessment of the proposed area.
- It was explained that Kent Simpson, P. Geo., GIS Specialist, (GeoSpatial Strategy Group Inc.) is working closely with RPS for geospatial data analysis and environmental assessment mapping requirements, in particular historical fisheries landings data, to present in the stakeholder consultations with Fishers.
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- Exclusive Economic Zone boundaries (MarineRegions.org)
- Province and Territory boundaries (Statistics Canada)
- Shrimp and Crab Fishing Areas (DFO)

FFAW indicated that displaying fishing activity history as "heat maps" to illustrate areas of repeat activity, rather than "stacking" subsequent years when mapping 5 years of historic fisheries data would be helpful for fisher's interpretation. He said that when someone is fishing they do not want seismic vessels to go in and disturb their fishing.

FFAW advised the importance of talking, working and communicating together. That must continue to guide the work for the least effect on harvesters. FFAW offered anything the FFAW can do to improve communication. FFAW talked about the FFAW working with these issues for the past 10 years, not just seismic but also cable companies etc., and communication is the key to both groups being in the same area with separate interests.

FFAW expressed the importance of the end of season crab survey. FFAW said, “Fishermen don’t start this until approximately September 1st”. “The crab survey is fixed stations, commercial gear, and contingent on weather”. “Fishermen are not allowed to partake in the commercial activity while doing the crab study”. “This makes it hard for fishers to plan the timing of the survey for other operators.”

FFAW expressed, “that the end of season crab survey is so important because this survey sets catch rates for the fishermen for the next year.” “FFAW stressed the importance for it to be as accurate as possible”. “Fishermen care deeply about this survey and don’t want seismic interfering with these results”.

FFAW advised “that for the weekly meetings with Polarcus while operating in NL, they will deal directly with Dwan Street whom is new to FFAW”.

FFAW asked, “How much lead in time the vessel needed to deploy equipment?” Polarcus responded, “It takes 24 to 36 hours to deploy” and “24 hours to pick up the gear”.

FFAW advised, “that since the project is from 2016- 2022 that Cod Fishery is expected to improve around mid-term and that he would like to see historical data on this activity as harvesting activity will change”. “That there has been nothing since 1992”.

RPS will investigate the availability of historical cod fishery data.

Polarcus committed to further communications with regards to the 2016 planned activities as the plans developed.

Meeting adjourned at 3:00pm

Appendix D – Multi Industry Workshop on Marine Seismic Surveying

2016 Multi Industry Workshop on Marine Seismic Surveying

Date: Monday February 8th

Time: 0800 – 1700

Address: Bally Haly Country Club
100 Logy Bay Road, St. John's, NL

As a starting point for the week's consultation meetings scheduled by RPS for Polarcus, both RPS and Polarcus attended the Industry Workshop on Marine Seismic Surveying organized by "One Ocean" and "C-NLOPB".

Attendees:

1. Lily Abbass; Fisheries and Oceans Canada (DFO)
2. Nikole Andres; DMDC ExxonMobil
3. Paul Barnes; Canadian Association of Petroleum Producers (CAPP)
4. Steve Bettles; Husky Energy
5. Glenn Blackwood; Fisheries and Marine Institute
6. Steve Bonnell; Amec Foster Wheeler
7. Lesa Brushett Tanner; WesternGeco Canada
8. Dave Burley; Canada-Newfoundland Offshore Petroleum Board (C-NLOPB)
9. Nelson Bussey; Fish Food and Allied Workers (FFAW-UNIFOR)
10. Derek Butler; Association of Seafood Producers
11. Strat Canning; Canning & Pitt Inc.
12. Andy Careen; FFAW-UNIFOR
13. Austin Cassell; FFAW-UNIFOR
14. John Christian; LGL Limited
15. Kim Coady; Statoil Canada
16. Edgar Coffey; Quin Sea
17. Stephanie Curran; Statoil Canada
18. Darlene Davis; RPS Energy
19. Rob Dunphy; Hebron ExxonMobil Canada Properties
20. Ken Dyer; Husky Energy
21. Rick Ellis; Ocean Choice International (OCI)
22. Dave Finn; Petroleum Research Newfoundland and Labrador
23. Ray Finn; Fisheries and Oceans Canada (DFO)
24. Rendell Denge; FFAW-UNIFOR
25. Ernest Hynes (Student); Marine Institute
26. Greg Janes; Suncor Energy
27. Hanna Janzen; ExxonMobil Canada Ltd.
28. Kjell Karlson; Seabird Exploration Americas
29. Jason Kelly; DFO
30. Sean Kelly; C-NLOPB
31. Dean Kennedy; GXT-ION Geophysical
32. Calvin Kerrivan; FFAW-UNIFOR
33. Murray Lavers; FFAW-UNIFOR
34. Barry McCullum; DFO

35. Brent Miller; Suncor Energy
36. Corey Morris; DFO
37. Maureen Murphy; One Ocean
38. Troy Nelson; arcis Seismic Solutions, A TGS Company
39. Neil Paddy; Petroleum Geo-Services (MKI)
40. Dave Pinsent; Husky Energy
41. Rob Pitt; GXT-ION Geophysical
42. Craig Rowe; C-NLOPB
43. Dwight Russell; FFAW/UNIFOR
44. Eric Ruygrok; Seitel Canada
45. Tom Scoulios; Polarcus US Inc.
46. Stephanie Snow (Student); Marine Institute
47. Wade Spurrell; Canadian Coast Guard
48. Drew St. Peter; Polarcus US Inc.
49. Heather Starkes; FFAW-UNIFOR
50. Gisle Stjern; Statoil Canada
51. Dwan Street; FFAW-UNIFOR
52. Keith Sullivan; FFAW-UNIFOR
53. Dave Taylor; DG Taylor Inc.
54. Scott Tessier; C-NLOPB
55. Ellen Tracy; Stantec Consulting Ltd.
56. Kris Vascotto; Ground fish Enterprise Allocation Council (GEAC)
57. Sarah Walsh (Student); Marine Institute
58. Bill Welsh Viscount; Ocean Choice International (OCI)
59. Bill Wells; One Ocean
60. Mike White; Nalcor Energy
61. Glen Winslow; FFAW-UNIFOR
62. Elizabeth Young; C-NLOPB

AGENDA:

0800	Welcoming remarks and Workshop overview – Bill Wells, One Ocean Chairman

The Following presentations were given;

0820	What is marine seismic surveying and why is it conducted? - Paul Barnes, Manager Atlantic Canada, CAPP
0850	Regulatory regime for marine seismic surveys in CAN-NL offshore area and overview of Call for Bids process- Craig Rowe, Director Exploration and Dave Burley, Director of Environmental Affairs, C-NLOPB
0920	DFO's role in the review of marine seismic survey programs – Jason Kelly, A/Team Leader, Client Liaison, Partnerships, Standards and Guidelines, DFO
0950	One Ocean overview of joint industry initiatives on seismic survey operational activities – Maureen Murphy Rustad, Managing Director, One Ocean

1010 Question and Answer session

BREAK 1030-1045

The Newfoundland and Labrador fishing industry: Overview of commercial fishing and experiences with seismic survey activity:

1045 Fish, Food and Allied Workers (FFAW / UNIFOR) – Keith Sullivan, President

1115 Ocean Choice International (OCI) and Groundfish Enterprise Allocation Council (GEAC) – Dr. Kris Vascotto, Executive Director, GEAC

1145 Conducting seismic surveys in the Newfoundland and Labrador offshore: Experiences and perspectives from the seismic industry - PGS-MKI, Neil Paddy, Contract Manager, Marine Contract | North and South America

1215 Question and Answer session

LUNCH 1235-1330 (Lunch provided)

1330 Seismic research: What has been done; what is in the works and what are future opportunities for collaboration in Newfoundland and Labrador –Dave Taylor, Consultant, DG Taylor Inc.; Dr. Corey Morris, Research Technician, Ecological Sciences, Science Branch, DFO; Dave Finn, CEO, Petroleum Research Newfoundland and Labrador; John Christian, Senior Biologist, LGL Limited environmental research associates

1430 Question and Answer session

1445 Break-out Groups session

The room was organized into several groups at different table. Each group was asked to discuss and answer for the rest of the room the following questions;

Break-Out Group Questions;

1. Fishing and seismic survey activities often occur at the same time and the same place. Are current practices and mitigation measures meeting industry needs and expectations? If not, what operational improvements would you recommend and is there an expanded role for industry, the C-NLOPB and One Ocean?
2. Today we heard several presentations about scientific research projects on the potential effects of seismic surveys on fish. Is there a requirement for more research on this subject in Newfoundland and Labrador? If so, what are the priorities and what are the opportunities for collaborative research projects involving seismic companies?
3. Are there additional topics or avenues of approach not addressed at today's Workshop you would like to table?

1545 Break-out Groups report to plenary

1645 Summary of Workshop action items and closing remarks – Bill Wells, One Ocean Chairman

It was apparent that everyone in the room felt that this Workshop was beneficial to all involved and that everyone in the room had learned from it. The need for further workshops would be beneficial to both the Operators and the Fishing Industry and Regulators. The need for better communication was clearly established and better education with all parties and their role in the ocean sector was necessary and very informative to all involved.

Polarcus was pleased to be invited into the session as a new Operator in Newfoundland and Labrador, and to have the opportunity to meet with some Stakeholders for introductions and discussions, as well as other industry players.

Polarcus became very informed and aware that good communications was key to successful operations offshore Newfoundland.

Appendix E – Polarcus Shipboard Oil Pollution Emergency Plan

REV.	DATE	STATUS	PREPARED	CHECKED	APPROVED
C1	04-03-11	Issued for Approval	MM	RR	NB

Drydocks World-Dubai

DET NORSKE VERITAS 1864
APPROVED
Date: 2011-03-10
DET NORSKE VERITAS AS

PROJECT	**POLARCUS SX 134 Seismic Research Vessel**
TITLE	**SHIPBOARD OIL POLLUTION EMERGENCY PLAN (S.O.P.E.P) FOR POLARCUS ALIMA**

DD REFERANCE NO.	HULL NO.	DOCUMENT NO.	SHEET NO.
S 9956	NB72	S9956-A-C- 001	1/42

Polarcus
EXPLORE GREEN

Drydocks World

SHIPBOARD OIL POLLUTION EMERGENCY PLAN
(S.O.P.E.P)

Polarcus Alima

Polarcus
EXPLORE GREEN

Drydocks World

Contents

SHIP PARTICULARS

Ship's Name	:	Polarcus Alima
Flag	:	Bahamas
Port of Registry	:	Nassau
Official Number	:	8001620
IMO Number	:	9538139
Call Sign	:	C6XK4
GRT	:	7894
NRT	:	2369
Length Overall	:	92.0 m
Breadth Overall	:	21.0 m
Draft	:	7.5 m
Classification Society	:	DNV
Type of Ship	:	Seismic vessel
Operator	:	Polarcus DMCC Almas Tower, Level 32, Jumeirah Lakes Towers P.O. Box 283373, Dubai, U.A.E.

INTRODUCTION

1) This plan is written in accordance with the requirements of regulations 37 of annex I of the International Convention for the Prevention of Pollution from Ships, 1973, as modified by the protocol of 1978 relating thereto.

2) The purpose of the Plan is to provide guidance to the master and officers on board the ship with respect to the steps to be taken when a pollution incident has occurred or is likely occur.

3) Without interfering with ship owners' liability, some coastal States consider that it is their responsibility to define techniques and means to be taken against a marine pollution incident, and approve such operations, which might cause further pollution. The plan required by MARPOL in the regulations referred to in paragraph 1 above, will not fully meet regulations in such States applicable to ships which carry oil in bulk. The USA is the notable example, and owners or operators of ships carrying oil as cargo in US waters must additionally:

a) identify and ensure, through contract or other approved means, the availability of private firefighting, salvage, lightering and clean-up resources;

b) identify a qualified individual with full authority to implement the response plan, including the activation and funding of contracted clean-up resources; and

c) describe training and drill procedures.

4) The plan contains all information and operational instructions required by the Guidelines. The appendices contain names, telephone, telex numbers, etc., of all contacts referenced in the Plan, as well as other reference material.

5) This Plan has been approved on behalf of the Administration and, except as provided below, no alternation or revision shall be made to any part of it without the prior approval of the Administration.

6) Changes to section 5 and the appendices will not be required to be approved by the Administration. The Company should maintain the appendices up to date.

REVISIONS

1) Revisions and amendments shall be indicated on the revision sheet.

2) This Plan will be regularly reviewed and updated. Revisions, other than those to section 5 and the appendices will be submitted to the Administration for approval. Review and revisions of the plan is the responsibility of The Company and will be carried out at intervals 12 months.

Polarcus EXPLORE GREEN

Drydocks World

1. PREAMBLE

Recent oil incidents have focused attention on the desirability of shipboard contingency plans. As a consequence, MARPOL 73/78 requires all ships to carry an oil spill contingency plan.

The emphasis throughout this plan is on practical actions which might be taken after a spill by shipboard personnel in order to assist those dealing with the spill to reduce the severity of the spill. These actions would result in a reduction of any damage to sensitive coastal resources and the environment in general.

Action taken to reduce effects of spill may expose ship and its personnel to increasing hazard and it is stressed that the master's priority in the event of a spill is to take measures to ensure the safety of personnel and the ship.

One copy of his plan is to be kept available onboard and one copy in the operational office on shore to assist personnel in dealing with an unexpected discharge of oil. Its primary purpose is to set in motion the necessary actions to stop or minimize the discharge and to mitigate its effects. Effective planning ensures that the necessary actions are taken in a structured, logical and timely manner.

2. REPORTING REQUIREMENTS

2.1 When to Report

The provisions of MARPOL 73/78 require an incident report to be made by the ship to the nearest coastal state whenever the incident involves actual or probable discharge.

It should be borne in mind that the master has a duty to report even when no actual spill has occurred, but there is a probability that one could occur.

The master should first report as fast as possible to head office/duty management and then to the local administration.

2.1.1 Actual Discharge

The definition of actual discharge is as follows:

a) a discharge, resulting from damage to the ship or its equipment, or for the purpose of securing the safety of a ship or saving life at sea;

or

b) a discharge during the operation of the ship in excess of the quantity or instantaneous rate permitted under MARPOL 73/78.

2.1.2 Probable discharge

Where a report should be made when there is a probability of discharge, depends on the following factors:

a) the nature of the damage, failure or breakdown of the ship, machinery or equipment;
b) ship location and proximity to land or other navigational hazards
c) Weather, tide current and sea state; and
d) Traffic density.
e) Morale, health and ability of the crew on board to deal with the situation.

It is impractical to lay down precise definitions of all types of situations involving probable discharge, which would warrant an obligation to report.

As a general guideline, the master should make a report in cases of:

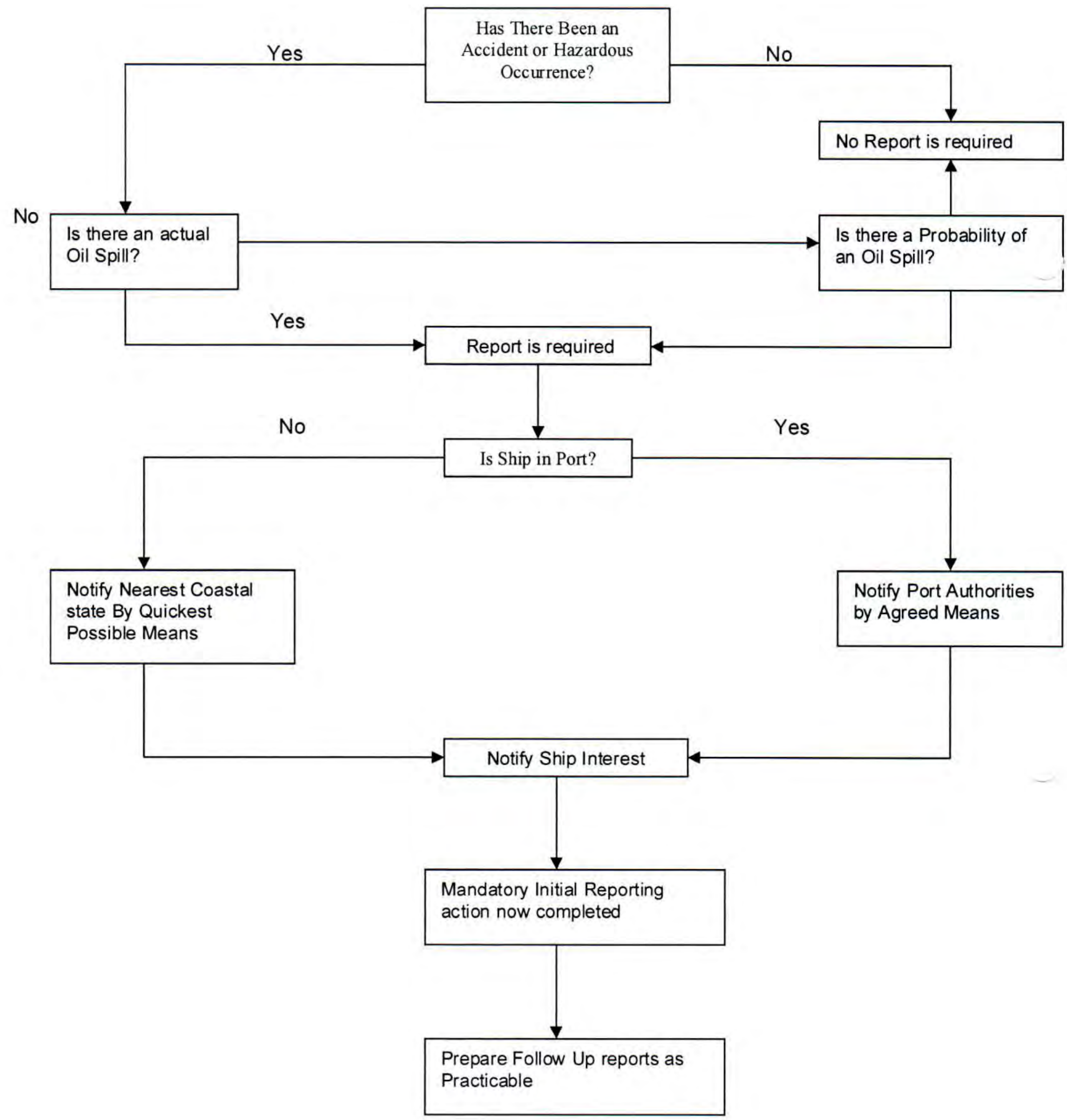
a) Damage, failure or breakdown which affects the safety of ship; example of such situations are collisions, grounding, fire, explosion, structural failure, flooding, cargo shifting; and

b) Failure or breakdown of machinery or equipment which results in impairment of the safety of navigation; example of such incidents are failure or breakdown of steering gear, propulsion, electrical generating system, essential shipboard navigational aids.

Polarcus
EXPLORE GREEN

Drydocks World

Reporting Requirements



2.2 Reporting Procedure

The reporting procedure to be followed by the Master or other persons in charge of the ship after an oil pollution incident is based on guidelines developed by the International Maritime Organization. ("*General principles for ship reporting system and ship reporting requirements, including guidelines for reporting incidents involving dangerous goods, harmful substances and/or marine pollutants*" adopted by the International Maritime Organization by Resolution A 648 (16)).

2.3 Information Required

2.3.1 Initial Report to Authorities

Reference should be made to IMO A. 648(16) for making the initial report to the authorities.

The Initial Report should contain the following information, and be in the form of (Table 1, page 15): -

a) Name of ship, call sign and flag.

b) Date, and time (GMT) of incident.

c) Ship's position (either latitude/longitude or true bearing and distance from a clearly stated landmark.)

d) Course at time of incident

e) Speed at time of incident.

f) Name of last port of call.

g) Name of next schedule port of call.

h) Full details of radio stations and frequencies being monitored

i) Type(s) and quantity(s) of cargo and board

j) Brief details of effects, damage, deficiencies or other limitations. This must include the condition of the ship and the ability to transfer cargo/ballast/fuel.

k) Brief details of any pollution. This should include the type of oil discharged, an estimate of the quantity discharged, whether the discharge is continuing, the cause of the discharge and if possible an estimate of the movements and area of the slick.

l) Brief details of weather and sea conditions

m) Name, address, telex and telephone number of owner or operator.

n) Ship size (Length, Breadth, Draft) in m and type of ship.

o) Brief details of incident

p) Need for outside assistance

q) Actions being taken

r) Number of persons on board

s) Details of P and I Club and local correspondent

2.3.2 Additional Information to Head Office

The following additional information should be sent to the head office either at the same time as the initial report or as soon as possible thereafter:

a) Number of casualties.

b) Further details of damage to ship and equipment.

c) Whether damage is still being sustained.

d) Assessment of fire risk and precautions taken.

e) Damage to other ship or property.

f) Disposition of cargo on board and quantities involved:

g) Time (GMT) assistance was requested and time (GMT) assistance expected to start.

h) Name of salver and type of salvage agreement. (Note, Head office to be consulted prior to engaging a salver).

i) Whether further assistance is required.

j) Priority requirements for spare parts and other materials.

k) Details of outside parties advised or aware of the incident.

2.3.3 Follow-up Reports to authorities and head office

Once the ship has transmitted the initial report to the shore authorities, further reports should be regularly sent to the authorities and head office; in order to keep them informed as the incident develops. Follow-up reports should include information on any significant changes in the ship's condition, the rate of release and spread of oil, weather conditions and details of agencies notified and any clean-up activities. Head office should also be advised of contact details for the on-scene commander appointed to control the clean up.

2.3.4 Characteristics of Oil Spilled

As well as giving details of the exact description of the oil lost, it will assist those involved in organizing the clean-up response if the precise characteristics of the oil are advised to shore authorities and head office. This information should include the following, if available, (and if known): -

- Type of bunker oil (cargo or bunkers)
- Specific Gravity, either in terms of API gravity or grams per cc.

- Viscosity at one or more temperatures, with the units and temperatures specified.

This information will enable those involve with the spill to assess the likely fate of the oil and organize the most appropriate response.

2.3.5 Cargo, Ballast and Bunker Disposition

When trying to Asses the on-going threat posed by a damage vessel, it will assist those involve if they are provided with details of bunker oil disposition and cargo oil (if any) obtained from the general arrangement plan.

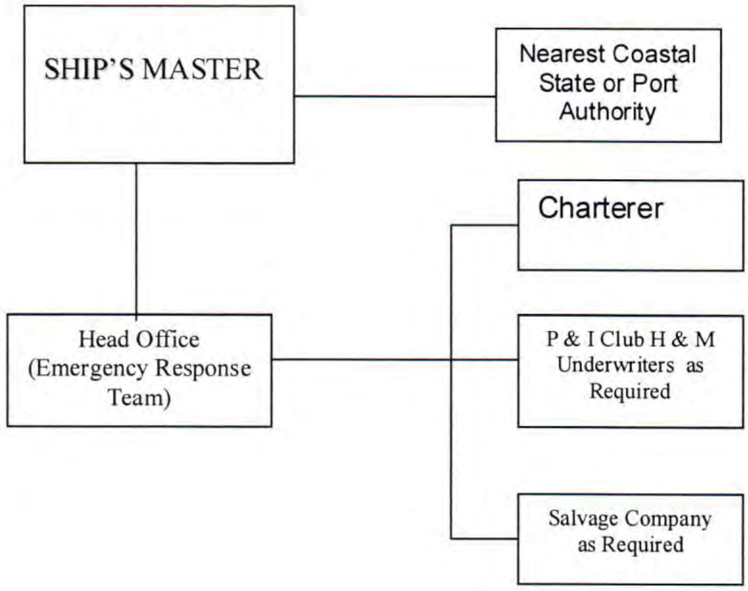
Information on the current cargo, bunkers and ballast (including quantities), specification and location is to be kept with this plan. The Master is responsible for ensuring that this information is kept up to date before the commencement of each leg of the voyage.

SHIPBOARD OIL POLLUTION EMERGENCY PLAN EMERGENCY PLAN

Sample format for initial notification

AA	(Ship name, call sign, flag)		
BB	(date and time of event, UTC) [D][D][H][H][M][M]		
CC	(position, latitude, longitude)OR [d][d][m][m][N or S] [d][d][m][m][E or W]	DD	(bearing, distance from landmark) [d][d][d] [N miles]
EE	(course) [d][d][d]	FF	(speed, knots) [kn][kn][1/10]
LL	(intended track)		
MM	(radio station(s)guarded)		
NN	(date and time of next report, UTC) [D][D][H][H][M][M]		
PP	(type and quantity of cargo/bunkers on board)		
QQ	(brief details of defects/defects/deficiencies/damage)		
RR	(brief details of pollution, including estimate of quantity lost)		
SS	(brief details of weather and sea conditions) Direction [ ][ ] [ ] WIND { Speed (Beaufort)		Direction [ ][ ] [ ] SWEEL{ Height (m)
TT	(contact details of ship's owner/operator/agent)		
UU	(ship size and type) Length: (m) Breadth: (m)		Draught: (m) Type:
XX	(Additional Information) Brief details of incident Need for outside assistance Actions being taken Number of crew and details of injuries Details of P & I Club and local correspondent & Others		

2.4 Whom to contact



Note: When an oil spill problem arises, the Master of the vessel should call the head office (The Company) as soon as possible, and the nearest coastal state or report authority. He should use the order of reporting to the Company as indicated in Appendix 3. Detailed instructions are indicated below.

2.4.1 Coastal States

The master has a statutory obligation to report an incident to the nearest coastal state, which should also be advised of the way the casualty situation progress. Full Co-operation should be extended to the authorities and all reasonable requests for information should be met.

Such reports should be transmitted either:-

a) When the ship is within or near to an area where a ship movement reporting system has been established, to the designated radio station of that system.

b) To the nearest coast radio station, designated ship movement reporting station or rescue co-ordination center on appropriate frequencies in the bands 405-525 kHz, 1605-2850 kHz: or

c) If the ship is not within reach of an MF or VHF coast radio station, to the most appropriate HF coast radio station.

d) The relevant maritime satellite communication system, as applicable.

In order to expedite response and minimize damage from a pollution incident, it is essential that appropriate coastal states be notified without delay. This process should begin with the initial report mentioned above (Table 1, page 15).

See Appendix 1 for list of authorities or officials of administrations responsible for receiving and processing reports as developed and updated by the Organization in conformance with article 8 of the Convention.

Should the master experience undue delay in contacting the responsible authority by direct means, or in the absence of a listed focal point, the master is advised to contact the nearest coastal radio station, designated ship movement reporting station or rescue co-ordination center by quickest available means.

2.4.2 Port Contacts

For ships in port, notification of local agencies will speed response.

Information on regularly visited ports is included in the appendix 2.

Should the port details not be included in the appendix, it is the responsibility of the master to obtain details of reporting procedures upon arrival in port. The Master shall append this information into the appendix for future use.

2.4.3 Ship Interest Contacts

Company Management

On becoming aware that a spill may be probable or if one has occurred, the master is to report the situation to one of the company executives listed in the Appendix 3. The head office response team shall contact relevant parties such as P & I Club, Insurers, and Classification Societies, cargo owners and salvers.

3. STEPS TO CONTROL DISCHARGE

3.1 Operational spills, which occur during the transfer of bunkers.

If, despite the adherence to proper procedures, an oil spill does occur, all bunker operations should be stopped by the quickest means and should not be restarted until the source of the leak has been identified and cured and hazards from the released oil have been eliminated. In most cases the cause of the leak will be obvious but, in some instances, such as spillage resulting from slight hull leakage, the source may be difficult to locate requiring the services of a diver.

The master is to ensure proper disposal of removed oil and clean materials. This may be through the use of on board resources or by hiring a clean up company, which shall be decide by the head office after consultation with the master.

3.1.1 Pipe Leakage

Should the leakage be from the ship's on-deck pipe work, the affected sections should be drained down to an availability empty or slack tank.

At its simplest, opening up the line to an empty tank could relieve pressure; other methods could involve using a pump to empty and de-pressurize. This latter option is used only when all compartments are full and the crew has a full understanding and appreciation of the safety implications involved, especially those relating to personnel access.

3.1.2 Tank Overflow

Should the spillage be due to the overflowing of a tank, dropping back to an empty or slack tank should lower the level within the tank. Should all other tanks be full, pumps should be ready and the excess oil transferred ashore.

3.1.3 Hull Leakage

Should spillage be due to suspected hull leakage, measures should be taken to reduce the head of oil in the tank involved either by transfer or discharge ashore. Unless timely corrective action is taken, oil will continue to flow out to sea until hydrostatic balance is achieved between the head of oil remaining in the tank and the seawater pressure exerted on the outer hull. Should it not be possible to identify the specific tank from which leakage is occurring, the levels of all tanks in the vicinity should be reduced, taking into account the effect on hull stress and stability. Should it be suspected that leakage is from a fracture in the bottom plating or lower shell plating, consideration should be given to reducing the level in the tank, if full, and then pumping water into the damage tank to prevent any further oil spillage.

Furthermore, no action should be taken that in any way could jeopardize the safety of personnel either onboard or ashore.

3.2 Spills resulting From Casualties (see checklist2, page 29)

A casualty spill is an oil spill, which occurs as a result of equipment or vessel damage. The most common cause is collision, fire or combination of these.

Each of the casualties listed below are treated separately, using checklists or other means where required. This ensures that the master considers all appropriate factors when addressing a casualty.

Specific personnel assignments for anticipated task are identified, however reference to fire control plans and muster lists onboard is sufficient to identify personnel responsibilities.

The following provides the master with guidance concerning:

- Priority actions
- Stress and stability considerations
- Lightening
- Grounding
- Fire/Explosion
- Collision
- Hull Failure
- Excessive List

3.2.1 Priority Actions

In the event of a casualty, the master's priority will be to ensure the safety of personnel and to take action to prevent escalation of the incident. In casualties involving spills, immediate consideration should be given to measures aimed at preventing fire and explosion, such as altering course so that the ship is unwind of the slick or shutting down non-essential air intakes.

If the ship is aground, and cannot therefore manoeuvre, all possible sources of ignition should be eliminated and action taken to prevent flammable vapours entering accommodation and engine room spaces.

When it is possible to maneuver, the master in conjunction with the appropriate shore authorities, may consider moving his ship to a more suitable location, for example, to facilitate emergency repair work or lightening operations , or to reduce the threat posed to any particularly sensitive shoreline areas.

Prior to considering remedial action, the master will need to obtain detailed information on the damage sustained to the ship. A visual inspection should be carried out and all bunker tanks, and other compartments sounded. Due regard should be paid to the indiscriminate opening of sounding pipe caps, especially when the ship is aground, as loss of buoyancy could result.

Having assessed the damage sustained by the ship, the master will be in a position to decide what action should be taken to prevent or minimize further spillage. When bottom damage is sustained, hydrostatic balance will be achieved fairly rapidly, especially if the damage is severe, in which case the time available for preventive action will often be limited.

When significant side damage is sustained in way of oil tanks, bunkers will be released fairly rapidly until hydrostatic balance is achieved and the rate of release will then reduce and be governed by the rate at which oil is displaced by water flowing in under the oil. When the damage is fairly limited and restricted, for example, to one or two compartments, consideration may be given to transferring oil internally from damaged to intact tanks.

3.2.2 Stress and Stability Considerations

Great care in casualty response must be taken to consider stability and stress when taking actions to mitigate the spillage of oil or to free the ship if aground. The master is ensure that these aspects are properly considered.

Internal transfers should be undertaken only with a full appreciation of the likely impact on the ships' overall stress and stability. When the damage sustained is extensive, the impact of internal stress and stability may be impossible for ship personnel to assess. Contact may have to be made with the head office in order that information can be provided so that damage stability and damage longitudinal strength assessments may be made.

The master shall make appropriate damage stability assessments using the stability booklet kept on board.

When the ship is damage, the following information should be sent to the head office (Appendix 3) in order that the stability and stress of the ship can be calculated:-

a) Loading Condition (Intact)

- Cargo/Ballast – amount and disposition
- Fuel oil – amount and disposition
- Draught – when free floating

b) Damage

- Location and extent

c) Condition of the ship

- Extent to which aground (soundings around ship)
- Draught – forward, amidships (port and starboard), aft
- Cargo and fuel – loss or change in amount or disposition
- Action already taken

d) Local Conditions

- Tide – range and weather rising or falling
- Wind – strength and direction
- Sea and swell - height and direction
- Current
- Weather forecast
- Air and Sea temperatures
- Other locally significant features

The above information, some of which will only be relevant in the case of grounding, should be supplemented with as much as detail as possible.

Once the stability of the ship has been computed, the head office will be in a position to advise the master on action that can be safely taken to minimize damage and prevent further pollution.

3.2.3 Lightening

Should the ship sustain extensive structural damage, it may be necessary to transfer all or part of the bunkers to another ship. During ship-to-ship transfer of bunkers, the master must ensure that safety standards and minimum equipment level are to be observed.

3.2.4 Grounding

If the ship is aground, and can not therefore maneuver, all possible source of ignition should be eliminated and action taken to prevent flammable vapors entering master, in conjunction with the appropriate shore authority, may consider moving the ship to a more suitable location in order, for example, to facilitate emergency repair work or lightening operations, or to reduce the thread posed to any particular sensitive shoreline areas. Such maneuvering may be subject to coastal state jurisdiction.

3.2.5 Fire / Explosion

In casualties involving spills, immediate consideration should be given to measures aimed at preventing fire and explosions, such as altering course so that the ship is upwind of a slick, shutting down non essential air intakes etc.

3.2.6 Collision

If a collision occurs:

- Sound the emergency alarm and initiate emergency procedures.
- Determine whether there are casualties.

The master should assess the situation for pollution purposes as follows, taking action where appropriate:

- Decide whether separation of the vessel may cause or increase the spillage of oil.
- If any oil tanks are penetrated, reduce the risk of further spillage by isolating penetrated tanks or transferring oil to slack or empty tank.
- If there is a spill of oil in connection with the collision, inform the appropriate parties in accordance with Section 2 of this plan.

3.2.7 Hull Failure

If the vessel suffers severe structural hull failure:

- Sound the emergency alarm and muster the crew.
- Reduced speed or stop to minimize stress on the hull
- Assess the immediate danger of sinking or capsize.
- Initiate damage control measures.

The master should then assess the situation for pollution purposes as follows:

- If oil has spilled, or it is necessary to jettison oil in order to maintain stability, inform the appropriate parties in accordance with Section 2 of this Plan.
- If the change in stability and stress cannot be calculated on board, contact the Company and arrange for the necessary calculations to be carried out.
- Consider the forecast weather conditions and the effect they may have on the situation.

3.2.8 Hull Failure

If excessive list occurs rapidly and unexpectedly it may be due to:

- Failure of the hull plating.
- Failure of an internal bulkhead between compartments
- Shift of cargo
- Flooding of the engine room, where free surface can cause a list
- Damage through grounding or collision.
- Incorrect operation procedures.
-

Steps to be taken immediately:

- Stop any bunkering or ballast operations in progress.
- Sound the emergency alarm and muster the crew.
- If under way. Reduce speed or stop.
- Establish reason for list.

Further measures

- If oil spilled, or it is necessary to jettison oil in order to maintain stability, inform the appropriate parties in accordance with section 2 of this plan.
- If possible, take corrective action to rectify the situation.

3.3 Initiating the clean up response

3.3.1 Small Operational Spills

In most instances, the ship's initial report to local authorities will trigger the mobilization of the local response organization. It is not normally practical for ship's personnel to be directly involved in the clean-up activities and their prime role is to provide as much information as is necessary to assist the response and co-operate fully with clean-up personnel. However, where their is no local response or there is a delay in it being activated, the master should the use of available shipboard materials to clean up or contain the spilled oil by, for example, using ship-stocked sawdust and rugs.

In cases of small operational spills, the ship should take whatever actions are necessary to prevent the oil escaping over side and, having done so, will need to take action to clean up the oil contained on desk.

It must be stressed that spilled oil should never be washed over side, nor should dispersant or de-greasants be used on oil in the water because their use could contravene local regulations. Once the oil is in the water, there is very little that the ship can do to respond practically and reliance must be placed on shore authorities and organizations.

3.3.2 Large Spills

In case of larger spills, the ship is even more restricted as to what action it can take to respond practically to the spill. In the case of a casualty, the safety of the ship and crew will also take priority. Invariably therefore, ship's actions will be limited to reporting details to the relevant authorities and head office and to requesting the appropriate clean-up response, if equipment is on board for fighting the oil spill overboard then the vessel should take immediate action to try to control the spill.

Operational Oil Spill Response (check list 1)

	Actions To Be Taken	Persons Responsible	Done
A	**IMMEDIATE ACTION**		
	Sound emergency alarm.	Any person	

	Initiate emergency procedures	Duty Officer	
B	**INITIAL RESPONSE**		
	Stop all bunkering operations.	Duty Engineer	
	Close all manifold valves.	Duty Engineer	
	Stop air intake to accommodations.	Duty Engineer	
	Stop non-essential air intake to engine room	Duty Engineer	
	Locate source of leakage.	Duty Engineer	
	Stop or reduce flow of bunkers.	Duty Engineer	
	Commence clean up operation using absorbent & permitted solvents.	Duty Officer	
	Comply with reporting procedures.	Master	
C	**SECONDARY RESPONSE**		
	Assess the fire risk from release of flammable substances.	Chief Officer	
	Reduce level of bunker in leaking tank by transferring to an unaffected tank.	Chief Engineer	
	Drain affected line to empty or slack tank.	Chief Engineer	
	Prepare pump for transfer of oil to other tanks, or to shore/lighter.	Chief Engineer	
	Prepare portable pumps if it is possible to transfer spilt oil to empty tank	Chief Engineer	
D	**FURTHER RESPONSE**		
	Pump water into leaking tank to create water cushion and prevent further oil loss	Chief engineer	
	Arrange diver for investigation if leakage is below waterline.	Master	
	Estimate stress and stability of the vessel, request shore assistance.	Chief Officer	
	Transfer bunker to alleviate high stress.	Chief Engineer	

Casualty Oil Spill Response (checklist 2)

	Actions To Be Taken	Responsible Person	Done
A	**IMMEDIATE ACTION**		
	Sound emergency alarm.	Duty Officer	
	Initiate emergency procedures	Duty Officer	

B	**INITIAL RESPONSE**		
	Stop air intake accommodation	Duty Officer	
	Stop non-essential air intake to engine room.	Duty Engineer	
	Assess further danger to ship & personnel such as capsize or immediate sinking of the ship	Master	
	Stop all bunkering and other non-essential operations.	Duty Engineer	
	Visual inspection of damage	Chief Officer	
	Sound all holds, ballast tanks, and void spaces	Chief Officer	
	Assess whether oil has actually been spilt or there is a probability that it will be spilt	Duty Officer	
	Comply with reporting procedures.	Master	
	Request for outside assistance	Master	
	Counter excessive list (if any).	Chief Officer	
	Contain spilt oil.	Duty Officer	
	Commence clean up operation using absorbent and permitted solvents.	Chief Officer	
C	**FURTHER RESPONSE**		
	Consider evacuation of non-essential crew.	Master	
	Assess likelihood of further damage to vessel or cargoes.	Master	
	Estimate stress and stability of the vessel, request for shore assistance	Chief Engineer	
	Request assistance to escort to port of refuge.	Master	
	Maneuver upwind of spill, or away from land. (if not grounded)	Master	
	Assess whether tide will worsen situation.	Duty Officer	
	Obtain weather forecast and assess its effects.	Master	
	Prepare pumps for transfer of oil or bunker to another tanks, or to shore/lighter	Chief Engineer	

4. NATIONAL AND LOCAL CO-ORDINATION

Quick efficient co-ordination between the ship and coastal state or other involved parties becomes vital in mitigating and effects of a pollution incident.

It is most important that assistance from local, national or international companies and organizations, if available, is obtained as quickly as possible by reporting any spill as detained in section 2 of this Plan. Additional assistance, if required and liaison with national and local agencies will be organized by the Company.

It is more important that the master obtains authorization from the relevant coastal state before undertaking certain mitigation actions. Authorization must always be sought when considering the use of dispersants to combat an oil spill. Many nations have regulations, which prohibit or strictly limit the use of dispersants. Thus, while there may be a temptation to use dispersant quickly before oil becomes emulsified, the master must not authorize such actions without the prior authorization of the nearest coastal state.

5. ADDITIONAL INFORMATION

5.1 Record Keeping and Sampling Procedures

It is essential that personnel onboard maintain a comprehensive, detailed record of spill events. Apart from detailing all actions taken on board, the log should also contain a record of communications with outside authorities, head office and other parties, as well as a brief summary of information passed and received, and decisions made. The observed movement of the spilled oil should also be recorded together with details of prevailing wind, current and sea conditions. When the spill occurs in port a brief description of areas contaminated by the oil will be useful together with information on other craft and facilities likely to be affected. Written data should be supported by photographs whenever possible.

Brief details of any response initiated by shore authorities should also be recorded and, when known, information on numbers of personnel engaged in the clean-up as well as type and quantity of clean-up equipment and material being used. It may be particularly useful to collect samples of all the different types of oil carried on board as well a sample of the spilled oil, especially in cases where is is suspected that not all the oil pollution comes from our source. If the ship is not responsible for a particular spill, photographs of the hull and deck may help in verifying this. Similarly, if another ship is observed spilling oil, this should be photographed, if possible, and reported on sighting.

Photographs of the oil on the sea close to the tanker may help in ascertaining the magnitude of the spill.

When taking samples, which may eventually be required as evidence in legal proceedings, it is essential to establish their authenticity. Collection of samples should therefore be witnessed and containers should be properly sealed and labeled. As pollution control authorities will probably also require samples for their own use, it may be appropriate for sampling to be undertaken as a joint exercise with samples being split between the two parties and authenticated at the same time.

5.2 Shipboard Response Materials

The following minimum stock shall be carried in the Bosun's Store, and must be replacement as required to ensure that it is always available:-

- 1 roll of Plastic Bags
- 2 pcs Sorbent Pads U94200
- 6 pcs Spill Kit Gloves
- 6 pcs 1- Time Suits
- 6 pair of Safety Boots
- 25 litres Aquabreak PX (waterbased cleaning chemical)
- 1pcs Jet Spray
- 5 litres Natural Handcleaner
- 1 pcs Oil Spill Kit Bag 1000 litres
- 8 pcs Sorbent Booms U94410S
- 1 pcs Oil Spill Kit Bag 1000 litres
- 1 pck Sorbent Pads U9450
- 1 pck Sorbent Rolls U94150S

5.3 Training and Exercise of Plan

The master shall be responsible for training procedures. Regular exercise will ensure that contingency arrangements function properly and all those likely to be involved in a spill, or the threat thereof, become fully familiar with their responsibilities. For any plan to be effective it has to be:

- Familiar to those with key functions on board the ship.
- Review and updated regularly, and
- Tested for viability in regular exercise.

5.4 Health and safety

Whilst cleaning up oil on deck, the crew must wear the necessary protective clothing.

Although it is unlikely that vapor from oil spilled on open water or open deck will remain in the area in sufficient concentration to present a major problem, the following precaution should be taken.

- All sources of ignition in the area must be removed or isolated.
- Spill should always be approached from an upwind direction.

5.5 References

The following publications are referred o in the text or are of particulars relevance to oil spill contingency planning:-

Manual on Oil pollution, Section II, Contingency Planning – (IMO)

ISBN 92 801 1233 3

Available from IMO, Publication Section 3.4

Albert Embankment, London SEI 7SR

Response to Marine Oil Spills – (ITOPF)

Available from Witherby & Co. Ltd.

32-36 Aylesbury Street, London ECIR OET

Provisions concerning the Reporting of Incidents Involving Harmful Substances under

MARPOL 73/78 – (IMO)

ISBN 92 810 1261 9

Available from IMO Publications Section

Peril at Sea and Salvage – A Guide for Masters – (ICS/OCIMF)

ISBN 0 948691 46 8

Available from Witherby & Co. Ltd., London

Resolution 684(16) International Maritime Organization

APPENDICES

Appendix 1 List of Coastal State Contacts

Appendix 3 List of Ship Interest Contacts

1. **Polarcus DMCC (Technical Manager)**
   Almas Tower, Level 32, Jumeirah Lakes Towers P.O. Box 283373, Dubai, U.A.E
   www.polarcus.com
   Emergency Phone (24/7) : +971 50 5545200
   DPA contact: ~~+971 50 4506857~~
   +971 502897015

2. **The Bahamas Maritime Authority (Flag State)**
   120 Old Broad Street
   London EC2N 1AR
   United Kingdom
   Tel: +44 20 7562 1300
   Fax: +44 20 7614 0655
   www.bahamasmaritime.com

3. **Gard (P&I Club)**
   Emergency contact for P&I matters: International: +47 90 52 41 00

4. **DNV (Class)**
   Bur Juman Office Tower, 14th Floor, Trade Center Road,
   Dubai, United Arab Emirates
   Phone: +971 4 3526626

Appendix 4 Records of Plan Review & Amendment (Revision)

Appendix 5 Records of Oil Pollution Prevention Drills

ANNEX 2

LIST OF NATIONAL OPERATIONAL CONTACT POINTS RESPONSIBLE FOR THE RECEIPT, TRANSMISSION AND PROCESSING OF URGENT REPORTS ON INCIDENTS INVOLVING HARMFUL SUBSTANCES, INCLUDING OIL FROM SHIPS TO COASTAL STATES

1 The following information is provided to enable compliance with Regulation 37 of MARPOL Annex I which, *inter alia*, requires that shipboard pollution emergency plans for oil (SOPEP) shall contain a list of authorities or persons to be contacted in the event of a pollution incident involving such substances. Requirements for oil pollution emergency plans and relevant oil pollution reporting procedures are contained in Articles 3 and 4 of the 1990 OPRC Convention.

2 This information is also provided to enable compliance with Regulation 17 of MARPOL Annex II which, *inter alia*, requires that the shipboard marine pollution emergency plans for oil and/or noxious liquid substances (SMPEP) shall contain a list of authorities or persons to be contacted in the event of a pollution incident involving such substances. In this context, requirements for emergency plans and reporting for hazardous and noxious substances are also contained in Article 3 of the 2000 OPRC-HNS Protocol.

3 Resolution MEPC.54(32), as amended by resolution MEPC.86(44), on the SOPEP Guidelines and resolution MEPC.85(44), as amended by resolution MEPC.137(53), on the SMPEP Guidelines adopted by the IMO require that these shipboard pollution emergency plans should include, as an appendix, the list of agencies or officials of administrations responsible for receiving and processing reports as developed and up-dated by the Organization in compliance with Article 8 (Reports on incidents involving harmful substances) and Protocol I (Provisions concerning Reports on Incidents Involving Harmful Substances) of the MARPOL Convention. Under Article 8 of Convention, each Party to the Convention shall notify the Organization with complete details of authorities responsible for receiving and processing reports on incidents for circulation to other Parties and Member States of the Organization. Attention is also drawn to both Guidelines which stipulate that "in the absence of a listed focal point, or should any undue delay be experienced in contacting the responsible authority by direct means, the master should be advised to contact the nearest coastal radio station, designated ship movement reporting station or rescue co-ordination centre (RCC) by the quickest available means".

4 The "List of national operational contact points responsible for the receipt, transmission and processing of urgent reports on incidents involving harmful substances, including oil from ships to coastal States" contained in the circular is updated at the end of each calendar year. This list is an update of that contained in MSC-MEPC.6/Circ.6 dated 31 December 2009, as amended.

5 The above mentioned "List" is available on the Internet and can be accessed as follows: http://www.imo.org/OurWork/Environment/PollutionPrevention/OilPollution/Pages/Shipboard-Marine-Pollution-Emergency-Plans.aspx (select "**SOPEP National Operations Focal Points**" on the right hand side of the given link) or http://www.imo.org (select either "**National Contacts**" or "**Circulars**" links on the bottom of the IMO homepage). This Internet version is updated on a quarterly basis and includes **a summary indicating which country has submitted changes to its information, since the previous update.**

6 On receipt of this latest version and in order to maintain an accurate list, it is necessary that Member States check their respective information to ensure that it is correct. Effective 29 February 2008, Member States are requested to directly update their respective information in the Global Integrated Shipping Information Systems (GISIS) using the reporting facilities of the Contact Points module.

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