5 ENVIRONMENTAL EFFECTS ASSESSMENT

This Chapter provides an assessment and evaluation of the potential environmental effects of the Project on the identified VECs, each of which is addressed in a separate subsection which follows the EA structure and methodology described in Chapter 3.

5.1 Key Project Components, Activities and Environmental Considerations

The primary components of a marine geophysical survey for petroleum exploration include a survey vessel, a sound source, a buoyant receiver cable (streamer with embedded hydrophones) and associated supporting elements and activities. During such a survey, the sound source (airguns) is towed behind a vessel while it travels along a track line in a prescribed grid, and is fired at regular intervals directing high energy (low frequency) sound bursts toward the seafloor which can penetrate below the surface. The reflected sound energy is then recorded by a sensitive hydrophone streamer or streamers up to several kilometres in length) towed behind the vessel near the ocean surface. Data processing systems convert the reflected sound (acoustic signals) into data that are used for geological mapping.

As described in Chapter 2, the proposed Project will entail the conduct of a 2D (single streamer) marine geophysical survey to collect seismic, gravity and magnetic data. The planned program is a regional Basin Span survey, which will occur within the May – December period, potentially each year from 2014 to 2018. The 2D seismic survey involves a maximum of 14,000 km of seismic survey acquisition each survey year within this period. The lines will be widely spaced (except where they cross in some locations). The Project will also include the operation of support craft, such as standby / picket vessels and aircraft.

The main components and activities that will be associated with the proposed Project, and which are particularly relevant to the environmental effects assessment, are therefore:

- The presence and movement of the geophysical survey vessel and other supporting vessels / aircraft;
- Seismic array sound and its introduction to and transmission through the marine environment;
- Other Project related noise (vessels, aircraft) and air emissions (exhausts);
- Lighting on Project vessels and aircraft;
- The generation of solid and liquid waste materials and their management; and
- Potential accidental spills or the loss of material/equipment (debris) into the marine environment.

Based on these key Project elements, some key environmental considerations that may be associated with marine geophysical surveys are listed below, with a focus on the VECs identified previously (adapted from AMEC 2013, 2014):

- Possible injury or mortality of marine animals resulting from exposure to seismic sound at very close range (e.g. within a metre or two for fish);

- Possible avoidance of locations that would otherwise be used, due to underwater noise or other disturbances during the survey, which may alter the presence and abundance of marine animals as well as disturbing their movements / migration, feeding, communication, or other activities;

- Attraction of marine animals to seismic and support vessels and their associated lighting, with increased potential for injury, mortality, contamination or other interactions;

- Possible contamination of marine animals and their habitats as a result of environmental discharges due to planned project activities and/or accidental events;

- Changes in the availability, distribution or quality of feed sources and/or habitats as a result of project activities and their environmental emissions;

- Potential effects on fisheries (landings and values) and other marine activities due to possible behavioural or biophysical effects on the marine environment (including resource abundance, distribution or quality);

- Reduced access to preferred fishing or other marine areas during survey activities in certain locations, with possible decreases in activity success, efficiency, value or enjoyment; and

- Potential damage to fishing gear, vessels of other equipment and infrastructure as a result of direct interactions with seismic equipment, activities or environmental discharges.

5.2 Environmental Planning, Management and Mitigation

Each of the various, potential environmental issues and interactions that may be associated with this proposed Project can be avoided or otherwise mitigated through the use of good planning and sound operational practices and procedures, supported by standard mitigations that are well established and outlined in relevant regulatory procedures and guidelines. These mitigations have been routinely and successfully applied to similar geophysical programs in the NL Offshore Area and elsewhere in recent years. For this Program, these will by supplemented by other specific measures (primarily directed towards fisheries mitigations) that have been developed through GXT's consultations and discussions with stakeholders and agencies; these were also used and proved to be effective during GXT's 2013 LabradorSPAN seismic program. All applicable measures from that program (as described in the EA for that Project as included below) will be applied for GrandSPAN as well. These planning and management measures, in combination with GXT's environmental management systems and associated policies, plans and procedures, will help to ensure that the Project will not result in significant adverse environmental or socioeconomic effects.

As described in Chapter 3, environmental planning, management and effects mitigation measures are considered integrally in the environmental effects assessment that is presented in this Chapter. This includes those that have been "built-in" to the Project through its planning and design in order to avoid or reduce

potential environmental issues proactively (Chapter 2) as well as the other environmental protection (mitigation) measures which are further identified and described in this section. Given that many of these proposed mitigation measures are integral to the planning and proposed implementation of the Project itself, and because most are relevant to one or more of the identified VECs, the key environmental mitigation measures for the Project are identified and described together in this initial section of the Chapter.

There are a number of key mitigation measures which are typically proposed and/or required in relation to seismic programs in the NL Offshore Area, including those outlined in the *Statement of Canadian Practice with Respect to the Mitigation of Seismic Sound in the Marine Environment* (DFO 2007a). These are included as part of the C-NLOPB's *Geophysical, Geological, Environmental and Geotechnical Program Guidelines*, and set out a series of mitigation requirements related to these activities, including measures related to the:

- Planning of seismic surveys;
- Establishment and monitoring of a safety zone for marine mammals and sea turtles;
- Prescribed marine mammal and sea turtle observation and detection measures;
- Prescribed pre-start-up and start-up procedures; and
- Prescribed shut-down requirements.

The C-NLOPB's *Geophysical, Geological, Environmental and Geotechnical Program Guideline* also include information and measures related to, for example, interactions with other ocean users and for seabird and marine mammal monitoring and reporting during and after offshore seismic survey work.

GXT recognizes that the careful and thorough implementation of, and adherence to, these and other such measures will be important for ensuring that the Project does not result in unacceptable environmental consequences. This section describes the mitigation measures that will be established and applied for this Project, some of which are founded in regulations, guidelines, or "best practices" as outlined above, while others have been developed specifically for this Project. These measures will be adhered to in each survey year, with adjustments as necessary.

5.2.1 Survey Layout and Location

The layout of GXT's Basin Span surveys (see typical line pre-plots presented in Figure 2.1), with very long and widely spaced lines - typically several hundred kilometres long and 50 or more km apart except where they cross - means that in most areas (fishing grounds and wildlife habitat) there will be only a one-time exposure to Project activities, unlike most 2D or 3D seismic surveys. With the seismic ship travelling at approximately 8.3 km / hour, for any given location, the survey will be tens of 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 or other location in any program year. The Project Area is an offshore one, and survey activities will therefore not take place in proximity to coastal areas. No part of the Project Area enters within 22 km of NL shorelines or islands (i.e. it does not enter within Canada's Territorial Sea).

5.2.2 Communications and Liaison

Consultations and discussions for this Project have indicated that frequent, timely and effective communications with fishing industry organizations / participants must be a central part of the fisheries mitigations for the survey. This will help to ensure that the seismic program does not operate in the area of active fisheries, and will allow the survey to plan its acquisition and proceed in the most efficient way possible in light of concurrent fishing locations. The following procedures and measures will be implemented for this Project. (These were also developed and applied successfully for GXT's 2013 LabradorSPAN seismic program.)

Information Exchange: On-going Project planning will be based on detailed and up-to-date information about the fisheries likely to be active in specific parts of the Project Area at specific times. Maps of recent fish harvesting activities (see Section 4.3.1) are a valuable planning tool, but exact times and locations are known to change somewhat from year to year. To be accurate, the information flow about current fishing activities will need to be a continuous 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 and harvesting companies on a regular basis, including through the mechanisms described below, such as the FFAW Petroleum Information Liaison person, the FLOs, direct contacts with representatives of relevant fisheries companies and organizations, and with DFO (for fisheries survey / research information). Operational details of these on-going communications will be finalized with the relevant representatives as the fishing season information and plans become known.

Ten / Five Survey Outlook: Plans of where the seismic ship will be working in the next 10 days will be sent by GXT to fishing organizations and/or fishers every five days (or on a similar functional schedule given conditions at the time). The GXT 10-day plan will indicate expected seismic survey locations, in light of expected fishing locations (as above) and various other factors (e.g. acquisition priorities, weather). These will be issued from the ship every five days, so that fisheries interests have an opportunity to respond if any of the planned acquisition raises concerns about a potential fisheries conflict, and so that this can be addressed. Issuing the 10-day plans every five days will also take into account the reality that the survey plans often have to change (e.g. because of weather, repairs, changing sea conditions).

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

As described in the 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 (Section 4.6 FLO Operational Responsibilities, Protocols and Communications) - will include the following:

- Be stationed on-board the Project seismic vessel and 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 the seismic vessel's bridge about best course of action to avoid gear and/or fishing activities;
- Serve as the 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 operational briefings;
- Attend safety meetings and participate in all relevant Health Safety and Environment (HSE) initiatives and procedures as requested;
- Complete and submit a daily report (electronic / hardcopy) including all observations, communications and meetings attended to the onboard Client Representative; and
- Other duties as identified and approved through consultation with the Operator and Service Provider.

The One Ocean Protocol document also notes that the FFAW / One Ocean Petroleum Industry Liaison (see below) usually prepares a Summary Report on fishing activity for the FLO, including Vessel Monitoring System (VMS) data (see below) before departure on the seismic ship, and continues to provide data to the FLO while on board the seismic vessel on an as-needed basis throughout the program. (See *www.oneocean.ca/pdf/2013%20Seismic%20Protocol%20Document.pdf*.) This will be very important information source considering the expected Project Area activities. The FLO would also assist if there are any gear damage incidents, as detailed below (Fishing Gear Damage 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. This

has become a standard and effective mitigation for seismic surveys over many years. Typical services provided include the following:

- Documenting the locations of known vessels for seismic survey operators, and providing current information about the locations of seismic activities and fishing activities;
- Regularly updating 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 and One Ocean;
- Providing information directly to fishers when requested via email or a toll-free phone line maintained for this purpose, based on the best-available data provided to them by the survey;
- Attempting to identify (from CFV ID numbers, etc.) any gear located in the water or involved in an incident, as requested by the survey operator;
- Providing survey information to fisheries groups and organizations as required; and
- Providing initial contacts (via email and/or the toll free phone number) for any gear damage or loss claims, for the survey's fishing gear compensation program.

GXT will establish a 24-hour a day, 7-days a week live SPOC operator to receive Project-related calls via a toll-free telephone number, as was done during LabradorSPAN. SPOC contact information will be broadcast in the Coast Guard Notices to Shipping and communicated to fishers through the above noted organizations and directly to fishing companies. The SPOC will also have duties if there are any gear damage incidents, as detailed below.

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

VMS Data: GXT will again access and use VMS data to understand and help avoid fishing locations and monitor area fisheries-related marine activities generally, for logistics and safety. This data source proved to be very valuable to the project during LabradorSPAN. The One Ocean Protocol (Section 3.3) notes that "One Ocean and

Fisheries and Oceans Canada (DFO) have an arrangement to provide Vessel Monitoring System (VMS) information to petroleum company members of One Ocean. The VMS program at DFO Newfoundland Region provides a satellite based, near real time, positional tracking system of fishing vessels within the Canadian Exclusive Economic Zone (EEZ), as well as foreign and domestic vessels in the Northwest Atlantic Fisheries Organization (NAFO) Regulatory Area outside the 200 nautical mile limit. The ability to access current fisheries data (location of activity) is an important component in the development of operational plans for offshore petroleum related activities. The VMS data generated by DFO consists of coordinates only and does not divulge information of a confidential or sensitive nature." GXT secured access to these data in 2013 and will do so again throughout the GrandSPAN Project.

Notices to Shipping: As a standard procedure and requirement, GXT will file and update such Notices 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 (toll-free phone number) for the survey's SPOC and Fishing Gear Damage program (see below).

Survey Start-Up Sessions (Project Ships' Crews): GXT places a strong emphasis on training and informing the at-sea Project personnel on each ship before the survey begins, through several presentation modules, about the environmental issues and concerns in the area in which they will be working, GXT's environmental commitments and regulatory requirements, safety, emergency response, the duties and authority of the MMOs and the FLOs, and other matters. Sessions will include showing the Canadian Association of Petroleum Producers (CAPP) "Fishery Liaison Officer Video" about the information provided by FLOs and the importance of their participation in offshore Newfoundland and Labrador exploration activities, as recommended in the One Ocean Protocol. Meetings will be led by GXT's Project and Environmental Managers and the FLO and MMOs will be present at key meetings. The FLO will also be given the opportunity to provide the information and detailed briefings described in the Protocol and the CAPP video to the ships' key operating personnel.

These sessions have proven to be very valuable for ensuring that all at-sea personnel understand GXT's commitments, the Project mitigations, and their individual environmental responsibilities.

Communications Follow-Up: As stated in the Consultations section (Section 3.2), GXT will continue to consult with fisheries (and other) groups before and during the Project (with the active participation of GXT 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: GXT will also follow several additional procedures / vehicles to facilitate effective and efficient communications for the Project, including the following:

- GXT will employ the latest technology in at-sea communications with and between the survey ships (VHF, HF, Satellite telephone and internet, VMS);

- GXT will provide regular and frequent operational e-mail communications directly to interested fishing organizations, companies, agencies, government (including Forces Canada) and regulatory personnel.

- GXT will provide information (the NotShip text) to the CBC Fisheries Broadcast;

- GXT will also issue a Newsletter (by email) during the survey to interests and any others who request to be added to the distribution list. This will provide information and updates about the Project. The newsletter will provide direct contact (telephone and email addresses) to the responsible GXT Managers;

- GXT will also establish a Project-specific web site to supplement the Newsletter and post recent information and Project contact details;

- GXT will supply photographs (from different points of view) of the planned survey vessels to the FFAW as requested so that fishers at sea have a better chance to identify them if they are in the area.

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

5.2.3 Fisheries and Science Surveys

Avoiding Fishing Areas: GXT will work with the FLO, at-sea contacts with vessels, and information provided by organizations / companies to avoid locations of active fishing.. In particular, for fixed gear fisheries (including large pelagic longlines), GXT will monitor the locations of active grounds where gear is or is likely to be deployed and plan its work away from them until the gear has been removed, The communications protocols and methods described above will be the key means for GXT to have the information needed about harvesting activities. Continuing contact between the Project and fishing group representatives, the on-board FLOs, the SPOC, DFO and the FFAW PIL will be essential for this process. GXT understands that fish harvesters are not required to move their vessels or gear from the seismic survey program area, and they will not be told to do so. This information will be clearly communicated at the start-up meetings (described above).

No Gear Deployment Enroute to Survey Area: GXT will not deploy its array or streamer in Canadian waters during transits to the Project Area. In addition, the FLOs will advise the vessel on the way to the area to ensure fishing gear is avoided by the ships during transits. Within the Project Area, a suitable location will be determined away from any fixed gear (such as crab pots) to begin deployment, with guidance from the FLO and other locational information.

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 to ensure that seismic operations did not interfere with the research survey. The procedures, which GXT will follow, involve adequate "quiet time" before the research vessel arrived at its survey location. The avoidance protocol includes a 30 km (16 nm) spatial separation and a seven day pre-research survey temporal separation.

Use of Scout Vessel: If there is a possibility of Project activities occurring in areas adjacent to active fishing, GXT will use a vessel (the program support ship or an additional smaller vessel) to scout ahead, usually along the planned route of a survey line, to make sure there are no fishing boats or gear in the area, to supplement the

VMS data Information about any sightings or radio communications will be relayed back to the survey ship and the FLOs.

Monitoring and Follow-up: As described above, GXT will continue to monitor the effectiveness of the mitigations during the survey, in consultation with relevant groups and mechanisms (such as the FLOs), and will consider these outcomes before subsequent year programs.

5.2.4 Fishing Gear Damage or Loss

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

The SPOC will follow through with any claim received, in communication with the FLO and the relevant fisheries organization or harvesting company. For responding to a claim, GXT 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 (Section 4.8 and 4.9) describes responses to a gear conflict to be followed on board a Project ship. GXT 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 FLOs will follow the following procedures:

- If personnel on board the GXT seismic and/or scout vessel observe fishing gear (abandoned, adrift or active) it should be communicated to the FLO. Gear should not be touched / retrieved by project personnel as it is illegal for anyone but the gear owner to move the gear;

- If the support / scout vessel makes the observation, personnel should record exact positions and name or Canadian Fishing Vessel (CFV) number on the gear (buoy/highflyer) and report it to the FLO;

- The FLO will communicate with fishing vessels in the vicinity in an attempt to identify the gear owner;

- If the CFV number is known, the FLO or the SPOC may be able to identify and contact the owner;

- If identification and contact with the gear owner is successful, the FLO will attempt to determine the plans/schedule of the gear owner with respect to the gear and will encourage the owner to communicate with the FLO at sea;

- If it is not possible to contact the gear owner the survey ship should attempt to work in another area and return to the location at a later time;

- The FLO will record the information in the daily report and submit it to the on-board Client representative;

- If there is any indication a project vessel or its equipment made contact with fishing gear it should be communicated to the FLO immediately;

- The FLO will contact the on-board Client Representative and vessel Master as soon as possible after discovery of the incident;

- The FLO will take all reasonable action to prevent any further or continuing damage, and will:

    - If possible, photograph the gear or gear debris in the water and after recovery;

    - If necessary, secure and retain any of the gear debris;

    - Record the incident in the Daily Report; and

    - File a Fishing Gear Incident Report and give it to the on-board GXT Client Representative;

- Any contact with fishing gear must be reported immediately even if no damage to the gear has occurred.

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

5.2.5 Marine Wildlife

The following marine mammal and sea turtle related measures are based on the *Statement of Canadian Practice with Respect to the Mitigation of Seismic Sound in the Marine Environment* (DFO 2007a), which are included as part of the C-NLOPB's *Geophysical, Geological, Environmental and Geotechnical Program Guidelines*.

Use of a Safety Zone: The survey will establish a safety zone which is a circle with a radius of at least 500 m as measured from the center of the air source array.

Pre-Start Up Watch: A qualified Marine Mammal Observer will continuously observe the safety zone for a minimum period of 30 minutes before array start up when the safety zone is visible, and will maintain a regular watch of the safety zone at all other times during which the array is active.

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. If the seismic survey is in an area that has been identified as critical habitat for a vocalizing cetacean listed as endangered or threatened on Schedule 1 of the *Species at Risk Act*, or one that has been identified as a species for which there could be significant adverse effects the array cannot start unless the full safety zone is visible and a pre-start-up watch has been completed.

Shut-down of Array: The air source array will be shut down immediately if any of the following is observed by the Marine Mammal Observer within the safety zone:

a) A marine mammal or sea turtle listed as Endangered or Threatened on Schedule 1 of the *Species at Risk Act*; or

b) 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, but ramp-up procedures will not be required when seismic surveying resumes.

Seabird Strandings: Any seabirds (such as 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.). GXT holds a CWS Migratory Bird Handling Permit, applicable to both ships. GXT will request that the ships 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 on an opportunistic basis. This will include observations about marine mammal responses and behaviour to the ships and/or the array. Seabird surveys (standardized counts) will be conducted throughout the seismic program from the seismic vessel by qualified environmental observer(s) 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) will be utilized. A schedule for conducting seabird surveys (likely three times per day) at appropriately spaced intervals will be followed.

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

5.2.6 Pollution Prevention and Incident Response

Waste Management: As described in the Project Description sections of this EA (Chapter 2), 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. 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 may 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 vessel's policies and procedures will be reviewed against the GXT Waste Management Plan, which will be filed with the C-NLOPB. Only ports with licensed waste contractors will be used for any waste returned from offshore.

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

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

Response to Accidental Events: In the unlikely event of the accidental release of hydrocarbons during the Project, GXT and its seismic survey contractor will implement the measures outlined in the Shipboard Oil Pollution Emergency Plans (SOPEPs) which will be filed with the C-NLOPB. In addition, GXT has an Emergency Response Plan (Appendix B) in place which bridges the emergency plans of all project entities and vessels to the local facilities and the Halifax Search and Rescue Region. The GXT representative onboard will represent GXT in all offshore Quality, Health, Safety and Environment (QHSE) activities. The GXT Project Manager (Dean Kennedy) will represent GXT onshore from an office in St. John's, NL.

The SOPEPs are designed to assist the ships' personnel in dealing with an unexpected discharge of oil or other such materials. The primary purpose is to set in motion the necessary actions to stop or minimize the discharge of such substances and to mitigate its potential environmental effects. Effective planning ensures that the necessary actions are taken in a structured, logical and timely manner. The primary objectives of this Plan are to prevent oil pollution, to stop or minimize oil outflow when damage to the ship occurs, to stop or minimize oil outflow when an operational spill occurs, and to help contain / clean-up a spill. The ships also carry spill kits which typically contain such equipment as:

- Air operated pump;
- Polypropylene scoops;
- Swabs, shovels, brooms with handle;
- Bags with absorbent;
- Absorbent sheets;
- Absorbent bond;
- Guard bond;
- Plastic drums;
- Plastic garbage bin;
- Plastic bags;
- Rubber gloves and boots; and
- Chemical protective suits

In the unlikely event of the spill, all Project-related ships would work together and utilize their gear to collectively respond to the incident and contain any released hydrocarbons.

Use of Solid Core Streamer: GXT will use a solid core streamer, manufactured by parent-company ION, and therefore there will be no risk of a leakage of streamer floatation fluid during the proposed Project activities.

A summary of some of the main mitigation measures that are planned to be implemented during the Project is presented in Table 5.1.

Table 5.1 Summary of Key Planned GXT Mitigation by Environmental Issue

Potential Issues and Interactions	Key Planned Mitigation Measures
Interference with fishing vessels / mobile and fixed gear fisheries	- Upfront communications, liaison and planning to avoid fishing activity - Continuing communications throughout the program - FLOs - SPOC - Advisories and communications - VMS data - Avoidance - Start-up meetings on ships
Fishing gear damage	- Upfront communications, liaison and planning to avoid fishing gear - Use of scout vessel - SPOC - Advisories and communications - FLOs - Compensation program - Reporting and documentation - Start-up meetings on ships
Interference with shipping	- Advisories and at-sea communications - FLOs (fishing vessels) - Use of scout vessel - SPOC (fishing vessels) - VMS data
Interference with research surveys	- Communications and scheduling; mapping locations - Avoidance
Temporary or permanent hearing damage/disturbance to marine animals	- Pre-watch of safety zone - Delay start-up if marine mammals or sea turtles are within 500 m - Ramp-up of airguns - Shutdown of airgun arrays for *endangered* or *threatened* marine mammals and sea turtles within 500 m - Use of qualified MMO(s)
Temporary or permanent hearing damage / disturbance to Species at Risk or other key habitats	- Pre-watch of safety zone - Delay start-up if marine mammals or sea turtles are within 500 m - ramp-up of airguns - Shutdown of airgun arrays for *endangered* or *threatened* marine mammals and sea turtles within 500 m - Use of qualified MMO(s) to monitor for marine mammals and sea turtles. [No critical habitat has been identified in or near the Study Area.]

Potential Issues and Interactions	Key Planned Mitigation Measures
Injury (mortality) to stranded seabirds	- Daily monitoring of vessel - Handling and release protocols - Minimize lighting if safe
Seabird oiling	- Adherence to MARPOL - Spill contingency and response plans - Use of solid streamer

5.3 Marine Fish and Fish Habitat: Environmental Effects Assessment

Fish and their habitats are important considerations in any EA of proposed projects and activities that occur within, and which may affect, the marine environment, particularly given the ecological and socioeconomic importance of fish and invertebrate populations in the Study Area. This VEC includes finfish and shellfish, as well as plankton, algae and other benthos because of the clear interrelationships among these ecological components as well as their habitats.

An overview of fish and fish habitat in the Study Area was provided in Section 4.2.1, including information on the life histories and known habitat preferences and reproduction and movement patterns of these species within the region. This information has been used to identify and evaluate the key potential interactions of the Project with this VEC and any resulting environmental effects and required mitigations. This analysis considers potential Project interactions with pelagic and demersal finfish and invertebrates, including egg, larval, juvenile and adult life stages.

5.3.1 Environmental Assessment Study Areas and Effects Evaluation Criteria

As described in Section 3.4, the EA focuses upon a number of spatial boundaries, including the:

> *Project Area*, which encompasses the overall area within which the proposed geophysical survey activities will take place; and
>
> *Study Area,* which encompasses the Project Area and the likely zone of influence of any Project related emissions (set at approximately 20 km beyond the area of proposed seismic data acquisition).

In addition to the above described spatial boundaries for the Project and its EA, the environmental effects assessment also considers the particular characteristics, distributions and movements of the individual VECs under consideration, including the larger Regional Areas within which they occur. Although these are not specifically “mappable” per se for the VEC overall, key aspects of marine biota movements and distributions as they relate to the Project and Study Areas are as presented in Chapter 4.

Ecological boundaries for marine fish and fish habitat vary between species in the Study Area, due to difference in their ranges, habitat preferences, movement patterns and key activities. The EA assesses potential effects to fish (individuals and populations) which are known or likely to use the EA Study Area during the period of planned survey activities, including those that occur in the water column or near the water’s surface or seafloor. The environmental effects assessment also considers the nature of likely Project-VEC interactions and the associated zone of influence of Project-related disturbances in the marine environment (particularly the propagation of sound from the seismic array).

The temporal boundaries encompass the potential timing of Project survey-related activities and the overall lifespan of the proposed Project, as well as the likely duration of any resulting environmental effects. In conducting the assessment, consideration is also given to timing of fish presence within the EA Study Area, any particularly sensitive or critical periods, and other factors.

The Project's likely environmental effects on this VEC are assessed and their significance is evaluated applying the above described spatial and temporal boundaries.

Significant environmental effects are considered to be those that could cause a change in a VEC that would alter its status or integrity beyond an acceptable and sustainable level. For the purposes of this EA, significant environmental effects on Marine Fish and Fish Habitat are defined as those that are likely to cause one or more of the following:

- Mortality or life-threatening injury to individuals of a designated (protected) fish species at risk, or destruction or alteration of the critical habitat of any such species;

- Effects to more than 10 percent of individual fish (of any species) within the area of Project-related emissions / disturbances, such that size, health, ecological function and/or sustainability of a fish population would be measurably and adversely affected; or

- Destruction of, or displacement of fish from, important feeding, spawning, nursery grounds, migratory routes or other essential habitats, during time periods and for durations over which the size, health, ecological function and/or sustainability of a fish population would be measurably and adversely affected.

5.3.2 Potential Environmental Issues and Interactions

The potential environmental interactions between offshore geophysical exploration activities and marine fish and their habitats may be both direct and indirect in nature, and can include the following (adapted from AMEC 2013, 2014):

- Possible injury or mortality due to exposure to seismic signals at very close range (particularly, immobile fish species);

- Behavioural changes by fish and invertebrates in response to insonification of the water column as a result of seismic energy, which could displace individuals and alter feeding, migration, predator avoidance and reproduction activities;

- Interference with (and the masking of) sounds that originate from and/or are interpreted by marine fish, such as in communication and the identification and detection of predators and prey;

- Potential contamination of fish and invertebrates and their habitats due to environmental discharges during routine activities (e.g., hydrocarbons or other deleterious substances in deck drainage);

- Changes in the presence, abundance, distribution and/or health of fish and invertebrates as a result accidental spills from exploration vessels (through physical exposure, ingestion, effects on prey and habitats, etc); and

- The introduction or further spread of invasive species (in ballast water or through attachment to the ship and seismic array).

An overview of the potential interactions between each of the main Project components and activities and the various key indicators and parameters that have been identified for this VEC is presented in Table 5.2, in order to help focus and frame the environmental effects assessment.

Table 5.2 Marine Fish and Fish Habitat: Potential Project-VEC Interactions

Project Component / Activity	Key Indicators and Parameters				
	Presence and Abundance	Habitat Availability and Quality	Feeding (Availability and Quality)	Migration and Reproduction	Health (Individuals or Populations)
Presence of Vessels / Streamer	●				
Seismic Sound	●	●	●	●	●
Other Sound (vessels, etc)	●				
Air Emissions					●
Lighting	●				
Solid Waste					
Liquid Waste					●
Potential Accidental Spills	●	●	●		●
On-Shore Activities					

5.3.3 Existing Knowledge

A considerable amount of research has been conducted on the effects of offshore seismic surveys (of various types and intensities) on marine fish. This has included scientific research, monitoring studies and anecdotal reports of observed reactions to such activities by various fish species. The possible effects on this VEC resulting from sound in the marine environment due to offshore seismic surveys may be behavioural (avoidance, other changes in distribution or activities) or involve injury to or mortality of individual fish. Although our 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 (such as vessel activity) have been documented across a variety of fish and invertebrate species in many studies.

Several relevant studies are summarized in Table 5.3. More detailed reviews of this information are available through other sources, including the Southern Newfoundland (LGL 2010), Orphan Basin (LGL 2003) and Eastern Newfoundland (AMEC 2014) SEAs, as well as other sources. The summary below is intended to provide a brief (and concise) overview of the known and likely environmental issues and interactions, as background and context for predicting Project effects and for identifying mitigation needs.

Table 5.3 Environmental Effects on Marine Fish and Fish Habitat: Summary of Existing Knowledge

Overview of Previous Studies	Summary and Key Findings
Seismic Noise: Potential Fish Mortality or Injury	
A number of studies have investigated potential injury to fish as a result of seismic airguns, such as damage to hearing structures (e.g. Popper et al 2005) and/or mortality of fish, fish eggs or larvae (e.g. Parry and Gason 2006). Most studies have found that stationary fish affected by seismic surveys had to be located within a few metres of airguns, caged close to the source after being subjected to multiple passes of the array (see McCauley et al 2003 and Turnpenny and Nedwell 1994 for a review). Studies using caged fish have also noted that the response of the fish is a vigorous attempt to move away from the sound (e.g. McCauley et al 2003). The effects of seismic surveys on marine phytoplankton, zooplankton and the planktonic life stages of various marine fish species have also been investigated (see Dalen et al 2007 for a review). Mortality of fish, fish eggs, and larvae has been observed only within a few metres of airguns (Kostyuchenko 1973; Dalen and Knutsen 1987; Matishov 1992; Kosheleva 1992; Holiday et al in Turnpenny and Nedwell 1994; Parry and Gason 2006). Seismic waves can, for example, have lethal or sublethal effects on plankton at short range (<5 m; Ostby et al 2003, in Boertmann and Mosbech 2012). In Norway, for example, it was estimated that 0.45 percent of planktonic organisms in the top 10 m of water could be killed by seismic activities (Sætre and Ona 1996). Davis et al (1998) estimated up to one percent of the ichthyoplankton in the top 50 m of the water column 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 m. Mortality of fish eggs, caused by exposure to seismic activities, was very low compared to natural mortality and was considered not significant to fish recruitment (Sætre and Ona 1996). Payne et al (2008) indicated there was no evidence for delayed mortality or egg loss in snow crab exposed under the conditions of an actual seismic program in deep waters off Cape Breton. In snow crab, over a period of days to several months, there were no effects of delayed mortality or damage to mechanosensory systems associated with animal equilibrium and posture. There was also no evidence of leg loss or other appendages (Payne et al 2008). A snow crab test group exposed to seismic sound showed elevated bruising of the hepatopancreas; bruising of ovaries; dilated oocytes with detached chorions (DFO 2004) (However, that study notes, “It was not known if these differences were due to environmental differences between the test and control sites”.)The timing and location of seismic activity and closeness to the array is a key factor in the likelihood and potential degree of effect. Airguns operating in areas and times of strong seasonal stratifications or upwelling may affect more planktonic material because of their high densities (Boudreau et al 2001).	• Studies indicate that plankton, eggs or larval mortality (if it occurs) would be limited to within a few metres of a seismic array. • There is little indication or evidence that direct physical damage to fish occurs at distances greater than several meters from the source, particularly due to the avoidance behaviour exhibited by mobile marine organisms.

Overview of Previous Studies	Summary and Key Findings
Although it is evident that fish often respond to sounds emitted from air guns (see below), little direct physical damage to fish occurs at distances greater than a few meters from the source. Due to the avoidance behaviour by free-swimming fish, they typically do not suffer physical damage from seismic surveys (Gausland 1993). Indeed, there are no documented cases of fish mortality under exposure to seismic sound under field operating conditions (DFO 2004; Payne 2004), nor have FLOs or other seismic ship's personnel reported observing dead fish around survey operations. Overall, exposure to seismic sound is considered unlikely to result in direct fish mortality (DFO 2004).	
Seismic Noise: Behavioural Responses	
Behavioural reactions to exposure to seismic noise have been widely documented in marine organisms (DFO 2004). When exposed to an operating air-gun, mobile marine fish may exhibit a range of responses, including alarm responses and temporary avoidance of the area (eg, McCauley et al 2000a, 2000b). When exposed to an operating air-gun, mobile marine fish may swim deeper, mill in compact schools or become more active (eg, Slotte et al 2004). Given the opportunity, fish will generally avoid areas where noise levels exceed their threshold of hearing by 30 dB or more (ICES 1995). There are well documented observations of fish and invertebrates exhibiting behaviours that appeared to be in response to exposure to seismic activity. These include startle responses, changes in swimming direction and speed, or changes in vertical distribution (Blaxter et al 1981, Schwartz and Greer 1984, Pearson et al 1992, McCauley et al 2000a, 2000b, Wardle et al 2001, Hassel et al 2003). Gadoids, for example, have been shown to leave the area during seismic surveys (Skalski et al 1992, Løkkeborg and Soldal 1993, Engås et al 1996, Slotte et al 2004, Parry and Gason 2006). Species such as cod, rockfish and whiting (*Merlangius merlangus*) have been reported to change depth in response to seismic pulses (Pearson et al 1992; Wardle et al 2001). Other studies have found that many species of fish dive to avoid intense sound (Protasov 1966, Schwartz and Greer 1984, Knudsen et al 1992). McCauley et al (2000 a, b) describes a more intense "generic" fish alarm startle response of seeking shelter in tight schools and moving near the bottom. Anthropogenic noise appears to have a more pronounced effect on larger fish (Engås et al 1996) and invertebrates (Wale et al 2013) than smaller individuals. In contrast, other studies indicate that fish do not change behaviour when exposed to an air gun (eg, Pickett et al 1994; Wardle et al 2001; Andriguetto-Filho et al 2005). Wardle et al (2001), for example, report that neither finfish nor invertebrates showed signs of moving away from a reef on the west coast of Scotland after four days of seismic airgun firing. Similarly, Pena et al (2013) indicated that feeding herring were undeterred by seismic activity as they approached to within 2 km of seismic operations. Snow crab located 50 m from a seismic source did not exhibit alarm responses, changes in physiology (Christian et al 2004), nor did they show evidence for effects on egg hatch time (Payne et al 2008).	• A wide range of behavioural responses by marine fish to seismic airguns have been reported in the literature and through anecdotal reports. • For the most part, however, any such responses (if they do occur) are expected to be localized and temporary, and of low ecological significance (except possibly in instances where key habitats or life stages such as reproductive activity are significantly and repeatedly affected). • Recent reviews also reiterate, however, that research results and observations have not always provided clear or consistent findings, and that our knowledge of the effects of anthropogenic noise on fish and invertebrates remains incomplete.

Overview of Previous Studies	Summary and Key Findings
Some studies indicate that any behavioural changes that do occur are very temporary while others imply that marine animals might not resume pre-seismic behaviours or distributions for several days (Engås et al 1996, Løkkeborg 1991, Skalski et al 1992). Most available literature (Blaxter et al 1981, Dalen and Raknes 1985, Pearson et al 1992, McCauley et al 2000a, 2000b, Davis et al 1998) indicates that the effects of noise on fish are brief and if the effects are short-lived and outside a critical period, they are expected not to translate into biological or physical effects. However, Slabbekoorn et al (2010), emphasize that the understanding of anthropogenic noise effects on fish remains incomplete.	
Seismic Noise: Observed Effects on Fishing Activity	
A number of studies have documented changes in fishing success rates during and following nearby seismic survey activity. Skalski et al (1992), for example, cite seismic activity as the cause of decreased fish abundance, and Lokkeborg (1991) observed reduced catches in fish for days following seismic exposure as a result of changes in fish behaviour. Similarly, Engås et al (1996) documented reduced catches within several kilometres that continued for days after seismic activity stopped. Catches for some species / gear types (such as gillnet catches of orange rockfish and halibut) have actually increased during seismic activity, whereas others (such as longline catches of haddock) have been observed to decrease. At larger scales, regions with seismic activity had decreased catches for only a few species for certain gear types (eg, saithe and haddock with gill nets; Vold et al 2009). Parry and Gason (2006) found no evidence of seismic effects on catch rates of Australian rock lobster. The effects of seismic activity on fish catch rates therefore appear to vary by species and gear type (Hirst and Rodhouse 2000; Lokkeborg et al 2012; Vold et al 2012). Fishers in the Study Area have also expressed concern that seismic activity can affect catch rates and the results of research surveys (AMEC 2014).	• Seismic activity has been shown to influence catch rates of fish in some areas. • The observed effects of seismic activities appear to vary, however, by species, gear type and other factors. • In some cases catches have appeared to temporarily decrease while in others they did not change or even increased during seismic activities. • Logically, if fish move away from the local of seismic activity, this might result in their moving toward the location of fish harvesting activity.
Seismic Noise: Sound Levels that may Affect Fish and Invertebrates (Physical and Behavioural)	
Studies of fish reactions to anthropogenic noise in the marine environment have produced a range of results across different sound levels and between species. Subtle behavioural changes of rockfish exposed to seismic sounds, for example, commenced at 149 dB and alarm response became significant at 168 dB (Pearson et al 1992). Eastern striped grunter displayed persistent C-turn startle responses at 182 – 195 dB (McCauley et al 2000a,b), whereas various fish showed startle responses to noises ranging from 183 - 207dB (Wardle et al 2001). The onset of 'alarm' behaviours typically begin at 156 – 161 dB (McCauley et al 2000 a,b) Blaxter et al (1981) found that schooling herring changed direction with a sudden noise level of 144 dB re 1 µPa. Lokkeborg and Soldal (1993) estimated that avoidance behaviour in fish occurs between 160 and 171 dB re 1 µPa. Engas et al (1996) noted that mild behavioural effects can extend to tens of kilometres from the source. This is supported by DNV Energy (2007, in Hurley 2009) which states that scare effects have been demonstrated in a radius of more than 30 km from the sound source.	• The effects of seismic exposure appear to differ by species and life stage. • Behavioural responses of fish begin to occur at sound levels above 155 dB. • Auditory damage in fish starts at 180 dB, transient stunning at 192 dB and internal injuries begin to occur at 220 dB (Turnpenny and Nedwell 1994) • Some invertebrate species show injury at levels as low as 217 dB while others can experience louder noises with no observable consequence.

Overview of Previous Studies	Summary and Key Findings
Some examples of studies which have investigated the *potential physical damage* to fish are a result of exposure to different levels of seismic sound are provided below. It should be noted that most of these studies exposed subjects at very close range to find these effects. • Matishov (1992) showed that five day old cod experienced delimitation of retina at 250 dB. • Cod eggs exposed to seismic shots (202 – 220 dB) showed no signs of injury (Dalen and Knutsen 1987). • No injury to red mullet eggs occurred at 210d B but eight percent were injured at 230 dB (Kostyuchenko 1973). • Swimbladders of anchovy larvae were ruptured at 238 dB (Holiday et al, in Turnpenny and Nedwell 1994). • Kosheleva (1992) reported no obvious physiological effects of fish beyond 1 m from a source of 220 to 240 dB. • Hastings (1990) reported that lethal threshold for fish occurs at 229 dB and a stunning effect in the 192 to 198 dB range. • At 217 dB, Matishov (1992) observed shell damage in Iceland scallops while urchins lost 15 percent of their spines. • No detectable differences were observed in mussels, crustaceans or periwinkles within 30 days after exposure to 229 dB seismic guns (Kosheleva 1992). • At 231.dB, Dungeness crab larvae molt times and long term survival was not affected (Pearson et al 1994). • Kostyuchenko (1973) reported more than 75 percent survival of fish eggs at 0.5 m from the source (233 db at 1 m) and more than 90 percent survival at 10 m from the source. • Cod larvae (220 dB) and fry (234 dB) were shown to experience immediate mortality, but eggs	• Depending on airgun source levels and accounting for sound spreading, behavioural effects could occur from less than 1 km to dozens of km from a seismic vessel's location (Turnpenny and Nedwell 1994). • The spatial range of behavioural responses in fish will vary greatly with changes in the physical environment in which the sounds are emitted (Turnpenny and Nedwell 1994) but can potentially extend up to several kilometres (Engas et al 1996; DNV Energy (2007 in Hurley 2009).

Overview of Previous Studies	Summary and Key Findings
showed no signs of injury (Dalen and Knutsen 1987) • Pollock eggs (242 dB) show delayed mortality (Booman et al 1996). • Brown Shrimp exposed to 190 dB showed no injury (Webb and Kempf 1998).	
Seismic Noise: Ability of Fish and Invertebrates to Detect	
Many fish species and invertebrates are capable of emitting noise that share frequencies with those of seismic noise (Myrberg 1980; Turnpenny and Nedwell 1994; Engen and Folstad 1999, Hawkins and Amorin 2000; Slabbekoorn et al. 2010). Some species use acoustic communication during reproduction, agonistic encounters and predator interactions (Slabbekoorn et al. 2010). Some fish are also able to distinguish and interpret competing sounds (MMS 2004). Marine invertebrates typically lack organs that detect pressure waves but some species (e.g. marine crabs) have statocysts that are capable of sound detection through particle motion (Popper et al 2001; Morley et al. 2014). Organisms that rely exclusively on particle motion (most invertebrates) to detect sound are more resilient to anthropogenic noise exposure (Morley et al. 2014) Hearing sensitivities of finfish are reviewed by Popper and Carlson (1998) and Popper et al (2003). Cod, salmon, America plaice and herring have hearing sensitivities between 80 and 200 Hz, with a sensitivity threshold at 80 to 100 dB re to 1µPa (Mitson 1995). Laboratory studies show that some crustaceans (e.g. Norway lobster) will respond to sounds that are within the frequency range of that used in seismic surveys (Goodall et al. 1990). Deep water species and those lacking swim bladders (e.g. Greenland halibut) may be less vulnerable to effects from seismic activities (Boertmann and Mosbech 2012)	• Both fish and invertebrates use sound in ecologically important processes (i.e. to communicate, understand their environment, avoid predators and forage). • Seismic frequencies can overlap with naturally produced noises and have the potential to disrupt (mask) an important sensory field for some marine animals.

5.3.4 Environmental Effects Assessment

The potential effects of the Project on Marine Fish and Fish Habitat will be spread across a relatively large area and time period, but any Project interactions with this VEC will be limited to a localized, one-time and short-term disturbance at any one location.

The following sections provide an assessment and evaluation of the potential effects of the Project on Marine Fish and Fish Habitat, including the seismic energy (underwater noise), vessel traffic and the various potential emissions (atmospheric, liquid and solid) that will or may be associated with Project activities. Mitigation measures to prevent or reduce adverse effects upon this VEC are identified and considered integrally within the effects analysis.

5.3.4.1 Presence and Movement of Project Vessels

The proposed Project will involve vessel traffic within the Project Area during the May – December period possible during multiple years, including the presence and movement of the seismic survey vessel itself, as well as a supply ship and possibly an additional small support vessel during operations in certain areas. Like all marine vessel activity, the operation of these vessels will introduce a number of perturbations into the marine environment, including the noise, lights and other potential emissions that are typically associated with marine traffic. Noise from vessels has been shown to mask the acoustic sensory environment of fish and invertebrates and affect behaviour (Slabbekoorn et al 2010, Wale et al 2013a, Wale et al 2013b; Morley et al 2014), although their remains an incomplete understanding of the overall environmental consequences of these disturbances (Slabbekoorn et al 2010; Morley et al 2014).

Although the presence and operation of these marine vessel may result in some degree of attraction, avoidance or other behavioural responses amongst individuals (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 similar to daily and frequent marine traffic in the area. During seismic survey operations, any vessel noise will likely be over-ridden by the acoustic outputs of the seismic airguns, as discussed below, and will therefore not be a detectable contributor to any Project-related noise effects on marine biota.

5.3.4.2 Seismic Sound

As summarized above, a wide and varied range of physiological and behavioural responses by marine fish to seismic airguns have been reported in the literature and through anecdotal reports. Previous studies indicate that seismic effects vary by species, life stage, intensity of sound, distance from source and in the case of fishing effects, by gear type and other factors.

Individual species differ in their sensitivity and reactions to underwater noise, with some groups of organisms (such as finfish) having elevated vulnerability due to the presence of hearing organs and/or air filled structures (swim bladders), whereas many invertebrates show much more limited effects of exposure to seismic activity, typically even at very close range. More mobile fish species and life stages are able to avoid behaviourally the more acute possible effects of seismic exposure (mortality and injury) by moving away from the source, whereas some larval stages may be unable to avoid such exposure. Even in very close proximity (a few metres),

however, eggs and larvae have been shown to exhibit only modest levels of mortality, particularly in comparison to natural causes of mortality.

Previous studies therefore indicate that although some immobile components or species may be affected through injury or mortality due to close exposure to seismic energy, there is little indication that any such direct physical damage to fish occurs at distances greater than several meters from the source. The avoidance behaviour exhibited by mobile fish species further reduces the potential for such effects, and there have been no reports of observed fish mortality under exposure to seismic survey activity in the field. A wide and varied range of behavioural response to seismic airguns have been observed and reported, however, including altered distributions and changes in activity such as increased refuge seeking or schooling. Although past studies and reports that these have not provided definitive or consistent findings, any such responses (if they do indeed occur) are expected to be somewhat localized (up to several kilometres from the source) and temporary in nature.

Operational procedures, such as the standard use of a gradual "ramp-up" procedure over a minimum 20 minute period to allow mobile marine animals to move away from the area if they are disturbed by the underwater sound levels associated with the seismic survey, will also help further to avoid fish injury or morality, as will the planned shut-down of seismic sound source (or reduction to one array element) during transit for line changes and maintenance activities. The very localized and short-term nature of these underwater disturbances at any one location and time during the seismic program and the wide spacing of the seismic acquisition lines also considerably reduces the potential for adverse effects through either injury or disturbance / avoidance. With the seismic ship moving continuously at approximately 4.5 knots (8.3 km / hour), the vessel and associated survey equipment will be tens of kms away from any particular location within a few hours. Once it departs a survey site, the vessel will not return to that location, except for grid crossing points although any Project presence at those locations will be separated by days, weeks or even longer.

It is therefore very unlikely that any fish will be displaced from key habitats or disrupted during key activities (such as reproduction) over extended areas or periods, or be otherwise affected in a manner that causes negative and detectable effects to fish populations in the region.

5.3.4.3 Other Possible Environmental Discharges (Routine or Accidental)

Other potential environmental emissions relate to the release of oily water and discharges such as deck drainage, bilge water and other possible sources of emissions from offshore vessels. Any such potential discharges to the marine environment will be managed through strict adherence to applicable regulations and standards (Chapter 2), which will prevent adverse effects upon fish and their habitats. Atmospheric emissions during offshore activities would originate from vessel exhaust and from the burning of fuel in any other on-board equipment, although these would be negligible overall. Each of the vessels involved in this Project will manage and dispose of their waste products in accordance with applicable regulations and standards, and will have a Waste Management Plan in place that will be strictly adhered to throughout the life of the Project.

Although the potential for, and possible magnitude of, accidental events that could occur during a marine geophysical program are far lower than those that may associated with offshore drilling (exploration or production), one potential source of spills into the marine environment that is somewhat unique to seismic programs is an accidental release of fluid from a streamer. Both solid and fluid-filled streamers are used in the

offshore oil and gas industry, and many of the seismic operators that work in the North Atlantic use non-solid streamers which contain light oils or kerosene (for floatation purposes only). Although the potential for, and possible environmental implications of, such a spill is relatively low (especially due to the high volatility and relatively small volume of the spilled streamer fluid), only solid streamer sections will be used for this Project. This will avoid any risk of streamer fluid being accidentally discharged into the marine environment at any time during the survey program.

Again, because the proposed geophysical program will not result in the recovery of oil and gas resources from the seafloor, the potential for, and likely magnitude of, any such accidental spill is relatively low as compared to other types of offshore exploration and production activities, and the possible spills would be no greater in volume than for an equivalent sized cargo or fishing ship. There will, however, be limited amounts of marine fuel and oils onboard the seismic and support vessels that could potentially be spilled into the ocean. Fuel spills can have lethal and sublethal impacts on a variety of taxa including phyto and zooplankton, benthic invertebrates and fish (Teal and Howarth 1984). 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 an Oil Spill Response Plan in the unlikely event of a spill.

Invasive species can threaten aquatic ecosystems, occupying habitats or out-competing native species, introduce new diseases and altering ecosystem processes (Bax et al 2001). These species may show rapid population growth in the absence of natural predators and may soon become established to the point where eradication is impossible. Local and international marine transport in general is implicated in many of the accidental introductions of marine invasive species, as ship hulls and bilge water serve as vectors for the range expansion of such species (Bax et al 2001; McKenzie et al 2011; Benoit et al 2012). Several invasive alien species have been identified in the NL Offshore Area (Templeman 2010), all of which have been shown to have detrimental effects on the native species and ecosystem, although these effects are generally thought to be more important to the benthic coastal communities as compared to in the open ocean (Templeman 2010).

As with any ocean-going vessel in international waters or on the Grand Banks, the presence of Project-related vessels in the Study Area could result in the accidental introduction and spread of invasive species. Prevention is considered to be key in controlling the introduction and spread of such species, as control of established populations is often costly and ecologically risky (Bax et al 2001). The likelihood of introduction of invasive species will depend on the recent sailing history of the vessel and its operational practices (cleaning schedule, ballast water management etc.). Vessels from foreign waters that are biofouled have greater potential to serve as vectors for such species (Benoit et al 2012). It is also important to note that these ships do not carry or use ballast water since they are not container carriers or tankers, and therefore do not require balasting.

Although the likelihood that a Project vessel will result in the introduction and spread of an invasive species is low, some of the mitigations that will help to further prevent this include:

- All Project vessels - if carrying ballast - would comply with the requirements of the *Canada Shipping Act*, including the associated *Ballast Water Control and Management Regulations* during ballasting and de-ballasting activities;

- Measures will be taken to minimize biofouling on the ships' hulls and seismic array; and
- Movements between the Study Area and foreign waters during the Project are very unlikely.

A summary of the predicted (residual) environmental effects of the Project on Marine Fish and Fish Habitat is provided in Table 5.4 below.

Table 5.4 Marine Fish and Fish Habitat: Environmental Effects Assessment Summary

Project Activity and Potential Effect(s)	Environmental Effect Descriptors						
	Nature	Magnitude	Extent	Duration	Frequency	Reversibility	Certainty
Presence of Vessels / Streamer • Disturbance • Introduction / spread of invasive species	A	L	2	2	6	R	H
Seismic Sound • Potential injury • Disturbance	A	L	3	2	5	R	H
Other Sound (Vessel, etc) • Disturbance	A	L	2	2	5	R	H
Air Emissions • Exposure / contamination	A	N	5	2	3	R	H
Lighting • Disturbance	A	N	2	2	3	R	H
Solid Waste • Exposure / contamination	N	-	-	-	-	-	H
Liquid Waste • Exposure / contamination	A	N	2	2	2	R	H
Potential Accidental Events • Potential injury • Exposure / contamination	A	L	2	1	1	R	H

Overall, Resulting Effect(s) of Project on the VEC	Evaluation of Significance
• Project effects, if they occur, are likely to entail low level, localized, and ephemeral disturbance to individual fish and invertebrates. • The Project is not anticipated to have substantial negative effects on any species, or especially, at the population level.	• The proposed Project is not likely to result in significant adverse environmental effects on Marine Fish and Fish Habitat

Nature / Direction:	**Magnitude**:	**Geographic Extent**:	**Duration**:	**Frequency**:
A = Adverse	N = Negligible or No Effect	1 = < 1 km^2	1 = < 1 month	1 = <11 events/year
N = Neutral or No Effect	L = Low	2 = 1-10 km^2	2 = 1-12 months	2 = 11- 50 events/year
P = Positive	M = Medium	3 = 11-100 km^2	3 = 13-36 months	3 = 51-100 events/year
	H = High	4 = 101-1,000 km^2	4 = 37-72 months	4 = 101-200 events/year
		5 = 1,001-10,000 km^2	5 = > 72 months	5 = >200 events/year
		6 = >10,000 km^2		6 = Continuous

Project Activity and Potential Effect(s)	Environmental Effect Descriptors						
	Nature	Magnitude	Extent	Duration	Frequency	Reversibility	Certainty
Reversibility:	**Certainty in Prediction:**						
R = Reversible	L Low						
I = Irreversible	M Moderate						
	H High						

As described above, the proposed Project is not likely to result in significant adverse environmental effects on Marine Fish and Fish Habitat.

5.3.5 Cumulative Environmental Effects

The environmental effects of individual projects and activities are not necessarily mutually exclusive of each other, but can accumulate and interact in environmental systems to result in cumulative environmental effects. The C-NLOPB's Scoping Document for this EA requires an assessment of the "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".

Marine fish and their habitats in the Study Area and in the larger Northwest Atlantic have been and are being affected by a variety of natural and anthropogenic factors and processes. These include past and on-going fishing activity, offshore petroleum exploration and production, general vessel traffic and other human activities, as well as the effects of climate change and other processes. These have all collectively influenced the presence, distribution and abundance of fish and invertebrate species in particular areas, depths and times, as well as the overall size and health of fish populations. The effects of previous and on-going projects and activities within the Study Area (and elsewhere) are thus reflected in the existing (baseline) environmental conditions for this VEC, as described in Section 4.2.

As described in the preceding sections, offshore oil and gas activities may affect marine fish and fish habitat through direct and indirect influences. This includes possible injury, mortality or behavioural effects due to noise or other disturbances in the marine environment, possible contamination resulting from routine activities (discharges) or unplanned and accidental events (oil spills), and through the alteration of marine habitats. The proposed Project that is the subject of this EA will have the potential to interact with fish within and adjacent to the proposed Project Area, although as described in Chapter 2, the geophysical survey itself will involve a single vessel operating within parts of a very large survey area, potentially over a multi-year period. The proposed survey lines will be spaced quite far apart, and the vessel and its sound source will only be present in any one location for a very short time. Any potential interactions with fish and fish habitat as a result of the Project will therefore entail a very short-term, infrequent and mild environmental disturbance at any one location and time, and with the implementation of the mitigation measures outlined in this EA, the Project will itself not likely result in significant adverse effects to this VEC.

In terms of other on-going and future projects and activities which may affect fish and fish habitat within the Study Area, the commercial fishing industry will continue to be a key influence, resulting in fish catches (mortality) and habitat disturbance through current and future fishing activities, practices and management processes. The rather dynamic nature of fishing activity throughout the region (in terms of fishing locations, seasons, gear types and key species) makes it difficult to predict specific areas and times from year to year for

both domestic and foreign fleets, and thus, the potential for interactions between activities and their effects. The eastern and southern portions of the NL Offshore Area are also subject to on-going and planned offshore oil and gas development (particularly, in the Jeanne d'Arc Basin) and exploration activities, including a number of proposed offshore seismic programs which were being subject to EA review by the C-NLOPB as of the time of writing (Section 3.4). Offshore petroleum exploration and development activities also have associated vessel traffic, and there are vessel movements associated with fishing vessels, cargo transport, and other marine activities that will continue to occur throughout the region. The widespread and migratory nature of many species also increases the potential for fish populations to be affected by multiple perturbations, and therefore, for cumulative environmental effects to occur.

The vessel presence and movements associated with the proposed Project would represent a very small fraction of the total marine activity in the eastern and southern portions of the NL Offshore Area. Although the often extensive survey areas covered by offshore seismic surveys can increase the potential for spatial interactions between their effects and those of other projects and activities in the marine environment, the proposed survey vessel will only operate for a very short period of time in one location, resulting in a short-term disturbance within a relatively limited zone of influence. This will reduce the potential for particular individuals and populations to be affected through multiple interactions with this Project and other activities in the marine environment, and for species populations to be affected simultaneously and repeatedly by multiple projects and activities.

As a result, the proposed Project is not likely to result in significant adverse cumulative environmental effects on fish and fish habitat in combination with other projects and activities that have been or will be carried out. Moreover, the relative contribution of this Project and its potential effects to any overall effects on this VEC within the Study Area will be very low, and will not likely be perceptible.

5.3.6 Environmental Monitoring and Follow-up

GXT is committed to obtaining all required authorizations for the proposed Project, and to complying will all applicable regulations, guidelines and mitigations as identified and committed to in the proceeding sections, the implementation of which will be planned, managed and tracked in accordance with GXT's existing operational procedures and policies. No specific follow-up related to the Marine Fish and Fish Habitat VEC is considered necessary in relation to the proposed Project.

5.4 Marine Fisheries and Other Activities: Environmental Effects Assessment

Marine fisheries are an important and integral component of the socioeconomic environment of Newfoundland and Labrador, including the various communities and regions that surround the Study Area. A number of other human activities also occur throughout the marine environment that comprises the Study Area, including commercial and recreational pursuits.

5.4.1 Environmental Assessment Study Areas and Effects Evaluation Criteria

As described in Section 3.4, the EA generally focuses upon a number of spatial boundaries, including the:

Project Area, which encompasses the overall area within which the proposed geophysical survey activities will take place; and

Study Area, which encompasses the Project Area and the likely zone of influence of any Project related emissions (set at approximately 20 km beyond the area of proposed seismic data acquisition).

In addition to the above described spatial boundaries for the Project and this EA, the effects assessment for this VEC also includes consideration of the overall geographic extent and spatial distribution of fishing and other human activities within and adjacent to the Study Area, as well as the seasonality of particular activities and these sectors as a whole, including any key times.

Significant environmental effects on the Marine Fisheries and Other Human Activities VEC are defined as follows:

- For *commercial activities*: Those that are likely to cause a detectable reduction the overall economic returns generated from commercial fisheries or other marine activities within the Study Area over one or more years.

- For *recreational activities*: Those that would result in a decrease in overall activity levels and/or the enjoyment or cultural value of such activities for a community or region over multiple years.

5.4.2 Potential Environmental Issues and Interactions

Possible interactions between offshore petroleum activities and other human activities may again be both direct and indirect in nature and cause, and include (adapted from AMEC 2013, 2014):

- Damage to fishing gear, vessels or other components and equipment as a result of direct interactions with oil and gas related equipment, activities and/or environmental discharges (routine or accidental);

- Reduced access to preferred fishing grounds or other marine areas during offshore oil and gas activities, with possible resulting decreases in the success, efficiency, enjoyment and/or value of these pursuits;

- Indirect effects on fisheries or other uses of the marine environment due to possible biophysical effects on marine biota (resource abundance, distribution or quality – real or perceived) resulting from planned activities or accidental events such as spills;

- 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.

An overview of the potential interactions between each of the main Project components and activities and the various key indicators and parameters that have been identified for this VEC is presented in Table 5.5.

Table 5.5 Marine Fisheries and Other Activities: Potential Project-VEC Interactions

Project Component / Activity	Key Indicators and Parameters				
	Distribution and Intensity of Marine Use / Activity	Effectiveness and Efficiency of Marine Use / Activity	Abundance, Location and Quality of Marine Resources	Quality and Value of Marine Activities (Economic)	Quality and Value of Marine Uses (Socio-cultural)
Presence of Vessels / Streamer	●	●	●	●	●
Seismic Sound		●	●	●	●
Other Sound (vessels, etc)			●		
Air Emissions					
Lighting			●		
Solid Waste			●		
Liquid Waste			●		
Potential Accidental Spills	●	●	●	●	●
On-Shore Activities					

5.4.3 Environmental Effects Assessment

The following sections provide an assessment and evaluation of the potential effects of the Project on Marine Fisheries and Other Activities, including each of the components and activities that will be associated with the Project. Again, mitigation measures to prevent or reduce adverse effects upon this VEC are considered integrally within the environmental effects analysis.

5.4.3.1 Presence and Movement of Project Vessels and Survey Equipment

The potential for the Project to interact with and affect marine fisheries and other human activities will clearly depend upon the specific location and timing of these activities, their potential for overlap, and the equipment or gear involved. Fishing and other commercial and recreational pursuits occur throughout the May-December period, and given the limited manoeuvrability of the seismic vessel during survey activity (due to the length of the deployed streamer and other factors), other mobile vessels must normally give way for safety reasons under the *Shipping Act*. A greater potential for a conflicting interaction would be for fixed fishing gear (such as crab pots) that have been deployed along or near a survey line at the same time as

planned Project activities. Both of these situations will therefore require advance planning and avoidance to minimize the potential for affecting fisheries.

A description and mapping of marine fisheries within the Study Area was provided in Section 4.3.1, based upon existing and available catch statistics and geospatial information provided by DFO. As illustrated, a variety of commercial fisheries occur within and throughout the Study Area at various times, and the region is characterized by a complex (and dynamic) spatial and temporal mosaic of fishing and other marine activities, including with regard to the location, timing and intensity of specific activities, the particular marine resource (species) of interest, and the equipment types used, and other factors. Although there are limited known Aboriginal fisheries in the Study Area, the Miawpukek First Nation harvests a number of fish species in and around the Study Area as part of on-going commercial fisheries, particularly in NAFO 3Ps, and recreational fisheries take place off southern and eastern Newfoundland in season (particularly near the coast).

Detailed and specific operational plans for the proposed survey work - including for each of the potential five years of activity - are not (and cannot be) available at this stage, since the specific locations of later year's lines will depend on previous year's findings, changing commercial interests, etc. At this point 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 there.

Based on the potential environmental issues and interactions outlined above, the Proponent's experience with previous oil and gas exploration activities in the NL Offshore Area and elsewhere GXT has identified and committed to a number of principles and procedures to help prevent adverse interactions between the Project and other marine activities, in addition to the standard measures typically applied for 2D marine programs. These include "built in" mitigation as part of overall Project planning and design, as well as additional measures to further avoid or reduce potential adverse effects, which are outlined in detail in Section 5.2 and summarized below:

- Project location / layout and equipment, including the planned survey focus on the offshore marine environment, its relatively long and widely spaced survey lines, and the use of solid-core streamers;

- Operational procedures, such as soft-start / ramp up procedures, no gear deployment or array testing while en route to the survey area, and the use of a support vessel to identify and coordinate activities in active fishing areas when required;

- Active and continuous communications and coordination procedures throughout the life of the Project, involving GXT, industry representatives and regulatory authorities. This will include:

    - On-going information gathering on, and attempted avoidance of, key fishing areas and times and continued monitoring of fishing activity (through VMS data and other sources) and associated logistical planning;

- Regular communication of planned survey activities (ten / five survey outlook) with key industry representatives, and on-going liaison with FFAW / One Ocean contacts;

- The presence, active participation and advice of the Fisheries Liaison Officer (FLO) on board the seismic ship, and a shore-based Single Point of Contact (SPOC);

- The issuance of Notices to Mariners and other broad notifications / direct industry communications throughout the periods of Project operations;

- Avoidance of fisheries science survey areas (involving a 30 km locational and/or seven day temporal avoidance prior to a planned research survey).

- Educational and training initiatives for Project personnel (such as on the presence and role of the FLO, environmental procedures and requirements, and other issues); and

- Establishment, communication and implementation of a Fishing Gear Damage or Loss Compensation Program, should there be gear damage caused by conflicts/interference from seismic streamers or in the unlikely event of an offshore spill or loss of debris.

These mitigation measures will apply to, and help avoid or reduce any potential Project effects on, commercial, Aboriginal and recreational fisheries that occur within or near the Study Area.

Weather, ice and other environmental conditions in the NL Offshore Area usually require that offshore oil and gas exploration, commercial fishing and other marine-based activities be undertaken within the same (and often somewhat narrow) operating period. Indeed, the planned (May – December) timing of the offshore survey work that is being proposed as part of this Project will inevitably overlap with key periods for fishing and other offshore pursuits. The area of interest for the planned geophysical surveys is offshore, 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 existing and established commercial ports. 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.

The mobile and transitory nature, spatial extent (long and widely spaced survey grid) 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 year, which would therefore result in a one time (and very brief) potential interaction / disturbance at any particular location and time. With the seismic ship moving continuously, the vessel and associated survey equipment will be tens of kms away from any particular fishing location within several hours. Once it crosses and departs from a particular site, the survey vessel will not return to that location, except for grid crossing points although any Project presence at those locations will be separated by days, weeks or even longer. For locations where fixed gear is known or likely to be deployed, survey operations will avoid them until the gear has been removed.

On-going coordination and effective and timely communication between offshore oil and gas operators and the fishing industry and other marine interests, through the various processes and forums described above, has been and remains the best means for ensuring that such activities are carried out in a safe and environmentally responsible manner, avoiding or reducing adverse interactions between offshore geophysical programs and other users of the marine environment.

As noted above, the proposed survey activities will be planned and implemented to avoid interacting negatively with fisheries research surveys in the Study Area (through a 30 km distance, seven day time avoidance procedure). In addition, the various Fisheries Closure Areas that occur within the Study Area have been designated as such in order to help protect benthic areas from further destruction or disturbance from certain types of (bottom dragging) fishing activity. The exploration activities that are planned to be undertaken as part of this Project will not result in any direct contact with the seabed, and will therefore not physically disturb benthic animals or their habitats.

5.4.3.2 Seismic Sound and Potential Emissions (Routine or Accidental)

As described for the various preceding biophysical VECs, offshore seismic activities may, to varying degrees, result in a degree of localized and temporary avoidance or other disturbances to certain marine species, including commercially important fish species or other biota. A considerable amount of research has been conducted on the effects of offshore seismic surveys (of various types and intensities) on marine species. This has included scientific research, monitoring studies and anecdotal reports of observed reactions, which range from no change, to behavioural effects (such as avoidance, other changes in vertical or horizontal distribution or other activities) to possible injury to or mortality of individual fish (DFO 2004). With regard to any resulting implications for commercial fisheries, a number of studies cite seismic activity as the cause of decreased fish abundance and catches (e.g. Skalski et al 1992; Engås et al 1996), with such effects at times being evident within several kilometres of the sound source and continuing for a day or more after the cessation of seismic activity (Lokkeborg 1991). Other studies have shown that catches for some species / gear types have increased during seismic activity whereas others have been observed to decrease (Lokkeborg et al 2012). Still other studies have suggested, however, that seismic airguns have had little or no such apparent behavioural effects on fish or fish catches (e.g. Pickett et al 1994; Christian et al 2004; Andriguetto-Filho et al 2005; Parry and Gason 2006).

Any such 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 fish, birds, mammals, reptiles 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, waste management, and other potential environmental discharges and emissions. This includes the mitigation measures that are typically required and implemented for such programs in the NL Offshore Area as conditions of regulatory approvals and which have been committed to by GXT in this EA, in addition to the other measures described in Section 5.2. Any 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 habitats or usage (harvesting) areas for extended

periods, or be otherwise affected or disrupted in a manner that causes effects on the overall availability or quality of a marine resource.

Similarly, because the proposed Project will not result in the recovery of petroleum from the seabed, the potential for, and possible size and magnitude of, an accidental spill is much lower than for other types of offshore oil and gas activities - about the same potential as for a fishing ship. As discussed in Chapter 2, however, adequate and appropriate spill prevention and response measures will be in place for the duration of Project operations.

A summary of the predicted (residual) environmental effects of the Project on Marine Fisheries and Other Human Activities is provided in Table 5.6 below.

Table 5.6 Marine Fisheries and Other Activities: Environmental Effects Assessment Summary

Project Activity and Potential Effect(s)	Environmental Effect Descriptors						
	Nature	Magnitude	Extent	Duration	Frequency	Reversibility	Certainty
Presence of Vessels / Streamer • Disturbance	A	L	2	2	3	R	H
Seismic Sound • Disturbance	A	L	3	2	5	R	H
Other Sound (Vessel, etc) • Disturbance	A	L	2	2	1	R	H
Air Emissions • Exposure / contamination	N	-	-	-	-	-	H
Lighting • Disturbance	N	-	-	-	-	-	H
Solid Waste • Exposure / contamination	N	-	-	-	-	-	H
Liquid Waste • Exposure / contamination	A	N	2	2	1	R	H
Potential Accidental Events • Potential injury • Exposure / contamination	A	L	2	1	1	R	H
Overall, Resulting Effect(s) of Project on the VEC • The Project is not anticipated to affect the overall intensity, distribution (spatial or temporal) or value of marine fisheries or other marine activities in the Study Area.				**Evaluation of Significance** • The proposed Project is not likely to result in significant adverse environmental effects on Marine Fisheries and Other Activities.			
Nature / Direction: A = Adverse N = Neutral or No Effect P = Positive	**Magnitude**: N = Negligible or No Effect L = Low M = Medium H = High	**Geographic Extent**: 1 = < 1 km^2 2 = 1-10 km^2 3 = 11-100 km^2 4 = 101-1,000 km^2 5 = 1,001-10,000 km^2 6 = >10,000 km^2	**Duration**: 1 = < 1 month 2 = 1-12 months 3 = 13-36 months 4 = 37-72 months 5 = > 72 months	**Frequency**: 1 = <11 events/year 2 = 11- 50 events/year 3 = 51-100 events/year 4 = 101-200 events/year 5 = >200 events/year 6 = Continuous			

Project Activity and Potential Effect(s)	Environmental Effect Descriptors						
	Nature	Magnitude	Extent	Duration	Frequency	Reversibility	Certainty
Reversibility:	**Certainty in Prediction:**						
R = Reversible	L Low						
I = Irreversible	M Moderate						
	H High						

As described above, the proposed Project is not likely to result in significant adverse environmental effects on Marine Fisheries and Other Activities.

5.4.4 Cumulative Environmental Effects

Fisheries and other human activities in the marine environment may be affected both individually and collectively by offshore oil and gas exploration and production activities, general marine traffic and other activities and associated disturbances. Each of these may result in, for example, direct disturbance to such activity, damage to equipment, effects on marine resources and/or other disturbances, and these effects may accumulate or interact on a regional scale to result in cumulative environmental effects. The rather dynamic nature of fishing and other marine based activity throughout the region (in terms of locations, seasons, gear types and key species) makes it difficult to predict specific areas and times from year to year for both domestic and foreign fleets, and thus, the potential for interactions between activities and their effects.

Although the at times spatially extensive nature of seismic surveys, along with the somewhat widespread nature of some other uses (both geographically and seasonally), increases the potential for fishing enterprises and other pursuits to be affected by multiple projects and activities in a region, the potential for interference by offshore oil and gas installations and vessels as well as general marine traffic can be mitigated through good communication and cooperation between industries and the various mitigation measures outlined above and detailed in Section 5.2. These include the planning and mitigation measures and procedures outlined in this EA, through which the proposed seismic survey will be planned and implemented so as to reduce the potential for adverse interactions with commercial and recreational human activity. Although an unlikely and relatively infrequent occurrence, damage to gear, vessels or other marine assets would also be managed through applicable compensation policies and procedures.

As a result, the proposed Project is not likely to result in significant adverse cumulative environmental effects on this VEC in combination with other projects and activities that have been or will be carried out. Moreover, the relative contribution of this Project and its potential effects to any overall, cumulative effects on this VEC will be very low, and will not likely be perceptible.

5.4.5 Environmental Monitoring and Follow-up

As documented previously in this Chapter, GXT has committed to a number of measures and on-going processes to avoid or reduce the potential for adverse interactions with, and effects upon, fisheries and other marine activities and users. This includes on-going communication and cooperation mechanisms throughout the operational life of this Project (see Section 3.2, Consultation). These are intended to allow for an on-going discussion of Project related activities and any issues as they may arise during Project implementation, and to cooperatively and collaboratively plan and implement any required (adaptive) management measures

throughout the life of the Project. In addition, the FLO onboard the seismic ship at all times during the Project has a further direct monitoring function, and provides regular reports to the FFAW.

The various other environmental monitoring and follow-up measures proposed in relation to relevant components of the biophysical environment will also be indirectly applicable to Marine Fisheries and Other Human Activities.

5.5 Marine / Migratory Birds: Environmental Effects Assessment

A number of bird species are present within the Study Area and adjacent marine and coastal environments, including seabirds, waterfowl, shorebirds and other avifauna that inhabit the region at specific or extended periods for breeding, feeding, migration and/or other activities. Several important areas and habitats have also been identified at locations along the coastlines of Eastern and Southern Newfoundland.

5.5.1 Environmental Assessment Study Areas and Effects Evaluation Criteria

As described in Section 3.4, the EA generally focuses upon a number of spatial boundaries, including the:

Project Area, which encompasses the overall area within which the proposed geophysical survey activities will take place; and

Study Area, which encompasses the Project Area and the likely zone of influence of any Project related emissions (set at approximately 20 km beyond the area of proposed seismic data acquisition).

In addition to the above described spatial boundaries for the Project and its EA, the environmental effects assessment also considers the particular characteristics, distributions and movements of the individual VECs under consideration, including the larger Regional Areas within which they occur.

Birds are present in the Study Area throughout the year, with many species moving in and out of the area at different times according to their particular characteristics, habitat preferences and seasonal activities. Existing and available information on the presence and geographic and seasonal occurrence of birds in and near the region is presented in Section 4.2.2. Many avifauna have widespread distribution patterns, although ranges and activities vary considerably between individual species. This EA assesses potential effects to marine and migratory birds (individuals and populations) which are known or likely to occur within the EA Study Area during the period of proposed Project activities. In conducting the assessment, consideration is given to the timing of avifauna presence within the Study Area, as well as any particularly important or sensitive time periods for marine / migratory birds.

The Project's potential environmental effects are assessed and their significance is evaluated based on the above described spatial and temporal boundaries. Significant environmental effects are considered to be those that would cause a change in a VEC that will alter its status or integrity beyond an acceptable and sustainable level. For the purposes of this EA, significant environmental effects on the Marine / Migratory Bird VEC are defined as those that are likely to result in one or more of the following:

- Mortality or life-threatening injury to any individuals of a designated (protected) bird species at risk, or destruction or alteration of the critical habitat of any such species;

- Effects to more than 10 percent of individual birds (of any species) within the area of Project-related emissions / disturbances, such that size, health, ecological function and/or sustainability of a population would be measurably and adversely affected; or the

- Destruction of, or displacement of birds from, important feeding or breeding areas or migratory routes during time periods and for durations over which the size, health, ecological function and/or sustainability of a bird population would be measurably and adversely affected.

5.5.2 Potential Environmental Issues and Interactions

The main potential environmental interactions between offshore geophysical exploration activities and marine birds include (adapted from AMEC 2013, 2014):

- Attraction of, or disturbance to, birds as a result of the presence and movement of seismic and supply vessels or aircraft and their associated disturbances (lights, noise), with possible injury or mortality (strikes, strandings, disorientation, increased energy expenditure);

- Possible injury as a result of exposure to seismic energy (noise) within the water column (particularly diving birds) or other associated disruptions to and changes in their feeding and other behaviours;

- Changes in the availability, distribution and/or quality of food sources or habitats for birds; and

- Changes in the presence, abundance, distribution and/or health of birds as a result of exposure to marine spills, which may affect individuals (physical exposure, ingestion) and important habitats.

An overview of the potential interactions between each of the main Project components and activities and the various key indicators and parameters that have been identified for this VEC is presented in Table 5.7.

Table 5.7 Marine / Migratory Birds: Potential Project-VEC Interactions

Project Component / Activity	Key Indicators and Parameters				
	Presence and Abundance	Habitat Availability and Quality	Feeding (Availability and Quality)	Migration and Movements	Health (Individuals or Populations)
Presence of Vessels / Streamer	●	●	●	●	
Seismic Sound		●	●	●	●
Other Sound (vessels, etc)	●		●	●	
Air Emissions					●
Lighting	●		●	●	
Solid Waste					
Liquid Waste			●		●
Potential Accidental Spills		●	●	●	●
On-Shore Activities					

5.5.3 Existing Knowledge

A summary overview of some existing and available information from the literature and other sources regarding these potential effects is provided in Table 5.8, organized by project activity and key potential disturbance.

Table 5.8 Environmental Effects on Marine / Migratory Birds: Summary of Existing Knowledge

Overview of Previous Studies	Summary of Key Findings
Seismic Sound	
There have been no known studies that have tested the levels of sound that cause injury to marine birds, although temporary hearing impairment can occur in avifauna that are exposed to sound in air (Saunders and Dooling 1974). 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). Unlike some other marine animals, seabirds do not communicate vocally underwater, and a heightened auditory sensitivity in water is thus unlikely to have developed. A number of sources also indicate that there is no evidence of negative behavioural effects on various bird species resulting from seismic sound (see, for example, Davis et al 1998; MMS 2004). Stemp (1985) found no evidence of seismic-related effects on marine bird mortality or distributions in the Davis Strait, and Parsons (1980, in Stemp 1985) reported that shearwaters were observed within 30 m of seismic array with their heads underwater and demonstrating no response. Research in the Irish Sea also indicated no evidence that seabirds were attracted to or repelled by offshore seismic activity (Evans et al 1993), and Lacroix et al (2003) studied moulting Long-tailed Ducks (*Clangula hyemalis*) in the Beaufort Sea and found no changes in movements or diving behaviour during seismic surveys. Turnpenny and Nedwell (1994) also refer to other data in which trained observers reported no behavioural effects on guillemot, fulmar and kittiwake species that were monitored during air source seismic surveys.	• Although there has been limited research to date on the physiological and behavioural effects of seismic sound on marine birds, studies and observations reported in the literature to date do not indicate that birds are directly and adversely affected by underwater sounds.
Presence of Vessels and Aircraft	
Avifauna have long been observed to be attracted to offshore vessels as well as petroleum drilling and production platforms in or near the marine environment, which may lead to injury or mortality through collisions with equipment and infrastructure (Baird 1990; Montevecchi et al 1999; Wiese and Montevecchi 2000). In addition to direct interactions and any associated bird injury or mortality, the lighting and other environmental disturbances associated with offshore vessel traffic can affect marine birds through behavioural changes such as the avoidance of disturbed areas (Bramford et al 1990), as well as disorientation which can lead to increased energy expenditures, changes in feeding or migration patterns, and increased susceptibility to predation (Wiese et al 2001; Jones and Francis 2003; Schummer and Eddleman 2003). Similar behavioural (and resulting health-related) effects may also occur as a result of aircraft overflights (Ellis et al 1991; Komenda-Zehnder et al 2003). The effects of lighting on marine birds may be increased during times of poor weather, such as fog and drizzle, although in such situations coastal lighting can be more of an influence as birds fly closer to land (Chaffey 2003, Weir 1976, Blomqvist and Peterz 1984). Collisions of migrating seabirds (e.g., shearwaters, dovekies,	• Of particular concern in relation to planned and routine offshore oil and gas activities, lights can attract night-flying seabirds and possibly result in injuries or death. • Particularly sensitive times for potential effects on migratory birds include the spring and fall migration periods, as well as during specific meteorological conditions such as fog or inclement weather. • Chronic discharges from offshore vessels (such as small spills and waste materials) may also interact with birds both directly and indirectly.

murres and Leach's storm-petrel) is also often more of an issue with structures such as lighthouses, communication towers, illuminated buildings and large stationary offshore platforms (Gauthreaux and Belser 2006; Montevecchi 2006). Operational discharges from marine vessels and other offshore activities may lead to sheens of crude oil and other substances on the water's surface, and avifauna (especially pelagic seabirds) that are exposed to such materials can be subject to changes in their feather weight and microstructure (O'Hara and Morandin 2010) and other effects. Of particular concern is the overall (cumulative) effects of chronic small scale oil discharge from seagoing vessels, which can be an important cause of seabird mortality (Wiese and Roberston 2004).	
Accidental Events (Spills)	
An accidental, large scale spill of oil or other hydrocarbons into the marine environment can, depending upon the size, location and timing of the incident, result in the direct exposure of birds to these substances. Birds are at particular risk to exposure to marine oil spills, given that they often spend a considerable portion of time on the water's surface (LGL Limited 2005). The possible adverse effects of oil exposure varies considerably according to species as well as with different types of oil (Gorsline et al 1981), weather conditions, times of year, movement patterns (Wiese et al 2001; Montevecchi et al 2012) and other factors. There appears to be no direct relationship between the amount of oil and bird mortality, but rather it is primarily the timing and location of a spill that determines its environmental effects (Wiese et al 2001). The possible physical effects of oil exposure on marine birds include changes in thermoregulatory capability (hypothermia) and buoyancy (drowning) due to feather matting (Clark 1984; Hartung 1995; Montevecchi et al 1999). Oil may also be ingested due to excessive preening (Hartung 1995) and other factors, which can cause both lethal and sublethal health-related effects (Hartung and Hunt 1966; Lawler et al 1978; Peakall et al 1980; 1982; McEwan and Whitehead 1980; Khan and Ryan 1991; MMS 2001).	• The main possible effects of offshore petroleum activities on marine birds are associated with potential accidental oil spills, with the actual effects of any such oil spill being dependent on factors such as the time of year, sea conditions, the volume and type of material spilled, and type of spill (i.e., surface or sub-surface).

5.5.4 Environmental Effects Assessment

The following sections provide an assessment and evaluation of the potential effects of the Project on Marine / Migratory Birds, including the vessel activity, seismic energy (underwater noise), and potential emissions (atmospheric, liquid and solid) that will or may be associated with Project activities. Mitigation measures to prevent or reduce adverse effects upon this VEC are again identified and considered integrally within the environmental effects analysis.

5.5.4.1 Presence and Movement of Project Vessels

The conduct of the proposed geophysical survey program will involve vessel traffic, including the use of a seismic survey vessel and supply ship throughout the Project Area for up to eight months for multiple years. Overall, the marine bird species that occupy the Study Area will not likely be disturbed by Project-related vessel activity, due to its transitory nature (and thus, its 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. The area of interest for the planned geophysical surveys is offshore (at least 12 nautical miles from shore), and therefore the Project is not expected to interact with, or otherwise adversely affect, coastal breeding colonies.

On-board lighting is required for vessel activities during periods of darkness, and adequate navigation and deck lights must be in place and activated during the night for safety and regulatory compliance purposes. Marine birds may be attracted to vessel lighting, and some avifauna (such as storm-petrels and other species) can fly into vessel lights and other equipment resulting in possible injury or mortality due to strikes / strandings. Birds may also be affected through disorientation and associated energy expenditure, which may interfere with foraging, migration or other important activities and requirements in the life histories of particular species. The distance at which Project-related lighting in the offshore environment will be visible (and thus, its likely zone of influence) will vary considerably based on site and time specific factors. Such disturbances appear to occur most frequently during periods of drizzle and fog, conditions that often occur in offshore areas off Southern and Eastern Newfoundland. Moisture droplets in the air during conditions of drizzle and fog refract the light and increase the illuminated area, enhancing the attraction of vessel lighting for birds (Wiese et al 2001).

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 (low cloud cover, overcast skies, fog and drizzle conditions), where this is possible and practical without affecting operation and/or posing safety risks. Overall, however, the presence of one to three vessels in the NL Offshore Area as part of this Project would be a negligible addition of night lighting in this region, especially as compared to the fishing boats, commercial traffic and other vessel movements that transit the Study Area year round.

The timing of the survey activities (i.e., May to December) also decreases risk of interactions with sea ducks such as Common Eiders, scoters and two species at risk, the Harlequin Duck and Barrow's Goldeneye, because these species are most abundant in the winter months in the NL Offshore Area. Similarly, in Newfoundland the endangered Ivory Gull is usually seen only in the winter and is typically associated with pack ice, and it is therefore very unlikely that they will be affected by Project activities. Routine checks will be undertaken, and as described in Section 5.2, protocols for the collection and release of any birds that become stranded will be implemented, in accordance with applicable governmental guidance and requirements and GXT's bird handling permit .

5.5.4.2 Seismic Sound

There is little or no evidence that marine birds are adversely affected by marine geophysical surveys, particularly the underwater sound energy that is associated with these exploration activities. This is likely to especially be the case for birds during times when they are in the air or on the water's surface. Because seismic pulses are directed downward and highly attenuated at the surface, near surface feeding and even diving birds would not likely be exposed to sound levels that would result in mortality or injury. Above the water, the sound is reduced to a muffled shot that should have little or no effect on birds that have their heads above water or are in flight. It is possible that birds on the water at close range would be startled by the sound, although the presence of the vessel and associated gear dragging in the water should have already warned the bird of unnatural visual and auditory stimuli. Any such disturbances, if they occur at all, would be intermittent and very short-term at any one location.

Deep-diving birds (such as the alcids - murres, dovekies, puffins) and other bird species that spend considerable amount of time underwater, swimming or plunge diving for food may be at somewhat higher risk of injury or disruption due to exposure to underwater noise during seismic exploration. 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 m) and spending considerable time (25 to 40 seconds) underwater (Gaston and Jones 1998). Unlike fish or marine mammals, diving birds typically place their heads under the water suddenly in pursuit of prey, and could therefore potentially be exposed to high noise levels without the benefit of a steady gradient or associated ramp up procedures. Consequently, they would find it difficult to predict or avoid excessively high sound levels in the water column. This interaction may be further accentuated by the known attraction of many bird species to offshore vessels.

As described previously, there is relatively little information available on the effects of intense underwater noise levels on diving birds, and there have been no known investigations of the auditory effects of same on avifauna. The limited available information suggests that avian hearing underwater is poorer than in air, and likely to be much less sensitive than that of cetaceans. Bird auditory systems are broadly similar to those of other vertebrates, and presumably would be vulnerable to over-stimulation and consequent hearing loss. The very localized and short-term nature of these underwater disturbances at any one location and time during the seismic program, however, considerably reduces the potential for individuals and populations to be affected, either through injury or disturbance / avoidance. Also, many of the deep-diving birds that may be somewhat more likely to interact with underwater noise from a seismic survey airgun, including murres and dovekies, are most common in the Study Area during the winter months (November to February), which is mostly outside of the planned timing of Project Activities (Chapter 2). It is unlikely that non-diving marine species within the Study Area, such as gulls, shearwaters and storm-petrels, would be affected by the airguns.

Effects of noise disturbance on the nesting or foraging behaviour of surface-feeding seabirds are also unlikely, given that the above-water noise levels of airguns are minimal. Because the Project activities will be offshore, it is also unlikely that birds at nesting sites site will be subject to any disturbance due to noise from seismic activities, including adult attendance at nests.

Although diving species such as alcids and Northern Gannets, as well as pursuit plungers such as shearwaters, spend some amount of time below the water surface, sound is not believed to be important for seabirds in securing food, and available evidence suggests that avian hearing is relatively poor underwater. Underwater

noise from seismic surveys could also adversely affect surface-feeding and diving seabirds indirectly, through potential changes in the presence, abundance or concentration of prey and potential displacement from key foraging areas. As described in Section 5.3, however, extensive and persistent changes to fish resources are not expected to occur as a result of the Project, and so changes in the availability, location or quality of food sources for marine birds are not likely to occur as a result of this Project.

No additional mitigation specific to the seismic airguns and birds is therefore required or proposed, nor are any specific such measures outlined in the *Statement of Canadian Practice with Respect to the Mitigation of Seismic Sound in the Marine Environment* (DFO 2007a).

5.5.4.3 Other Possible Environmental Discharges (Routine or Accidental)

The organic wastes and other materials that may be generated and discharged by offshore vessels can attract marine bird species, such as gulls, which may increase the potential for interactions with offshore activities, as well as affecting predation, increasing the possibility of exposure to contaminants, and other disturbances. The discard of inorganic wastes, such as plastics, can also result in harmful effects through ingestion or entanglement. As discussed previously, each of the vessels involved in this Project will manage and dispose of their waste products in accordance with applicable regulations and standards, and will have a Waste Management Plan in place that will be strictly adhered to throughout the operational life of the Project.

The main possible effects of offshore petroleum activities on marine birds are associated with potential accidental oil spills, with the actual effects of any such oil spill being dependent on factors such as the time of year, sea conditions, the volume and type of material spilled, and type of spill (i.e., surface or sub-surface), and the nature and degree of interaction between the spilled material and marine birds and their habitats. Again, because the proposed geophysical program will not result in the recovery of oil and gas resources from the seafloor, the potential for, and likely magnitude of, any such accidental spill is relatively low as compared to other types of offshore exploration and production activities. In addition, solid streamer sections will be used for this Project, which will avoid any risk of streamer fluid being accidentally discharged into the marine environment at any time during the program.

There will be limited amounts of marine fuel and oils onboard the seismic and support vessels that could potentially be spilled into the ocean, and the potential for a marine spill and associated pollution incident is therefore very low for this proposed Project. Again, 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 an Oil Spill Response Plan in the unlikely event of a spill.

Other potential effects relate to the chronic release of oily water and discharges such as deck drainage, bilge water and other possible sources of emissions from offshore vessels. Any such potential discharges to the marine environment will be managed through strict adherence to applicable regulations and standards (Chapter 2), which will prevent adverse effects upon the various components of the marine environment that pertain to marine bird habitats and food sources. Moreover, as any such chronic oil discharges from marine vessel traffic in general are generally not associated with formation of a large surface slick, no direct effect on marine birds are anticipated. Atmospheric emissions during offshore activities would originate from vessel

exhaust and from the burning of fuel in any other on-equipment. Any emissions produced by the proposed exploration activities will not exceed applicable regulatory air quality standards.

A summary of the predicted (residual) environmental effects of the Project on marine / migratory birds is provided in Table 5.9 below.

Table 5.9 Marine / Migratory Birds: Environmental Effects Assessment Summary

Project Activity and Potential Effect(s)	Environmental Effect Descriptors						
	Nature	Magnitude	Extent	Duration	Frequency	Reversibility	Certainty
Presence of Vessels / Streamer • Disturbance	A	L	2	2	1	R	H
Seismic Sound • Disturbance	A	L	3	2	1	R	H
Other Sound (Vessel, etc) • Disturbance	A	L	2	2	1	R	H
Air Emissions • Exposure / contamination	A	L	5	2	1	R	H
Lighting • Disturbance	A	L	2	2	1	R	H
Solid Waste • Exposure / contamination	N	-	-	-	-	-	H
Liquid Waste • Exposure / contamination	A	N	2	2	1	R	H
Potential Accidental Events • Potential injury • Exposure / contamination	A	L	2	1	1	R	H
Overall, Resulting Effect(s) of Project on the VEC • The Project is not anticipated to have substantial, negative effects on any species, or especially, at the population level.				**Evaluation of Significance** • The proposed Project is not likely to result in significant adverse environmental effects on Marine / Migratory Birds			

Nature / Direction:	**Magnitude**:	**Geographic Extent**:	**Duration**:	**Frequency**:
A = Adverse	N = Negligible or No Effect	1 = < 1 km^2	1 = < 1 month	1 = <11 events/year
N = Neutral or No Effect	L = Low	2 = 1-10 km^2	2 = 1-12 months	2 = 11- 50 events/year
P = Positive	M = Medium	3 = 11-100 km^2	3 = 13-36 months	3 = 51-100 events/year
	H = High	4 = 101-1,000 km^2	4 = 37-72 months	4 = 101-200 events/year
		5 = 1,001-10,000 km^2	5 = > 72 months	5 = >200 events/year
		6 = >10,000 km^2		6 = Continuous
Reversibility:	**Certainty in Prediction:**			
R = Reversible	L Low			
I = Irreversible	M Moderate			
	H High			

As described above, the proposed Project is not likely to result in significant adverse environmental effects on Marine / Migratory Birds.

5.5.5 Cumulative Environmental Effects

The distribution, abundance and health of marine birds and their populations are often influenced by both natural phenomena such as weather, food availability and oceanographic variation, as well as human activities and their associated disturbances including hunting, fishing activity, vessel traffic, offshore structures and pollution. Vessel movements associated with fishing activity and general marine traffic throughout the region, as well as previous offshore exploration, may have, to varying degrees, affected marine bird populations in the Study Area, and hunting activity (both legal and illegal) also puts pressure on some bird populations. In addition to these local disturbances, migratory bird species may also be affected by a variety of activities and associated effects within their often very extensive ranges, including hunting, pesticides and other pollution. The widespread and migratory nature of many marine bird species also therefore increases the potential for avifauna populations to be affected by multiple perturbations, and therefore, for cumulative environmental effects to occur. The effects of previous and on-going projects and activities within the Study Area (and elsewhere) are reflected in, and considered as part of, the existing (baseline) environmental conditions for this VEC.

Potential interactions with, and effects on, marine birds as a result of the proposed Project relate primarily to possible disturbances from the lights, noise and possible waste materials associated with the seismic survey ship and other related vessel and aircraft traffic. Any potential interactions with marine birds as a result of the Project will, however, entail a very localized and short-term disturbance at any one location and time, which reduces the potential for particular individuals and populations to be affected repeatedly through multiple interactions with this Project, as well as the potential for, and degree and duration of, any overlap between the effects of this Project and other activities in the marine environment. The vessel presence and movements associated with the proposed Project would represent a very small fraction of the total marine activity in the eastern and southern portions of the NL Offshore Area.

As a result, the proposed Project is not likely to result in significant adverse cumulative environmental effects on marine birds in combination with other projects and activities that have been or will be carried out. Moreover, the relative contribution of this Project and its potential effects to any overall, cumulative effects on this VEC will be very low, and will not likely be perceptible.

5.5.6 Environmental Monitoring and Follow-up

GXT will develop and implement an operational monitoring program for marine birds throughout the course of the Project (Section 5.2). A qualified and experienced Environmental Observer will be onboard to record marine bird (and marine mammals) sightings during Project operations, which will be undertaken in accordance with the Canadian Wildlife Service's pelagic seabird monitoring protocol (Gjerdrum et al 2012), and will utilize other available information and sources, including the guide for pelagic seabirds of Atlantic Canada. A report from the bird monitoring program will be submitted to the relevant government authorities on a regular basis.

5.6 Marine Mammals and Sea Turtles: Environmental Effects Assessment

A number of marine mammal (cetacean) species are known or thought to occur within the Study Area, include various mysticetes (baleen whales), odontocetes (toothed whales and porpoises) and pinipeds (seals) as well as several sea turtles. These species vary considerably in their likelihood of presence and occurrence and in the particular locations and habitat types that they utilize and the times at which they occur in or pass through the region.

5.6.1 Environmental Assessment Study Areas and Effects Evaluation Criteria

As described in Section 3.4, the EA generally focuses upon a number of spatial boundaries, including the:

> *Project Area*, which encompasses the overall area within which the proposed geophysical survey activities will take place; and
>
> *Study Area,* which encompasses the Project Area and the likely zone of influence of any Project related emissions (set at approximately 20 km beyond the area of proposed seismic data acquisition).

In addition to the above described spatial boundaries for the Project and its EA, the environmental effects assessment also considers the particular characteristics, distributions and movements of the individual VECs under consideration, including the larger Regional Areas within which they occur.

Marine mammals and sea turtles are present in the Study Area throughout the year, with many species utilizing and moving into and out of the region for various activities at different periods. Available information on the known geographic and seasonal occurrence of these species in and near the region is presented in Section 4.2.3, which reflects that many species have widespread distributions and differing migration patterns. The following sections assess the potential effects of the Project on marine mammals and sea turtles (individuals and populations) which occur within the EA Study Area during the period of proposed Project activities, as well as considering any particularly important and/or sensitive time periods. The environmental effects assessment also considers the nature of likely Project-VEC interactions and the associated zone of influence of Project-related disturbances in the marine environment (particularly, the attenuation of sound from the seismic array).

The Project's likely environmental effects are assessed and their significance is evaluated based on the above described spatial and temporal boundaries.

Significant environmental effects are considered to be those that would cause a change in a VEC that will alter its status or integrity beyond an acceptable and sustainable level. For the purposes of this EA, significant environmental effects on the Marine Mammals and Sea Turtles VEC are defined as those that are likely to cause one or more of the following:

- Mortality or life-threatening injury to any individuals of a designated (protected) species at risk, or destruction or alteration of the critical habitat of any such species;

- Effects to more than 10 percent of individuals within the area of Project-related emissions / disturbances, such that size, health, ecological function and/or sustainability of a population would be measurably and adversely affected; or

- Destruction of, or displacement of individuals from important areas or migratory routes during time periods and for durations over which the size, health, ecological function and/or sustainability of a population would be measurably and adversely affected.

5.6.2 Potential Environmental Issues and Interactions

The main potential environmental interactions between offshore geophysical exploration activities and marine mammals and sea turtles include (adapted from AMEC 2013, 2014):

- Temporary hearing impairment or permanent injury or mortality from exposure to loud underwater noise after coming into close contact with a seismic airgun;

- Behavioural effects (avoidance) due to Project-related noise emissions or other disturbances, altering the presence, abundance and overall distribution of marine mammal and sea turtles and their movements, feeding and other activity;

- Interference with (and the masking of) sounds within the marine environment that originate from and/or are used by marine biota, such as in communication between individuals, the identification and detection of prey, echolocation and other activities and requirements;

- The possible attraction of individuals to offshore installations and vessels (seismic and supply), resulting in increased potential for injury or mortality through collisions or other interactions;

- Possible changes in the availability, distribution or quality of feed sources and/or habitats for marine mammals and sea turtles; and

- Changes in the presence, abundance, distribution and/or health (injury or mortality) of marine mammals and sea turtles as a result of accidental spills (through physical exposure, ingestion, effects on prey and habitats).

An overview of the potential interactions between each of the main Project components and activities and the various key indicators and parameters that have been identified for this VEC is presented in Table 5.10.

Table 5.10 Marine Mammals and Sea Turtles: Potential Project-VEC Interactions

Project Component / Activity	Key Indicators and Parameters				
	Presence and Abundance	Habitat Availability and Quality	Feeding (Availability and Quality)	Migration and Movements	Health (Individuals or Populations)
Presence of Vessels / Streamer	●	●	●	●	
Seismic Sound	●	●	●	●	●
Other Sound (vessels, etc)	●		●	●	
Air Emissions					●
Lighting	●				
Solid Waste					
Liquid Waste			●		●
Potential Accidental Spills	●	●	●	●	●
On-Shore Activities					

5.6.3 Existing Knowledge

A considerable amount of research has been conducted on the effects of offshore seismic surveys (of various types and intensities) on marine mammals, and to a lesser degree sea turtles. This has included scientific research, monitoring studies and anecdotal reports of observed reactions to such activities by various species. A number of relevant studies are summarized in Table 5.11, in order to provide a brief (and concise) overview of these known environmental issues and interactions as background and context for predicting Project effects and for identifying mitigation.

Table 5.11 Environmental Effects on Marine Mammals and Sea Turtles: Summary of Existing Knowledge

Overview of Previous Studies	Summary of Key Findings
Physical and Behavioural Reactions due to Seismic Noise	
Anthropogenic noise in the marine environment has been shown to have a variety of effects on marine mammals and sea turtles, particularly in the case of relatively intense sounds at close ranges. These may be physical (injury or mortality) or and/or behavioural (avoidance or other changes in distribution or activities) in nature. Although permanent hearing damage can result in some instances (Nowacek et al 2007), hearing deterioration due to prolonged or repeated exposure to high levels of noise (also referred to as temporary threshold shift, or TTS) can also occur, the degree and duration of which is influenced by such factors as the individual or species involved and the magnitude and duration of exposure (Richardson et al 1995; Davis et al 1998). Several previous studies have investigated this phenomenon (e.g., Finneran et al 2000, 2002, 2010; Southall et al 2007; Lucke et al 2009; Gedamke et al 2011), although the noise levels that cause TTS for most marine biota are not known, including the sound levels required to cause injury as well as the specific distances within which these may be produced for particular noise levels and other conditions. Studies related to potential TSS resulting from offshore seismic surveys have cited distances from less than 100 m from the sound source (Ridgway et al 1997), to several hundred meters (as described in LGL Limited 2005) to one km or more (Madsen et al 2006; Gedamke et al 2011). Behavioural effects may also occur as a result of marine seismic survey activity and these have been documented in a variety of species and situations. Such interactions occur when animals are disturbed or otherwise affected by intense noise, including the possibility that the sounds emitted and/or used by these animals may be interfered with. Other, indirect effects may also occur when underwater noise results in changes in the location or abundance of food sources. Some of the behavioural effects that underwater noise sources have been observed to have on marine mammals include changes in vocalizations (Parks et al 2007; Holt et al 2009; Miller et al 2000, 2009; Di Iorio and Clark 2010; Risch et al 2012); respiration, swim speed, diving, and foraging behaviour (Stone and Tasker 2006); displacement and avoidance (Castellote et al 2012, Weir 2008); shifts in migration paths, stress and immune depression (Romano et al 2004; Rao et al 2012) and strandings (Gentry 2000; Malakoff 2002; Weilgart 2007). Some species utilize underwater sounds to communicate and for other uses and activities (LGL 2013). These sounds may be “masked” or interfered with by anthropogenic sounds in the marine environment, including seismic sound, particularly where these are at similar frequencies (Richardson et al 1995). Several recent studies have indicated that marine mammal communications can be affected by operating seismic airguns (Gedamke 2011; Nieukirk et al 2012; Blackwell et al 2013), particularly low-frequency specialists such as baleen whales (Clark et al 2009).	• There is little indication or evidence that direct physical damage to marine mammals or sea turtles has occurred as a result of seismic airguns, particularly due to the avoidance behaviour exhibited by many species. • A wide range of behavioural responses have been reported in the literature and through anecdotal reports. Research results and observations have not provided conclusive or consistent findings, however, and knowledge of the behavioural effects of seismic noise remains incomplete. • For the most part, however, any such responses are expected to be localized (within one or perhaps several kilometres) and temporary, and of low ecological significance (except possibly in instances where key habitats or life stages such as reproductive activity are significantly and repeatedly affected).

Overview of Previous Studies	Summary of Key Findings
The behavioural responses of marine mammals to seismic sound have been shown to be highly variable between species and other factors and conditions (Weilgart 2007; Miller et al 2009), and generalizations about marine mammal behavioural reactions are therefore difficult to make as they can vary considerably based on such factors (Wood et al 2012). For example, some cetaceans have been known to utilize seismic surveys for foraging (e.g. bottlenose dolphins; Barry et al 2012), whereas others have been shown to avoid operating airguns, although these zones of influence are quite variable (as reviewed by LGL 2005). Some recent studies have, however, shown avoidance or other disturbances up to several hundred kilometres away from airguns, and well after the survey is completed (Nieukirk et al 2004, 2012; Risch et al 2012; Castellote et al 2012). Wood et al (2012) for example, describe relatively high levels of behavioural reactions to seismic noise at relatively low intensity (e.g., 120–140 dB re: 1 µPa rms), although some species (such as minke whales) have been observed in close proximity (less than 100 m) to operating seismic arrays (Boertmann and Mosbech 2012).The zones of influence for marine noise appear to be much larger for low frequency cetaceans compared to high frequency cetaceans (Laws 2012). Of particular concern is the potential for marine mammals disturbance associated with seismic surveys to interfere with species at risk and other rare species and small populations, particularly any associated disruption of animal movements, communication or other activities during key periods such as reproduction (Croll et al 2002; Beauchamp et al 2009). Seals have been observed 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). Sea turtles have also been shown to exhibit short-term physical, physiological and behavioural effects as a result of noise-related disturbances (McCauley et al 2000). The loggerhead turtle's hearing range overlaps with the sound frequencies produced by seismic activities (Martin et al 2012), as does that of leatherback turtles (Dow Piniak et al 2012). Temporary hearing loss has been reported in some instances (Moein et al 1994), as has a strong initial avoidance response to seismic air-gun operations (O'Hara and Wilcox 1990; McCauley et al 2000).	
Vessels	
Vessel traffic and associated noise can be a source of chronic stress for marine mammal populations (Rolland et al 2012; Rao et al 2012). The reactions of cetaceans to ships may be avoidance, approach, or indifference (Richardson et al 1995), as well as other behavioural effects such as changes in vocalizations (Clark et al 2009). Cetacean species are also susceptible to mortality or injury from vessel collisions (Williams and O'Hara 2010).	• The noise and other disturbances that are associated with marine vessel traffic may elicit behavioural responses in marine mammals, although this is again variable and likely reversible once the perturbation is removed.

Overview of Previous Studies	Summary of Key Findings
Accidental Events	
Oil spills can affect marine mammals and sea turtles through direct exposure and associated health effects Geraci 1990; Bence and Burns 1995; Dahlheim and Matkin 1994; Matkin et al 2008; Monson et al 2011; Gero et al 2011; Barron 2012) as well as by changing the availability and quality of their food sources and habitats. Exposure to oil through ingestion or dermal contact is also considered to be harmful and possibly fatal to sea turtles (Howard 2012). Marine mammals and sea turtles will likely avoid or move out of areas affect by oil spills, and have been observed to detect and thus avoid spills (Matkin et al 1994; Smultea and Würsig 1995; Ackleh et al 2012).	• Oil spills (particularly large scale accidental spills) may have health and/or behavioural effects on this VEC, depending upon the type, size, location and timing of the spill event.

5.6.4 Environmental Effects Assessment

The following sections provide an assessment and evaluation of the potential effects of the Project on Marine Mammals and Sea Turtles, with a particular focus on the seismic energy (underwater noise) that will be released into the marine environment during periods of survey activity. The effects assessment also considers other Project components, activities and disturbances which may interact with and affect this VEC, including the associated vessel traffic, other potential emissions to the marine and atmospheric environment during planned Project operations, and possible accidental events (such as a spill). As with each of the other VECs in this EA, mitigation measures to prevent or reduce adverse effects are identified and considered integrally as part of the analysis.

5.6.4.1 Presence and Movement of Project Vessels

The conduct of the proposed geophysical survey program will involve vessel traffic, including the use of a seismic survey vessel and supply ship throughout the Project Area for up to eight months each year for several years. Overall, the marine mammal and sea turtles species that occupy the Study Area will not likely be disturbed by Project-related vessel activity (and its associated vessel noise, lights and other disturbances), due to its transitory nature (and thus, its 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. Again, during seismic operations, the associated vessel noise will be overridden by the airguns guns, resulting in no or negligible implications resulting from ship-related noise. The avoidance behaviour exhibited by many marine mammals during seismic survey operations and the associated mitigations (such as the ramp-up procedures outlined earlier) will further reduce the potential for direct interaction between individuals and Project equipment, including potential collisions.

5.6.4.2 Seismic Sound

Of the various activities that may be associated with offshore oil and gas exploration and development, seismic surveys are often considered to have the highest potential for effects on marine mammals and sea turtles. These potential effects may be physical (injury or mortality) or behavioural (avoidance, other changes in distribution or activities) in nature.

Temporary threshold shift (TTS) is hearing deterioration due to prolonged or repeated exposure to high levels of noise and can last from minutes or hours to days, depending upon such factors as the receptor involved and the level and duration of noise exposure (Richardson et al 1995; Davis et al 1998). Permanent hearing impairment may also occur is some instances. Although a limited number of studies have investigated this issue, specific TSS thresholds for marine mammals and sea turtles are not currently known, including both the sound levels required to cause such injury as well as the distances at which these may be produced for air gun noise levels and oceanographic conditions.

There is, however, little potential for marine mammals or sea turtles to be killed or seriously and permanently injured as a result of exposure to the seismic noise that will be generated and released into the marine environment as part of this Project. The avoidance behaviour that has been observed by many species during offshore seismic programs will further reduce the potential for physical effects to occur. The proposed survey activities will also be carried out in strict compliance with the operational procedures outlined in the

Statement of Canadian Practice with Respect to the Mitigation of Seismic Sound in the Marine Environment (DFO 2007) and other mitigations committed to in this EA, including:

- Reduction of airgun source levels in the design and implementation of offshore seismic programs to the minimum level practical for the survey, including the amount and frequency of energy used and its horizontal propagation;

- Establishment of a safety zone around the seismic air source array (with a radius of at least 500 m), which will be monitored by a qualified Marine Mammal Observer and specific protocols regarding observation requirements and times and shut-down as required (see Section 5.2);

- The use of a gradual "ramp-up" procedure over a minimum 20 minute period to allow mobile marine animals to move away from the area if they are disturbed by the underwater sound levels associated with a seismic survey; and

- The shut-down of the seismic sound source during transit to the survey area and line changes and maintenance activities.

As noted elsewhere, behavioural reactions to exposure to seismic noise have been widely documented in marine organisms (DFO 2004), including marine mammals and sea turtles. The available literature indicates that individual species vary in their sensitivity and reactions to seismic noise, with other factors such as time of year also appearing to influence these responses. Moreover, previous research and reported observations have not yielded conclusive, nor particularly consistent, results, making it somewhat difficult to state specifically and definitively whether, how, to what degree and for how long individuals or species will react to underwater noise levels such as those that will be generated through this Project. It is however, anticipated – and for the purposes of this assessment, assumed - that any individuals that may come into close contact with sufficient underwater sound levels during this seismic program will exhibit a behavioural response to same, including displacement for a period of time from the affected area.

The predicted zone of influence of seismic sound in the marine environment (especially for marine biota as receptors) is typically defined by the area within which specific received sound levels are exceeded (LGL 2013). These thresholds can be established in terms of a maximum level of underwater sound to which cetaceans and reptiles should be exposed, which has been stated in some sources at between 160 to 190 db re 1 µPa (see LGL 2013), or as a minimum distance of separation, such as DFO (2007a) which recommends "a circle with a radius of at least 500 m as measured from the centre of the air source array(s)" (Section 6a).

Even if it is assumed that marine mammals and sea turtles will be displaced from an area of up to several kilometres immediately surrounding the active seismic airgun array, the very localized and short-term nature of this underwater disturbance at any one location and time during the seismic program considerably reduces the potential for adverse effects upon marine mammals and sea turtles (individuals or populations) to occur. Again, with the seismic ship moving continuously at approximately 4.5 knots (8.3 km / hour), the vessel and associated survey equipment will be tens of kms away from any particular location within several hours. 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 sea 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.

Underwater noise from seismic surveys could also adversely affect marine mammals and sea turtles indirectly, through potential changes in the presence, abundance or concentration of prey and potential displacement from key foraging areas. As described in Section 5.3, however, extensive and persistent changes to fish resources or other marine biota are not expected to occur as a result of the Project. Therefore, the availability, location or quality of food sources for marine mammals or sea turtles are not likely to be negatively as a result of this Project, and especially, not to a degree or for a duration that would translate into negative and detectable effects upon this VEC.

5.6.4.3 Other Possible Environmental Discharges (Routine or Accidental)

The organic wastes and other materials that may be generated and discharged by offshore vessel can attract marine biota, which may increase the potential for interactions with offshore activities. As discussed previously, each of the vessels involved in this Project will manage and dispose of their waste products in accordance with applicable regulations and standards, and will have a waste management plan in place that will be strictly adhered to throughout the life of the Project.

Other potential environmental emissions such as the release of oily water and discharges such as deck drainage, bilge water and other possible sources of emissions will be managed through strict adherence to applicable regulations and standards. There will be limited amounts of marine fuel and oils onboard the seismic and support vessels that could potentially be spilled into the ocean, and solid streamer sections will be used which will avoid any risk of streamer fluid being accidentally discharged into the marine environment at any time during the program. The potential for a marine spill and pollution incident is therefore very low for this proposed Project, and each of the vessels involved 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 also have appropriate equipment and procedures in place to prevent any accidental spills into the marine environment.

A summary of the predicted (residual) environmental effects of the Project on Marine Mammals and Sea Turtles is provided in Table 5.12 below.

Table 5.12 Marine Mammals and Sea Turtles: Environmental Effects Assessment Summary

Project Activity and Potential Effect(s)	Environmental Effect Descriptors						
	Nature	Magnitude	Extent	Duration	Frequency	Reversibility	Certainty
Presence of Vessels / Streamer • Disturbance	A	L	3	2	1	R	H
Seismic Sound • Disturbance	A	L	3	2	1	R	H
Other Sound (Vessel, etc) • Disturbance	A	L	2	2	1	R	H
Air Emissions • Exposure /	A	L	3	2	1	R	H

Project Activity and Potential Effect(s)	Environmental Effect Descriptors						
	Nature	Magnitude	Extent	Duration	Frequency	Reversibility	Certainty
contamination							
Lighting • Disturbance	N	L	2	2	1	R	H
Solid Waste • Exposure / contamination	N	-	-	-	-	-	H
Liquid Waste • Exposure / contamination	A	N	2	2	1	R	H
Potential Accidental Events • Potential injury • Exposure / contamination	A	L	2	1	1	R	H
Overall, Resulting Effect(s) of Project on the VEC • The Project is not anticipated to have substantial, negative effects on any species, or especially, at the population level.				**Evaluation of Significance** • The Project is not likely to result in significant effects on Marine Mammals and Sea Turtles.			

Nature / Direction: A = Adverse N = Neutral or No Effect P = Positive	**Magnitude**: N = Negligible or No Effect L = Low M = Medium H = High	**Geographic Extent**: 1 = < 1 km^2 2 = 1-10 km^2 3 = 11-100 km^2 4 = 101-1,000 km^2 5 = 1,001-10,000 km^2 6 = >10,000 km^2	**Duration**: 1 = < 1 month 2 = 1-12 months 3 = 13-36 months 4 = 37-72 months 5 = > 72 months	**Frequency**: 1 = <11 events/year 2 = 11- 50 events/year 3 = 51-100 events/year 4 = 101-200 events/year 5 = >200 events/year 6 = Continuous
Reversibility: R = Reversible I = Irreversible	**Certainty in Prediction:** L Low M Moderate H High			

As described above, the proposed Project is not likely to result in significant adverse environmental effects on Marine Mammals and Sea Turtles.

5.6.5 Cumulative Environmental Effects

The potential environmental effects of planned offshore geophysical activities on marine mammals and sea turtles relate primarily to noise. As a result of existing marine activities in the Study Area (e.g., fishing vessels, general marine traffic) and naturally occurring oceanographic sounds, the region's underwater environment is likely already quite noisy at particular locations and times. Marine mammals and sea turtles may also be affected by other natural factors and processes, as well as the disturbances which may be associated with other types of human activities in the marine environment. These include general vessel traffic and commercial fishing activity, which may result in effects due to entrapment and entanglement in fishing gear, collisions with marine vessels, and through pollution and other environmental effects. The widespread and migratory nature of marine mammals and sea turtles increases the potential for individuals and populations to be affected by multiple environmental disturbances, and thus, for cumulative effects to occur. This is reflected in the fact that many of the marine mammals and sea turtles that comprise this VEC have been designated (and are therefore protected) as species at risk or are otherwise of conservation concern. Again, the effects of

previous and on-going projects and activities within the Study Area (and elsewhere) are reflected in, and considered as part of, the existing (baseline) environmental conditions for this VEC.

The proposed Project that is the subject of this EA will involve a single vessel operating within a relatively large survey area over multiple years. The vessel presence and movements associated with the proposed Project would represent a very small fraction of the total marine activity in the eastern and southern portions of the NL Offshore Area. The proposed survey lines will be spaced quite far apart, and the vessel and its sound source will be present any one location for a very short period of time. Any potential interactions with marine mammals and sea turtles as a result of the Project would therefore entail a localized, short-term and infrequent (one-time) environmental disturbance at any one location and time, and GXT will be implementing a number of key mitigation measures to avoid or reduce possible effects on these species (Section 5.2). The proposed Project will therefore not likely result in significant adverse effects to this VEC.

Other on-going and future projects and activities which may affect marine mammals and sea turtles within the Study Area include the fishery, general vessel traffic, and other on-going and planned offshore oil and gas development (particularly, in the Jeanne d'Arc Basin) and exploration activities. The additional noise created as a result of this additional seismic survey will add to underwater noise levels in the region, and the often extensive survey areas covered by offshore seismic surveys can increase the potential for spatial interactions between their effects and those of other projects and activities in the marine environment. Based on previous studies, most potential effects to marine mammals and sea turtles as a result of seismic surveys and drilling programs occur within relatively close proximity (several kilometres) of the noise source. Avoidance of an area by marine mammals or other effects as a result of a single seismic survey or exploration drilling program would therefore likely be relatively localized and temporary in nature. Similarly, the environmental emissions and discharges associated with oil and gas exploration drilling and production projects are typically restricted to a fairly focussed zone of influence around the offshore installation rig itself, and these are therefore unlikely to overlap in space or time. This will reduce the potential for particular individuals and populations to be affected repeatedly through multiple interactions with this Project, as well as the potential for, and degree and duration of, any interaction or accumulation or interaction between the effects of this Project and other activities in the marine environment.

The proposed Project is therefore not likely to result in significant adverse cumulative environmental effects on this VEC in combination with other projects and activities that have been or will be carried out. The contribution of this Project and its potential effects to any overall effects on this VEC will be very low, and will not likely be perceptible.

5.6.6 Environmental Monitoring and Follow-up

As described in Section 5.2, GXT will develop and implement an operational monitoring program for marine mammals throughout the course of the Project. A qualified and experienced Environmental Observer will be onboard to record marine mammal (and marine bird) sightings during Project operations, and reports from these monitoring programs will be submitted to the relevant government authorities on a regular basis.

5.7 Species at Risk: Environmental Effects Assessment Summary

A number of marine fish, birds, mammals and reptiles that are known or likely to occur within the Study Area have been designated as being species at risk, and are therefore protected under provincial and/or federal legislation.

5.7.1 Legislative and Management Context

The Canadian *Species at Risk Act* (*SARA*) provides for the protection of species at the national level to prevent extinction and extirpation, facilitate the recovery of endangered and threatened species, and to promote the management of other species to prevent them from becoming at risk in the future. Designations under the Act follow the recommendations and advice provided by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC).

There are currently a number of schedules associated with the *SARA*. Species that have formal protection are listed on Schedule 1, which includes the following potential designations:

- *Extirpated*: A species that no longer exists in the wild in Canada, but exists elsewhere;
- *Endangered*: A species that is facing imminent extirpation or extinction;
- *Threatened*: A species that is likely to become endangered if nothing is done to reverse the factors leading to its extirpation or extinction; and
- *Special Concern*: A species that may become threatened or endangered because of a combination of biological characteristics and identified threats.

Schedule 1 of *SARA* is the official federal list of species at risk in Canada. Once a species is listed, measures to protect and recover a listed species are established and implemented, including the development of a Recovery Strategy. Action Plans summarize the activities required to meet recovery strategy objectives and goals, and Management Plans set goals and objectives for maintaining sustainable population levels of one or more species that are particularly sensitive to environmental factors.

At the provincial level, the Newfoundland and Labrador *Endangered Species Act* (*NL ESA*) provides protection for indigenous species, sub-species and populations considered to be endangered, threatened, or vulnerable within the province. These potential designations under the legislation are defined as follows:

- *Endangered*: A species that is facing imminent extirpation or extinction;
- *Threatened*: A species that is likely to become endangered if nothing is done to reverse the factors leading to its extirpation or extinction; and
- *Vulnerable*: A species that has characteristics which make it particularly sensitive to human activities or natural events.

Designations are based on recommendations from COSEWIC and/or the provincial Species Status Advisory Committee (SSAC). Habitat that is important to the recovery and survival of endangered or threatened species can also be designated as critical habitat or recovery habitat, and protected under the *NL ESA*.

5.7.2 Consideration of Species at Risk within the EA

Species at Risk have been identified, and their known or likely presence, abundance and geographic and temporal distribution are evaluated, as an integral part of the description of the existing biophysical environment (Section 4.2). Indeed, for certain VECs (especially, Marine Mammals and Sea Turtles), many of the individual species that are known or likely to occur within the Study Area are designated as protected under *SARA* or are otherwise considered to be of special conservation concern.

The potential effects of the Project on these species are assessed and evaluated within the Marine Fish and Fish Habitat, Marine / Migratory Birds, and Marine Mammals and Sea Turtles VECs themselves. As specified in the Scoping Document issued by the C-NLOPB for this EA, however, Species at Risk and potential effects on them are given special (and separate) attention and emphasis in the assessment, including in the identification and analysis of potential environmental effects and mitigation.

Therefore, while the overall content and findings of each of the other biophysical VECs are applicable to the individual Species at Risk within them - and, for the purposes of efficiency, this information and analysis is not repeated in its entirely here – the following sections provide an overview and "species-specific" analysis and summary of the potential effects of the Project on each such protected species.

5.7.3 Marine Fish and Fish Habitat

As described in Section 4.2.1 there are four marine fish species that are known or likely to occur in the Study Area that have formal designation and protection under *SARA*, including three species of wolffish (family *Anarhichadidae*) and the white shark. The main potential environmental interactions between the Project and these species are the same as those for the Marine Fish and Fish Habitat VEC as a whole as are the planned mitigation measures to avoid or reduce any such adverse interactions.

Further, information and analysis related to each of these species, and the potential for the Project to interact with, and affect, each of these Species at Risk is provided in the Table below:

Table 5.13 Marine Fish Species at Risk: Analysis of Potential Environmental Effects

Species	*SARA*	*NL ESA*	Summary of Presence and Potential Interactions
Atlantic wolffish	Special Concern		• Spawns September and October • Pelagic larvae • Adults remain in Study Area • Abundant in Flemish Pass and continental slopes
Northern wolffish	Threatened		• Spawns September through November • Pelagic larvae • Remain in Study Area • Aggregated in Flemish Pass and northeast slopes
Spotted wolffish	Threatened		• Spawn June, July and August

Species	*SARA*	*NL ESA*	Summary of Presence and Potential Interactions
			• Pelagic larvae • Remain in Study Area • Common on Flemish Cap, eastern Grand Banks and Newfoundland Shelf
White shark	Endangered		• Pelagic species • Rare in Study Area • Does not reproduce in Study Area • Very mobile species that could respond to ramp-ups
American eel		Vulnerable	• Spawn outside of the Study Area • Leptocephali move through the Study Area through the winter (up to April) to reach rivers on the south and northeast coast of Newfoundland from the Sargasso Sea where they were spawned. • Glass eels migrate into coastal rivers in May and June and therefore are beyond the Study Area.

Each of these fish species are highly mobile, and with the implementation of Project mitigations (such as the associated ramp-up procedures) any individuals within the Project's zone of influence are likely to move out of the area if they are disturbed by the Project – and thus, will not be adversely affected by it. The Project will not affect identified critical habitat for either of these species, and given that it will not result in physical disturbance of the seafloor or coastline, it will not affect the residences of other key habitats of any individual or populations.

5.7.4 Marine / Migratory Birds

The main potential environmental interactions between the Project and these species are the same as those for the Marine / Migratory Bird VEC as a whole as are the planned mitigation measures to avoid or reduce any such adverse interactions.

Again, additional species-specific information and analysis related to the potential for the Project to interact with, and affect, each of these Species at Risk is provided in the Table below:

Table 5.14 Marine / Migratory Birds Species at Risk: Analysis of Potential Environmental Effects

Species	*SARA*	*NL ESA*	Summary of Presence and Potential Interactions
Barrow's Goldeneye	Special Concern	Vulnerable	• Present in small numbers in the winter months, often in mixed groups with Common Goldeneye, at Terra Nova National Park (Port Blandford and Newman Sound) as well as Traytown Bay, St. Mary's Bay, and Spaniard's Bay. • Only a small proportion of the species' population occurs in the Study Area; the large majority overwinters in the St. Lawrence River. • They are present in the Study Area only in the winter and are generally found in coastal waters. • Interactions with Project activities are therefore very unlikely.

Species	*SARA*	*NL ESA*	Summary of Presence and Potential Interactions
Harlequin Duck	Special Concern	Vulnerable	• Harlequin Ducks may be found year round at Cape St. Mary's, which is one of just three known moulting sites in Newfoundland, and non-breeders have been seen there in the summer months. • Although they breed inland in fast-flowing streams, Harlequin Ducks occur in the coastal marine environment throughout the fall and winter months along rocky coastlines, subtidal ledges, and exposed headlands. • They are most common in the area outside of the Project activities (with the above-noted exception at Cape St. Mary's, where they may occur year-round), and are associated with coastal environments. • They are therefore unlikely to interact with Project activities.
Ivory Gull	Endangered	Endangered	• Ivory Gulls breed in the far north. • Outside of the breeding season, they spend almost all of their time in the marine environment. • No critical habitat exists in the Project area. • Small numbers occur in the winter months within the Project area, where they are found most often among the pack ice. • Because they are typically found among pack ice and only in the winter months, interactions with Project activities are unlikely.
Piping Plover (*melodus* subspecies)	Endangered	Endangered	• During the nesting season, Piping Plovers are found on sandy beaches along the coast. • In southern Newfoundland, major breeding areas include Grand Bay West to Cheeseman Provincial Park and Big Barasway, and nesting has also been observed in Codroy Valley Estuary. • Breeding has been reported at one location in northeastern Newfoundland, at Deadman's Bay. • Twelve critical habitat beaches have been identified in Newfoundland, including eight along the south coast . • Because of its offshore location, the proposed Project will not interact with Piping Plovers are their habitats (beaches).
Red Knot (rufa subspecies	Endangered	Endangered	• Found on open sandy inlets, coastal mudflats, sand flats, salt marshes, sandy estuaries and areas with rotting kelp deposits during fall migration, from August 1st to October 30th. • Newfoundland is not considered to be a major stopover location; nonetheless, sightings are widespread along the coast of Newfoundland. • In southern and eastern Newfoundland, they are considered to be regular or occasional species during fall migration at Bellevue Beach, Cape Freels, and around the Codroy Valley Estuary, and they are rare visitors at a number of other Atlantic Canada Shorebird Survey sites. • Due to their coastal habitat preferences and transient presence in the Study Area, they are unlikely to be affected by

Species	*SARA*	*NL ESA*	Summary of Presence and Potential Interactions
			Project activities.
Peregrine Falcon	Special Concern	Vulnerable	• Migrate along coastal Newfoundland during the fall, particularly the west coast, where they prey on concentrations of migrating shorebirds. • Peregrine Falcon sightings have been reported in the fall near Port-aux-Basques, St. Pierre et Miquelon, and on the Bonavista Peninsula, and at all times of year (but most frequently during the fall) on the Avalon Peninsula. • Peregrine Falcons are present in small numbers in coastal areas within the proposed Project area, particularly during fall migration. • However, due to their coastal habitat preferences and transient presence in the Study Area, they are unlikely to be affected by Project activities.
Gray-cheeked Thrush (*minimus* subspecies)		Vulnerable	• Nest in dense coniferous forest habitat throughout insular Newfoundland, and migrate south in the fall. • Within the province, they are most common on the Northern Peninsula and along the northeast coast, as well as the northern Avalon Peninsula, Placentia Bay, and Terra Nova National Park. • The Gray-cheeked Thrush is an inland species, and so is unlikely to be affected by offshore activities at most times of year.
Olive-sided Flycatcher	Threatened	Threatened	• Found in boreal forest habitat throughout insular Newfoundland during the breeding season, particularly in open areas such as wetlands with tall trees and snags. • They migrate to south and central America to overwinter. • As an inland species, the Olive-sided Flycatcher is unlikely to be affected by offshore activities at most times of year.
Short-eared Owl	Special Concern	Vulnerable	• Typically nests in coastal barrens and grasslands. Sightings have been reported throughout the eastern portion of the Island from Wadham Islands to the Avalon and Burin Peninsulas, as well as near Port-aux-Basques and Codroy Valley in southwestern Newfoundland; primarily during the summer months. • Due to their coastal habitat preferences in the area, they are unlikely to be affected by Project activities.
Red Crossbill (*percna* subspecies)	Endangered	Endangered	• The percna subspecies of Red Crossbill is a forest-dwelling species, essentially endemic to insular Newfoundland (with infrequent irruptions into the Maritime Provinces). • They do not migrate south for winter; irregular movements within its range to areas of high cone crop do occur. • Because it is an inland species and does not occur in the offshore environment at any time of year, it is unlikely to be affected by Project activities.

Species	*SARA*	*NL ESA*	Summary of Presence and Potential Interactions
Rusty Blackbird	Special Concern	Vulnerable	• Breeds throughout Newfoundland in wetland habitats, and may migrate over the offshore areas. • They are diurnal migrants, and so are unlikely to be vulnerable to disorientation from artificial marine lighting.
Chimney Swift	Threatened	Threatened	• Not known to nest in Newfoundland, but they have been sighted in the spring and fall months and may migrate over the offshore area. • No critical habitat has been identified for the species. • Chimney Swifts are diurnal migrants, and so are unlikely to be vulnerable to disorientation from artificial marine lighting. • Also, Newfoundland is outside of their known breeding range and they are only rarely seen in the province.

The Project will not affect critical habitat for either of these species, and given that it will occur in an offshore environment, it will not result in disturbance of coastline areas and any associated bird colonies.

5.7.5 Marine Mammals and Sea Turtles

As described in Section 4.2.3, a number of marine mammal and sea turtle species at risk are known to occur in the Study Area. Again, the main potential environmental interactions between the Project and these species are the same as those for the Marine Mammals and Sea Turtles VEC as a whole as are the planned mitigation measures to avoid or reduce any such adverse interactions.

Further, species-specific information and analysis related to the potential for the Project to interact with, and affect, each of these Species at Risk is provided in the Table below:

Table 5.15 Marine Mammal and Sea Turtle Species at Risk: Analysis of Potential Environmental Effects

Species	*SARA*	*NL ESA*	Summary of Presence and Potential Interactions
Blue Whale - Atlantic Population	Endangered		• Blue whales occur singly or in pairs in coastal and pelagic waters, frequently at shelf edge where food production is high. • No critical habitat has been identified for the species to date, although this information is expected in 2014. • In the Study Area, blue whales are present in small numbers throughout the year, although they are most commonly observed in the winter and early spring, outside the schedule of Project activities.
Fin Whale - Atlantic Population	Special Concern		• Fin whales are generally found along the coastal shelf edge and offshore waters. • Their summer distribution is typically in areas with high prey concentration (e.g., the Grand Banks). • In the Study Area, they are present year-round but are likely most common in the summer months.
North Atlantic Right Whale	Endangered		• The North Atlantic right whale is usually found in waters 100 to 200 m deep, with surface temperatures between 8 and 15°C. • They aggregate in five seasonal habitat areas along the east coast of North America, all of which are outside of the Study

Species	*SARA*	*NL ESA*	Summary of Presence and Potential Interactions
			Area. • In Canada, the lower Bay of Fundy and Roseway Basin on the Scotian Shelf (all of which are outside the Study Area) have been designated as critical habitat for the species. • North Atlantic right whales are likely to be extremely rare visitors to the Study Area, primarily in the summer months. • Therefore, interactions with Project activities are unlikely.
Northern Bottlenose Whale - Scotian Shelf population	Endangered		• The northern bottlenose whale is a deep-diving species, typically found alone or in small groups of up to 20 individuals, in waters between 800 and 1,500 m deep. • The Scotian Shelf population is apparently non-migratory. • Critical habitat for this population has been identified along the Scotian Shelf, outside of the Study Area. • They have been observed at all times of year in the Study Area, although most sightings have been in the spring and summer • It is unclear to which population individuals observed in the Study Area belong; however, of the two populations, the Davis Strait population is more mobile.
Sowerby's Beaked Whale	Special Concern		• A deep-water species found at continental edges and slopes in depths of 550 – 1,500 m or more, the Sowerby's beaked whale is seldom seen and its biology is poorly understood. • They are generally observed in groups of 3 to 10 individuals. • Seasonal movements of Sowerby's beaked whales are unknown • Although almost all sightings have been in the summer, that may be due to a relative lack of search effort in other times of year, and they may be present year round in deep water habitats in the Study Area.
Beluga Whale - St. Lawrence Estuary population	Threatened		• Belugas are a coastal species, and tend to be concentrated in estuarine breeding range for most of the year, dispersing in the winter months. • Critical habitat for the population is in the St. Lawrence Estuary and lower reaches of the Saguenay River, outside of the Study Area. • Only a very small proportion of the population occurs in the Study Area; belugas seldom range far from the St. Lawrence estuary. • They are present in the Study Area only in small numbers, typically in the winter, and they are generally found in coastal waters • Interactions with Project activities are therefore unlikely.
Leatherback Sea Turtle	Endangered		• Typically found in coastal shelf waters with depths of < 200 m, with most of their time spent in the upper 12 m of the water column. • Leatherback turtles occur in the Study Area mainly from April to December. • The existing Recovery Strategy for the species does not identify critical habitat.

Species	*SARA*	*NL ESA*	Summary of Presence and Potential Interactions
			• The area south and east of the Burin Peninsula (including parts of Placentia Bay) is one of three high-use feeding areas that were identified in a recent tracking study. • Information from this DFO study is being used to inform the identification of critical habitat in a forthcoming amendment to the Recovery Strategy (DFO 2013c).

Again, all of these species are highly mobile, and with the implementation of Project mitigations any individuals within the Project's zone of influence are likely to move out of the area if they are disturbed by the Project – and thus, will not be adversely affected by it. Key mitigations will follow the Statement of Canadian Practice, as described in Section 5.2. The Project will also not occur within identified critical habitat for either of these species.

5.7.6 Summary of Environmental Assessment for Species at Risk

As a result of the above, and with the implementation of the various mitigations outlined in Section 5.2, the proposed Project is not likely to result in significant adverse effects upon any Species at Risk.

The EA Scoping Document (January 28 2014, Section 5.2.5) makes specific reference to the following sections of *SARA*:

> *32. (1) No person shall kill, harm, harass, capture or take an individual of a wildlife species that is listed as an extirpated species, an endangered species or a threatened species*
>
> *33. No person shall damage or destroy the residence of one or more individuals of a wildlife species that is listed as an endangered species or a threatened species, or that is listed as an extirpated species if a recovery strategy has recommended the reintroduction of the species into the wild in Canada.*
>
> *58. (1) Subject to this section, no person shall destroy any part of the critical habitat of any listed endangered species or of any listed threatened species — or of any listed extirpated species if a recovery strategy has recommended the reintroduction of the species into the wild in Canada — if*
>
> > *(a) the critical habitat is on federal land, in the exclusive economic zone of Canada or on the continental shelf of Canada;*
> > *(b) the listed species is an aquatic species; or*
> > *(c) the listed species is a species of migratory birds protected by the Migratory Birds Convention Act, 1994.*

Based on the information and analysis provided in this EA Report, the Project and its likely environmental effects are not expected to contravene either of these prohibitions.

5.8 Protected and Sensitive Areas: Environmental Effects Assessment

A number of marine and coastal areas within and adjacent to the Study Area have been designated as protected under provincial, federal and/or other legislation and processes, or have been identified as being otherwise special or sensitive due to their ecological, historical and/or socio-cultural characteristics and importance. These areas were identified and described in Section 4.2, and are given particular attention in the EA. Marine areas have been identified as being particularly important or sensitive from an ecological perspective (such as fish spawning areas, bird colonies, etc) or for fishing activity have been considered and assessed integrally within the biophysical and/or marine fisheries / activities VECs themselves.

5.8.1 Environmental Assessment Study Areas and Effects Evaluation Criteria

As described in Section 3.4, the EA generally focuses upon a number of spatial boundaries, including the:

Project Area, which encompasses the overall area within which the proposed geophysical survey activities will take place; and

Study Area, which encompasses the Project Area and the likely zone of influence of any Project related emissions (set at approximately 20 km beyond the area of proposed seismic data acquisition).

In addition to the above described spatial boundaries for the Project and its EA, the effects assessment for the Protected and Sensitive Areas VEC also includes consideration of the full size and extent of any such areas that overlap in whole or part with the Study Area, as well as the overall geographic distributions of the ecological and / or socio-cultural components and processes that are relevant to the identification, and overall integrity and value, of these areas.

Significant environmental effects are considered to be those that would cause a change in a VEC that will alter its status or integrity beyond an acceptable and sustainable level. Significant environmental effects on the Protected and Sensitive Areas VEC are defined as those that are likely to cause an adverse change in one or more of the important and defining ecological and socio-cultural characteristics of such an area, resulting in a decrease in the integrity or value of one or more such areas

5.8.2 Potential Environmental Issues and Interactions

Environmental interactions between offshore petroleum activities and protected and sensitive areas may be both direct and indirect in nature and cause. Conducting an activity directly within or near such an area may, for example, have adverse implications through the presence of equipment, personnel and activities in the area including the associated noise and other emissions and any resulting disturbances. Any resulting decrease in the real or perceived integrity or value of these sites in the short or long term may, in turn, affect their ecological and/or socio-cultural value and (where applicable) the use and enjoyment of these areas. Biophysical effects resulting from offshore oil and gas or other human activities may also affect protected and sensitive areas by affecting marine fish, birds, mammals or other environmental components that are relevant to their designation, integrity and/or value.

An overview of the potential interactions between each of the Project components and activities and the various key indicators and parameters that have been identified for this VEC is presented in Table 5.16.

Table 5.16 Protected and Sensitive Areas: Potential Project-VEC Interactions

Project Component / Activity	Key Indicators and Parameters	
	Biophysical Features and/or Processes	Human Use and/or Value
Presence of Vessels / Streamer	●	●
Seismic Sound	●	●
Other Sound (vessels, etc)	●	●
Air Emissions	●	●
Lighting	●	●
Solid Waste	●	●
Liquid Waste	●	●
Potential Accidental Spills	●	●
On-Shore Activities		●

5.8.3 Environmental Effects Assessment

A description (and mapping) of each of the marine and coastal areas within and adjacent to the Study Area that have been designated as protected or identified as otherwise special or sensitive was provided in Section 4.2. The following sections provide an assessment and evaluation of the potential effects of the Project on Protected and Sensitive Areas, including each of the components and activities that will be associated with the Project. Again, mitigation measures to prevent or reduce adverse effects upon this VEC are identified and considered integrally within the effects analysis.

The planned geophysical surveys will occur in an offshore area, with the Project Area being at least 12 nautical miles from shore in all locations (see Figure 1.1). Project activities will therefore not occur within, or otherwise interact directly with, any of the existing provincial or federal Parks, Ecological Reserves, Wildlife Reserves, Marine Protected Areas, Migratory Birds Sanctuaries, Important Birds Area or other locations that have been designated as protected on the Island of Newfoundland or elsewhere.

The proposed Project Area does overlap, to varying degrees, with a number of identified special or sensitive areas in the offshore environment, including: an Areas of Interest (AOI); several Ecologically and Biologically Significant Areas (ESBAs) and a number of Fishery Closure Areas (DFO and NAFO designated). As noted previously, although these locations have been identified as important and/or sensitive for ecological reasons, they are not formally protected under legislation and/or there are no associated prohibitions of marine activities such as that being proposed as part of this Project within their boundaries. Indeed, there are regular vessel movements, fishing activity and other traffic within and across these areas, and previous offshore oil and gas exploration activities have taken place in these areas. The mobile nature and spatial and temporal extent of the planned vessel-based exploration program will mean that activity will occur at any one location for a very short period of time, and will be generally in keeping with (and will make a negligible contribution to) the marine traffic that has occurred throughout the region for years.

Table 5.17 below provides a summary of the approximate (minimum) distance between the edge of the Project Area and the various relevant Protected and Sensitive Areas identified and mapped in Section 4.2:

Table 5.17 Protected and Sensitive Areas: Summary of Minimum Distances from the Project Area

Protected / Sensitive Area	Distance from Project Area (km)
Parks and Ecological / Wildlife Reserves	
Funk Island Ecological Reserve	22.6
Lawn Islands Archipelago Provisional Ecological Reserve	22.6
Witless Bay Ecological Reserve	22.6
Mistaken Point Ecological Reserve	22.7
Baccalieu Island Ecological Reserve	23.8
Dungeon Provincial Park	24.9
Windmill Bight Provincial Park	26.1
Chance Cove Provincial Park	26.8
La Manche Provincial Park	28.1
Marine Drive Provincial Park	28.5
Deadman's Bay Provincial Park	29.2
Cape St. Mary's Ecological Reserve	29.4
Fortune Head Ecological Reserve	47.3
Gooseberry Cove Provincial Park	57.1
Frenchman's Cove Provincial Park	60.1
Terra Nova National Park	67.3
Sandbanks Provincial Park	75.5
Dildo Run Provincial Park	77.1
Big Barasway Wildlife Reserve	79.2
J. T. Cheeseman Provincial Park	82.1
Bellevue Beach Provincial Park	98.5
Jack's Pond Provincial Park	110.1
Migratory Bird Sanctuary	
Terra Nova Migratory Bird Sanctuary	80.2
Marine Protected Areas / Areas of Interest	
Laurentian Channel Area of Interest	Intersects with Project Area
St. Ann's Bank Area of Interest	13.3
Eastport – Duck Island Marine Protected Area	62.2
Eastport – Round Island Marine Protected Area	78.0
The Gully Marine Protected Area	144.8
Gilbert Bay Marine Protected Area	276.4
Ecologically and Biologically Significant Areas	
Laurentian Channel and Slope	Intersects with Project Area
Burgeo Bank	Intersects with Project Area
St. Pierre Bank	Intersects with Project Area
Placentia Bay Extension	Intersects with Project Area
Southwest Shelf Edge and Slope	Intersects with Project Area
Eastern Avalon Coast	Intersects with Project Area
Virgin Rocks	Intersects with Project Area
Southeast Shoal and Tail of The Banks	Intersects with Project Area

Protected / Sensitive Area	Distance from Project Area (km)
Lilly Canyon-Carson Canyon	Intersects with Project Area
Northeast Shelf and Slope	Intersects with Project Area
Fogo Shelf	Intersects with Project Area
Grey Islands	Intersects with Project Area
Notre Dame Channel	Intersects with Project Area
Orphan Spur	Intersects with Project Area
Smith Sound	70.1
Labrador Slope	263.2
Gilbert Bay	270.4
Labrador Marginal Trough	276.0
Hamilton Inlet	374.3
Lake Melville	508.0
Hopedale Saddle	639.3

The various Fisheries Closure Areas that overlap with the Study Area have been designated as such in order to help protect benthic areas from further destruction or disturbance from certain types of (bottom dragging) fishing activity. The offshore exploration (geophysical) activities that are planned to be undertaken as part of this Project will not result in any direct contact with the seabed, and will therefore not physically disturb benthic animals or their habitats.

As described for the various preceding biophysical VECs, the proposed Project is not expected to result in any significant adverse effects upon marine fish, birds, mammals, reptiles or their habitats. Although the vessel traffic and underwater sound energy will be associated with the Project has the potential to interact with marine biota, these activities will be undertaken in strict compliance with relevant standards and guidelines, including the mitigation measures that are typically required and implemented for such programs in the NL Offshore Area and which have been committed to by GXT in this EA. Offshore seismic activities may, to varying degrees, result in a degree of localized and temporary avoidance or other disturbances to certain marine species. However, the overall nature and likely zone of influence (spatial and temporal) of the proposed Project activities will not alter the overall physical, chemical or biological features and activities that occur within these special or sensitive marine areas. It is unlikely that any individuals will be displaced from key habitats or migration routes for extended periods or be otherwise disrupted in a manner that causes detectable or population wide effects.

The Project will therefore not adversely affect the ecological features, processes and integrity of any marine or coastal areas, including the protected and sensitive areas that are the subject of this VEC. The implementation of the various environmental protection measures and procedures outlined throughout this EA Report, including those which are designed to avoid or reduce Project-related discharges and/or disturbances and their associated environmental effects, will also serve to help address any potential effects on adjacent protected and sensitive areas.

A summary of the predicted (residual) environmental effects of the Project on Protected and Sensitive Areas birds is provided in Table 5.18 below.

Table 5.18 Protected and Sensitive Areas: Environmental Effects Assessment Summary

Project Activity and Potential Effect(s)	Environmental Effect Descriptors						
	Nature	Magnitude	Extent	Duration	Frequency	Reversibility	Certainty
Presence of Vessels / Streamer • Disturbance	N	-	-	-	-	-	H
Seismic Sound • Disturbance	N	-	-	-	-	-	H
Other Sound (Vessel, etc) • Disturbance	N	-	-	-	-	-	H
Air Emissions • Exposure / contamination	N	-	-	-	-	-	H
Lighting • Disturbance	N	-	-	-	-	-	H
Solid Waste • Exposure / contamination	N	-	-	-	-	-	H
Liquid Waste • Exposure / contamination	N	-	-	-	-	-	H
Potential Accidental Events • Potential injury • Exposure / contamination	A	L	2	1	1	R	H

Overall, Resulting Effect(s) of Project on the VEC	Evaluation of Significance
• The Project is not anticipated to have adverse effects upon this VEC.	• The proposed Project is not likely to result in significant adverse environmental effects on this VEC

Nature / Direction: A = Adverse N = Neutral or No Effect P = Positive	**Magnitude**: N = Negligible or No Effect L = Low M = Medium H = High	**Geographic Extent**: 1 = < 1 km^2 2 = 1-10 km^2 3 = 11-100 km^2 4 = 101-1,000 km^2 5 = 1,001-10,000 km^2 6 = >10,000 km^2	**Duration**: 1 = < 1 month 2 = 1-12 months 3 = 13-36 months 4 = 37-72 months 5 = > 72 months	**Frequency**: 1 = <11 events/year 2 = 11- 50 events/year 3 = 51-100 events/year 4 = 101-200 events/year 5 = >200 events/year 6 = Continuous
Reversibility: R = Reversible I = Irreversible	**Certainty in Prediction:** L Low M Moderate H High			

As described above, the proposed Project is not likely to result in significant adverse environmental effects on Protected and Sensitive Areas.

5.8.4 Cumulative Environmental Effects

The past, on-going and future environmental effects of offshore oil and gas, fishing and other human activities in the Study Area may interact with each other to result in cumulative environmental effects. Existing (and any future) protected areas in Newfoundland and elsewhere will not be subject to direct effects by such activities,

given the prohibition of such activities within their boundaries. This will also be the case for this Project, which will not occur within or otherwise affect protected areas in Newfoundland and Labrador or elsewhere.

Any interactions with other identified sensitive or special areas in the marine environment as a result of the Project will entail a very localized and short-term disturbance at any one location and time, which reduces the potential for particular locations and their associated ecological or socio-cultural components to be affected by multiple disturbances. Again, the marine activity that will be associated with the proposed Project would represent a very small fraction of the total marine activity in the eastern and southern portions of the NL Offshore Area, and so the Project is not likely to result in significant adverse cumulative environmental effects in combination with other projects and activities that have been or will be carried out, and certainly, the relative contribution of this Project and any such potential effects will not likely be perceptible.

5.8.5 Environmental Monitoring and Follow-up

The various environmental monitoring and follow-up measures proposed in relation to relevant components of the biophysical environment will also be indirectly applicable to Protected and Sensitive Areas (particularly, their ecological aspects). No additional and specific environmental monitoring or follow-up is considered necessary in relation to this VEC.

6 ENVIRONMENTAL ASSESSMENT SUMMARY AND CONCLUSIONS

GXT is planning to undertake a marine exploration program (including 2-D seismic, gravity and magnetic survey activities) within the Southeastern and Southern portions of the NL Offshore Area. The proposed Project will be a regional Basin Span survey, which will utilize typical industry equipment but is uniquely designed to examine very deep geological formations over quite broad (basin scale) areas. The proposed survey program will occur within the May – December period, potentially in each year from 2014 to 2018. It will involve up to a maximum of 14,000 line km of seismic survey acquisition annually, which will be widely spaced, and will include the operation of the seismic survey vessel and associated equipment as well as support craft as needed.

The Project will be an important contributor of new information to the region's offshore oil and gas industry, which is a highly valuable component of the Newfoundland and Labrador economy. Additional and on-going exploration is required in order to help sustain and grow this vitally important economic sector. Should the exploration program be successful in advancing scientific understanding of the region and helping locate additional hydrocarbon resources in this area, it could also eventually lead to significant additional economic activity in the region related to further exploration, and possibly, petroleum development activities and access to royalties.

This proposed Project requires authorizations from the C-NLOPB pursuant to the *Accord Acts*. This document provides an EA of the proposed offshore exploration program in accordance with the requirements of the Board, including information and analysis related to each of the following:

- Project purpose, rationale and alternatives;
- Project description (components, equipment, activities);
- The existing environment (biophysical and socioeconomic);
- Consultation activities and their outcomes;
- The predicted environmental effects of the Project on identified VECs;
- Proposed mitigation measures to avoid / reduce adverse effects;
- The significance of the Project's predicted (residual) environmental effects;
- Cumulative environmental effects; and
- Environmental monitoring and follow-up.

The conclusion of this EA is that each of the potential environmental issues and effects that might be associated with the proposed Project can be avoided or otherwise mitigated through the use of good planning and sound operational practices and procedures, supported by Project-specific and industry standard mitigations that are well established and outlined in relevant regulatory procedures and guidelines, and which have been identified and committed to by GXT as part of this EA.

Overall, the proposed Project will entail a very localized, short-term and transient disturbance in the marine environment at any one location and time throughout the operational life of the program. It is therefore not anticipated to displace or otherwise affect marine biota or other marine activities in such a way that causes negative and detectable effects to populations, at-risk individuals or human activities in the region. The proposed Project is *not* likely to result in significant adverse environmental effects.

7 REFERENCES

7.1 Personal Communications

Atkinson, T. (2014). President. Nova Scotia Swordfishermen's Association.

Baker-Stevens, N. (2014). Eastern Shore Fisherman Protective Association.

Boutilier, D. (2014). Property Officer, DFO Small Craft Harbours.

Boyd, C. (2014). Manager, Corporate Affairs. Clearwater Seafoods.

Budgell, T. (2014). Manager of Aquaculture Licensing and Inspectors. NL Department of Fisheries and Aquaculture.

Chapman, B. (2014). Executive Director, Canadian Association of Prawn Producers (CAPP) and the Groundfish Enterprise Allocation Council (GEAC).

Dedrick, G. (2014). Shelburne County Quota Group.

Drake, J. (2014). Netukulimk Fisheries Ltd.

Ellis, R. (2014). Director Fleet Operations. Ocean Choice International.

Giffin, C. (2014) MARLANT Safety and Environmental Officer for Commander, DND

Guiney, K. (2014). Marketing Officer, Marine Atlantic Inc.

Hart, D. (2014) President. Atlantic Shark Association; Sambro Fisheries Ltd.

Hooper, B. (2014) Professor of Biology, Memorial University of Newfoundland and Labrador

Kearney, J. (2014). Administrative Support Clerk, Maritime Forces Atlantic.

Martin, K. (2014). Manager of Evaluation and Research, NL Department of Transportation and Works

Sheppard, G. (2014). Fisheries and Oceans Canada

Stansbury, D. (2014) Fisheries and Oceans Canada

7.2 Literature Cited

Ackleh, A.S., Ioup, G.E., Ioup, J.W., Ma, B., Newcomb, J.J., Pal, N., Sidorovskaia, N.A., and Tiemann, C. (2012). Assessing the Deepwater Horizon oil spill impact on marine mammal population through acoustics: endangered sperm whales. Journal of the Acoustical Society of America. 131: 2306-2314.

ACS (American Cetacean Society) (2006). Species Fact Sheets., from http://acsonline.org/fact-sheets. Retrieved September 18, 2012

Ainley, D.G., Nettleship, D.N., Carter, H.R., and Storey, A.E. (2002). Common Murre (*Uria aalge*), The Birds of North America Online (A. Poole, Ed.). Ithaca: Cornell Lab of Ornithology; Retrieved from the Birds of North America Online: http://bna.birds.cornell.edu/bna/species/666

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.

Allen, K.R. (1971). A preliminary assessment of Fin Whale stocks off the Canadian Atlantic coast. Report of the International Whaling Commission 21:64-66.

Altman, B., and Sallabanks, R. (2012). Olive-sided Flycatcher (*Contopus cooperi*), The Birds of North America Online (A. Poole, Ed.). Ithaca: Cornell Lab of Ornithology; Retrieved from the Birds of North America Online: http://bna.birds.cornell.edu/bna/species/502

AMEC Environment and Infrastructure (2013). Western Newfoundland and Labrador Offshore Area Strategic Environmental Assessment Update. Draft Report, May 2013. Submitted to Canada-Newfoundland and Labrador Offshore Petroleum Board, St. John's, NL.

AMEC Environment and Infrastructure (2014). Eastern Newfoundland and Labrador Offshore Area Strategic Environmental Assessment Update. Draft Report, February 2014. Submitted to Canada-Newfoundland and Labrador Offshore Petroleum Board, St. John's, NL

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., Gregory, R. S., and Collins, W. T. (2002). Acoustic classification of marine habitats in coastal Newfoundland. – ICES Journal of Marine Science, 59:156–167.

Andriguetto-Filhoa, J. M., Ostrenskya, A., Pie, M. R., Silva, U.A., and Boeger, W.A. (2005). Evaluating the impact of seismic prospecting on artisanal shrimp fisheries. Continental Shelf Research. 25(2005):1720–1727.

Avery, M.L. (2013). Rusty Blackbird (*Euphagus carolinus*), The Birds of North America Online (A. Poole, Ed.). Ithaca: Cornell Lab of Ornithology; Retrieved from the Birds of North America Online: http://bna.birds.cornell.edu/bna/species/200

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.

Baird, P.H. (1990). Concentrations of seabirds at oil-drilling rigs. Condor. 92:768-771.

Baird, R.W. (2003). Update COSEWIC status report on the humpback whale *Megaptera novaeangliae* in Canada in COSEWIC assessment and update status report on the humpback whale *Megaptera novaeangliae* in Canada. Committee on the Status of Endangered Wildlife in Canada. Ottawa. 1-25 pp.

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 65: 171-188.

Barron, M.G. (2012). Ecological impacts of the Deepwater Horizon oil spill: implications for immunotoxicity. Toxicology and Pathology. 40: 315-320.

Barry, S.B., Cucknell, A.C., and Clark, N. (2012). A direct comparison of bottlenose dolphin and common dolphin behaviour during seismic surveys when air guns are and are not being utilized. Advances in Experimental Medicine and Biology. 730:273-276.

Bax, N., Carlton, J.T., Matthews-Amos, A., Haedrich, R.L., Howarth, F.G., Purcell, J.E., Reiser, A., and Gray, A. (2001). The control of biological invasions in the world's oceans. Conservation Biology 15: 1234-1246.

Beamish, F.W.H. (1966). Vertical migration by demersal fish in the Northwest Atlantic. Journal of the Fisheries Research Board of Canada 23: 109-139.

Beauchamp, J., Bouchard, H., de Margerie, P., Otis, N., Savaria, J.-Y. (2009). Recovery Strategy for the blue whale (*Balaenoptera musculus*), Northwest Atlantic population, in Canada [FINAL]. Species at Risk Act Recovery Strategy Series. Fisheries and Oceans Canada, Ottawa. 62 pp.

Beazley, L.L., Kenchington, E.L., Murillo, F.J. and del Mar Sacau, M. (2013). Deep-sea sponge grounds enhance diversity and abundance of epibenthic megafauna in the northwest Atlantic. ICES Journal of Marine Sciences

Bence, A.E. and Burns, W.A. (1995). Fingerprinting Hydrocarbons in the Biological Resources of the Exxon Valdez spill area. In P.G. Wells, J.N. Butler and J.S. Hughes (Eds.), Exxon Valdez oil spill: fate and effects in Alaskan Waters (pp. 84-140). Philadelphia, PA: American Society for Testing and Materials.

Benjaminsen, T. and Christensen, I. (1979). The natural history of the bottlenose whale *Hyperoodon ampullatus* (Forster). In: Behavior of Marine Animals (H.E. Winn and B.L. Olla, eds.), Vol. 3. Plenum Press, New York. Pp. 143-164.

Benoît, H.P., Savenkoff, C., Ouellet, P., Galbraith, P.S., Chassé, J., and Fréchet, A. (2012). Impacts of fishing and climate-driven changes in exploited marine populations and communities, with implications for management. In Benoît, H.P., Gagné, J.A., Savenkoff, C., Ouellet, P., and M.-N. Bourassa (Eds.), State-of-the-Ocean Report for the Gulf of St. Lawrence Integrated Management (GOSLIM) Area. Canadian Manuscript Report of Fisheries and Aquatic Sciences, 2986, 36-50.

Blackwell, S.B., Nations, C.S., McDonald, T.L., Greene, C.R., Thode, A.M., Guerra, M., and Macrander, A.M. (2013). Effects of airgun sounds on bowhead whale calling rates in the Alaskan Beaufort Sea. Mar. Mamm. Sci. doi:10.1111/mms.12001.

Blaxter, J.H.S., Gray, J.A.B., and Denton, E.J. (1981). Sound and startle responses in herring shoals. Journal of the Marine Biological Association of the United Kingdom 61: 851-869.

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 Study. Polar Biology. 20:325-334.

Bianchi, G., Carpenter, K.E., Roux, J.-P., Molloy, F.J., Boyer, D. and Boyer, H.J. (1999). Field guide to the living marine resources of Namibia. FAO species identification guide for fishery purposes. Rome, FAO. 265 p., 11 colour plates.

BIO (Bedford Institute of Oceanography). (2013). Research: Clams. http://www.bio.gc.ca/science/research-recherche/fisheries-pecheries/managed-gere/clam-palourde-eng.php. March 3, 2014.

BIO (Bedford Institute of Oceanography) (2014). Canadian Shark Research Laboratory: Shark Conservation. http://www.bio.gc.ca/sharks/conservation-eng.php. March 3, 2014.

Bishop, C.A. (1994). Revisions and additions to the stratification scheme used during research vessel surveys in NAFO Subareas 2 and 3. NAFO SCR. Doc 94/43 Serial No. N22413. 23 p.

Blomkvist, S., and Peterz, M. (1984). Cyclones and pelagic seabird movements. Marine Ecology Progress Series 20: 85-92.

Boertmann, D. and Mosbech, A. (eds.) (2011). The western Greenland Sea, a strategic environmental impact assessment of hydrocarbon activities. Aarhus University, DCE – Danish Centre for Environment and Energy, 268 pp. - Scientific Report from DCE – Danish Centre For Environment and Energy no. 22.

Booman, C., Dalen, J., Leivestad, H., Levsen, A., van der Meeren T., and Toklum, K. (1996). Effecter av luftkanonskyting på egg, larver ogy yngel. Fisken og Havet 1996(3): v+83p. [In Norwegian with English summary.]

Boudreau, P.R., Harding, G.C., Lee, K., and Keizer, P.D. (2001). The Possible Environmental Impacts of Petroleum Activities in the Southern Gulf of St. Lawrence and Sydney Bight Ecosystems. Canadian Science Advisory Secretariat Research Document 2001/112.

Bowen, W. D., Oftedal, O. T. and Boness, D. J. (1985). Birth to weaning in four days: extraordinary growth in the hooded seal (*Cystophora cristata*). Canadian Journal of Zoology. 63: 2841-2846.

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.

Bowyer, P. (ed) (1995). Where the Wind Blows. A Guide to Marine Weather in Atlantic Canada. Environment Canada: xiii + 178 pp.

Bradbury, I.R., Snelgrove, P.V.R., and Fraser, S. (1999). Transport and development of cod eggs and larvae in Placentia Bay (3PS) Newfoundland, 1997-1998. Canadian Stock Assessment Secretariat Research Document 99/71.

Bradbury, I.R., Laurel, B.J., Robichaud, D.R., Rose, G.A., Snelgrove, P.V.R., Gregory, R.S., Cote, D., Windle, D.J.S. (2008). Discrete spatial dynamics in a marine broadcast spawner: reevaluating scales of connectivity and habitat associations in Atlantic cod (*Gadus morhua* L.) in coastal Newfoundland. Fisheries Research 91: 299-309.

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.

Brattey, J. Cadigan, N.G., Healy, B.P., Lilly, G.R., Murphy, E.F., Shelton, P.A., Mahé, J.-C. (2004). Assessment of the cod (*Gadus morhua*) stock in NAFO subdivision 3Ps in October 2004. Canadian Science Advisory Secretariat Research Document. 2004/083: 101 pp.

Brodie, W., Power, D., and Healey, B. (2011). The Canadian fishery for Greenland halibut in SA2 + Div. 3KLMNO, with emphasis on 2010. NAFO Scientific Research Document 11/44. 20 pp.

Brown, C.R. and Bomberger Brown, M. (1999). Barn Swallow (*Hirundo rustica*), The Birds of North America Online (A. Poole, Ed.). Ithaca: Cornell Lab of Ornithology; Retrieved from the Birds of North America Online: http://bna.birds.cornell.edu/bna/species/452

Brown, M.W., Fenton, D., Smedbol, K., Merriman, C., Robichaud-Leblanc, K., and Conway, J.D. (2009). Recovery Strategy for the North Atlantic Right Whale (*Eubalaena glacialis*) in Atlantic Canadian Waters [Final]. Species at Risk Act Recovery Strategy Series. Fisheries and Oceans Canada. vi + 66p.

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.

Buhl-Mortensen, L., Vanreussel, A., Gooday, A.J., Levin, L., Priede, I.J., Buhl-Mortensen, P., and Raes, M. (2010). Biological structure as a source of habitat heterogeneity and biodiversity on the deep ocean margins. Marine Ecology Progress Series 31: 21-50.

Butler, R.G. and Buckley, D.E. (2002). Black Guillemot (*Cepphus grylle*), The Birds of North America Online (A. Poole, Ed.). Ithaca: Cornell Lab of Ornithology; Retrieved from the Birds of North America Online: http://bna.birds.cornell.edu/bna/species/675

Cairns, D. K., Montevecchi, W.A., and Threlfall, W.. (1989). Researcher's guide to Newfoundland seabird colonies. 2nd ed. Memorial Univ. of Newfoundland Occas. Pap. Biol. no. 14. Memorial University of Newfoundland, St. John's.

Cameron, G.D.M. and Best, M.A. (1985). Surface features of the continental margin of eastern Canada. Map compilation for the Atlantic Geoscience Centre, Bedford Institute of Oceanography.

Campbell, J.S., and Simms, J.M. (2009). Status Report on Coral and Sponge Conservation in Canada. St. John's, NL: Fisheries and Oceans Canada.

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.

Carey, F.G., and Scharold, J.V. (1990.) Movements of Blue Sharks (*Pronace glauca*) in depth and course. Marine Biology. 106:329-342.

Castellote, M., Clark, C.W., and Lammers, M.O. (2012). Acoustic and behavioural changes by fin whales (*Balaenoptera physalus*) in response to shipping and airgun noise. Biological Conservation. 147(1):115-122.

CCG (Canadian Coast Guard) (2013). Marine Communications and Traffic Services. Retrieved from: http://www.ccg-gcc.gc.ca. September 20, 2013.

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

Chaffey, H. (2003). Integrating scientific knowledge and local ecological knowledge (LEK) about common eiders (*Somateria mollissima*) in southern Labrador. M.Sc. thesis, Memorial University of Newfoundland, St. John's.

Christian, J.R., Mathieu, A., Thomson, D.H., White, D., and Buchanan R.A. (2004). Effect of seismic energy on snow crab (*Chionoecetes opilio*) 7 November 2003. Environmental Studies Research Funds Report No. 144. Calgary. 106 pp.

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. Canadian Manuscript Report of Fisheries and Aquatic Sciences. 2925: vi + 207 p.

Cink, C.L., and Collins, C.T. (2002). Chimney Swift (*Chaetura pelagica*), The Birds of North America Online (A. Poole, Ed.). Ithaca: Cornell Lab of Ornithology; Retrieved from the Birds of North America Online: http://bna.birds.cornell.edu/bna/species/646

Clark, C.W., Ellison, W.T, Southall, B.L., Hatch, L., Van Parijs, S.M., Frankel, A., and Ponirakis, D. (2009). Acoustic masking in marine ecosystems: insights, analysis, and implications. Marine Ecology Progress Series. 395:201-222.

Clark, R.B. (1984). Impact of Oil Pollution on Seabirds. Environmental Pollution. 33:1-22.

Colbourne, E.B. and Murphy, E.F. (2008). Physical oceanographic conditions in NAFO Division 3P during 2007-potential influences on the distribution and abundance of Atlantic cod (*Gadus morhua*). Fisheries and Oceans Canada Research Document - 2008/027.

Collette, B.B. and Nauen, C.E. (1983). FAO Species Catalogue. Vol. 2. Scombrids of the world. An annotated and illustrated catalogue of tunas, mackerels, bonitos and related species known to date. Rome: FAO. FAO Fisheries Synopsis 125(2):137 p.

Collette, B., Acero, A., Amorim, A.F., Boustany, A., Canales Ramirez, C., Cardenas, G., Carpenter, K.E., Chang, S.-K. de Oliveira Leite Jr. N., Di Natale, A., Die, D., Fox, W., Fredou, F.L., Graves, J., Guzman-Mora, A., Viera Hazin, F.E., Hinton, M., Juan Jorda, M., Minte Vera, C., Miyabe, N., Montano Cruz, R., Masuti, E., Nelson, R., Oxenford, H., Restrepo, V., Salas, E., Schaefer, K., Schratwieser, J., Serra, R., Sun, C., Teixeira Lessa, R.P.., Pires Ferreira Travassos, P.E., Uozumi, Y., and Yanez, E. (2011). *Thunnus alalunga*. In: IUCN 2013. IUCN Red List of Threatened Species. Version 2013.1. <www.iucnredlist.org>. Downloaded on 29 January 2014.

Cook, E.J., Jahnke, M. Kerckhof, F., Minchin, D., Faasse, M., Boos, K. and Ashton, G. (2007). European expansion of the introduced amphipod *Caprella mutica* Schurin 1938. Aquatic Invasions 2(3): 411-421.

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). (2003) COSEWIC assessment and update status report on the North Atlantic right whale *Eubalaena glacialis* in Canada. Committee on the Status of Endangered Wildlife in Canada, Ottawa, ON. 28 pp.

COSEWIC (Committee on the Status of Endangered Wildlife in Canada). 2003. COSEWIC assessment and status report on the sei whale *Balaenoptera borealis* in Canada. Committee on the Status of Endangered Wildlife in Canada. Ottawa. vii + 27 pp.

COSEWIC (Committee on the Status of Endangered Wildlife in Canada). (2004). COSEWIC assessment and update status report on the beluga whale *Delphinapterus leucas* in Canada. Committee on the Status of Endangered Wildlife in Canada. Ottawa. ix + 70 pp. (www.sararegistry.gc.ca/status/status_e.cfm).

COSEWIC (Committee on the Status of Endangered Wildlife in Canada). (2005). COSEWIC assessment and update status report on the fin whale *Balaenoptera physalus* in Canada. Committee on the Status of Endangered Wildlife in Canada, Ottawa, ON. 37 pp.

COSEWIC (Committee on the Status of Endangered Wildlife in Canada). (2006a). COSEWIC assessment and status report on the white shark *Carcharodon carcharias* Atlantic Population, Pacific Population in Canada. Committee on the Status of Endangered Wildlife in Canada. Ottawa. vii + 31 pp. (www.sararegistry.gc.ca/status/status_e.cfm).

COSEWIC (Committee on the Status of Endangered Wildlife in Canada). (2006b). COSEWIC assessment and update status report on the Sowerby's beaked whale *Mesoplodon bidens* in Canada. Committee on the Status of Endangered Wildlife in Canada. Ottawa. vi + 20 pp.

COSEWIC (Committee on the Status of Endangered Wildlife in Canada). (2006c). COSEWIC assessment and update status report on the harbour porpoise *Phocoena phocoena* (Northwest Atlantic population) in Canada. Ottawa, ON.

COSEWIC (Committee on the Status of Endangered Wildlife in Canada) (2007). COSEWIC assessment and status report on the Olive-sided Flycatcher *Contopus cooperi* in Canada. Committee on the Status of Endangered Wildlife in Canada. Ottawa, ON.

COSEWIC (Committee on the Status of Endangered Wildlife in Canada). (2008). COSEWIC assessment and update status report on the Killer Whale *Orcinus orca*, Southern Resident population, Northern

Resident population, West Coast Transient population, Offshore population and Northwest Atlantic / Eastern Arctic population, in Canada. Committee on the Status of Endangered Wildlife in Canada. Ottawa. 65 pp.

COSEWIC (Committee on the Status of Endangered Wildlife in Canada). (2009a). 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) (2009b). COSEWIC assessment and status report on the Eskimo Curlew *Numenius borealis* in Canada. Committee on the Status of Endangered Wildlife in Canada. Ottawa. vii + 32 pp.

COSEWIC. (Committee on the Status of Endangered Wildlife in Canada) (2010a). COSEWIC assessment and status report on the Atlantic cod *Gadus morhua* in Canada. Committee on the Status of Endangered Wildlife in Canada. Ottawa. Xiii + 105pp. (www.sararegistry.gc.ca/status/status_e.cfm)

COSEWIC. (Committee on the Status of Endangered Wildlife in Canada) (2010b). COSEWIC assessment and status report on the Atlantic salmon *Salmo salar* in Canada. Committee on the Status of Endangered Wildlife in Canada. Ottawa. xlvii + 136pp. (www.sararegistry.gc.ca/status/status_e.cfm).

COSEWIC (Committee on the Status of Endangered Wildlife in Canada). (2010c). 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.

COSEWIC (Committee on the Status of Endangered Wildlife in Canada). (2010d). 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 + 80 pp. (www.sararegistry.gc.ca/status/status_e.cfm.

COSEWIC (Committee on the Status of Endangered Wildlife in Canada). (2011). COSEWIC Assessment and Status Report on the Northern Bottlenose Whale *Hyperoodon ampullatus* in Canada. Committee on the Status of Endangered Wildlife in Canada, Ottawa, ON. 31 pp.

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 Thorny Skate *Amblyraja radiata* in Canada. Committee on the Status of Endangered Wildlife in Canada. Ottawa. ix + 75 pp. (www.registrelep-sararegistry.gc.ca/default_e.cfm).

COSEWIC (Committee on the Status of Endangered Wildlife in Canada) (2012c). COSEWIC assessment and status report on the Buff-breasted Sandpiper *Tryngites subruficollis* in Canada. Committee on the Status of Endangered Wildlife in Canada. Ottawa. x + 44 pp.

COSEWIC (Committee on the Status of Endangered Wildlife in Canada). (2012d) COSEWIC status appraisal summary on the Blue Whale *Balaenoptera musculus*, Atlantic population, in Canada. Committee on the Status of Endangered Wildlife in Canada. Ottawa. xii pp. (www.registrelep-sararegistry.gc.ca/default_e.cfm).

COSEWIC (Committee on the Status of Endangered Wildlife in Canada). (2012e). 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.

COSEWIC. 2013. COSEWIC Annual Report 2012-2013. http://www.sararegistry.gc.ca/virtual_sara/files/cosewic/car_rapport_cos_report_0913_e.pdf

Cote, D., Moulton, S., Scruton, D.A., and McKinley, R.S. (2001). Microhabitat use of juvenile Atlantic cod in a coastal area of Bonavista Bay, Newfoundland. Transactions of the American Fisheries Society 130: 1217-1223.

Cote, D., Gregory, R.S., Morris, C.J., Newton, B.H., and Schneider, D.C. (2013). Elevated habitat quality reduces variance in fish community composition. Journal of Experimental Marine Biology and Ecology. 440:22-28.

Croll, D. A., Clark, C. W., Acevedo, A., Tershy, B., Flores, S., Gedamke, J., and Urban, J. (2002). Only male fin whales sing loud songs. Nature, 417 (6891), 809. Retrieved from http://polymer.bu.edu/hes/articles/aabmsss02.pdf

Cruise NL. (2013). 2013 Cruise Newfoundland and Labrador Cruise Schedule. Revised October 28, 2013.

Cushing, D.H. (1990). Plankton production and year-class strength in fish populations: an update of the match-mismatch hypothesis. Advances in Marine Biology 26: 249–293.

Cuthbert, F.J., and Wires, L.R. (1999). Caspian Tern (*Hydroprogne caspia*), The Birds of North America Online (A. Poole, Ed.). Ithaca: Cornell Lab of Ornithology; Retrieved from the Birds of North America Online: http://bna.birds.cornell.edu/bna/species/403

CWS (Canadian Wildlife Service) Waterfowl Committee. (2012). Population Status of Migratory Game Birds in Canada: November 2012. CWS Migratory Birds Regulatory Report Number 37.

CWS (Canadian Wildlife Service) (2013). Migratory Game Birds Hunting Regulations. Retrieved from: http://www.ec.gc.ca. October 8, 2013.

Dahlheim, M.E. and Matkin, C.O. (1994). Assessment of injuries to Prince William Sound killer whales. In T.R. Loughlin (Ed.), Marine mammals and the Exxon Valdez (pp. 163-171). San Diego, CA: Academic Press.

Dalen, J. And Knutsen, G.M. (1987). Scaring effects in fish and harmful effects on eggs, larvae and fry by offshore seismic explorations. S. 93-102 i MERKLINGER, H.M. red. Progress in Underwater Acoustics. Plenum Publishing Corporation.

Dalen, J. and Raknes, A. (1985). Scaring effects on fish from 3D seismic surveys. Institute of Marine Research Report, No. P.O. 8504, Bergen, Norway.

Dalen, J., Dragsund, E., Næss, A. and Sand, O. (2007). Effects of seismic surveys on fish, fish catches and sea mammals. Report for the Cooperation group – Fishery Industry and Petroleum Industry. Report no.: 2007-0512. Det Norske Veritas AS, 24.04.07. Høvik. 29p.

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.

Dalley, E.L., Anderson, J.T. and Davis, D.J. (2000). Short term fluctuations in the pelagic ecosystem of the Northwest Atlantic. Canadian Stock Assessment Secretariat Research Document 2000/101.

Dalley, E.L., Anderson, J.T. and Davis, D.J. (2001). Decadal time-series of invertebrate zooplankton on the Newfoundland Shelf and Grand Banks 1991-1999. Canadian Stock Assessment Secretariat Research Document 2001/110.

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.

Davoren, G.K. and Montevecchi, W.A. (2003). Signals from Studybirds indicate changing biology of capelin stocks. Marine Ecology Progress Series 258: 253-261.

Dawe, E.G., Koen-Alonso, M., Chabot, D., Stansbury, D., and Mullowney, D. (2012). Trophic interactions between key predatory fishes and crustaceans: Comparison of two Northwest Atlantic systems during a period of ecosystem change. Marine Ecology Progress Series. 469:233-248.

Day, R.H., Stenhouse, I.J. and Gilchrist, H.G. (2001). Sabine's Gull (*Xema sabini*), The Birds of North America Online (A. Poole, Ed.). Ithaca: Cornell Lab of Ornithology; Retrieved from the Birds of North America Online: http://bna.birds.cornell.edu/bna/species/593

Dayton, P.K. 1985. Ecology of kelp communities. Annual Reviews of Ecology and Systematics 16: 215-245.

Desrosiers, G., Savenkoff, C., Olivier, M., Stora, G., Juniper, K., Caron, A., Gagne, J.P., Legendre, L., Mulsow, S., Grant, J., Roy, S., Greham, A., Scaps, P., Silverberg, N., Klein, B., Tremblay, J.E., and Therriault, J.C. (2000). Trophic structure of macrobenthos in the Gulf of St. Lawrence and on the Scotian Shelf. Deep-Sea Research II. 47(2000):663-697.

Devine, J.A. and Haedrich, R.L. (2011). The role of environmental conditions and exploitation in determining dynamics of redfish (*Sebastes* species) in the northwest Atlantic. Fisheries Oceanography. 20:66-81.

deYoung, B., Harris, R., Alheit, J., Beaugrand, G., Mantua, M., and Shannon, L. (2004). Detecting regime shifts in the ocean: Data considerations. 60(2-4): 143-164.

DFA (Department of Fisheries and Aquaculture). (2001a). Fisheries diversification program: By-catch reduction in shrimp beam trawls. Project Summary: EACT-1.2001.DFO FDP 292. 4 pp.

DFA (Department of Fisheries and Aquaculture). (2001b). Emerging Species Profile Sheets: Whelk (*Buccinum undatum*). Department of Fisheries and Aquaculture. 4 pp.

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) (2001).Proceedings of the Workshop on Greenland Halibut Montreal, Quebec 27 February- 2 March 2001. DFO Canadian Science Advisory Secretariat Science Advisory Report. 2001/036. 102 pp.

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 (Department of Fisheries and Oceans Canada). (2005). Atlantic Seal Hunt 2003 Management Plan. Available at: http://www.dfo-mpo.gc.ca/seal-phoque/reports-rapports/mgtplan-plangest2003/mgtplan-plangest2003_e.htm.

DFO (Department of Fisheries and Oceans Canada). (2006a). Recovery potential assessment report on White sharks in Atlantic Canada. Canadian Science Advisory Secretariat 2006/052.

DFO (Department of Fisheries and Oceans Canada). (2006b). 2006 - 2010 Seal Management Measures. Available at: http://www.dfo-mpo.gc.ca/seal-phoque/reports-rapports/facts-faits/facts-faits20062010_e.htm.

DFO (Fisheries and Oceans Canada) (2006c). Canadian Atlantic pelagic shark integrated fisheries management plan 2002-2007.Fisheries and Oceans Canada. 47 pp.

DFO (Department of Fisheries and Oceans Canada). (2007a). Statement of Canadian Practice with respect to the Mitigation of Seismic Sound in the Marine Environment Retrieved from http://www.dfo-mpo.gc.ca/oceans/management-gestion/integratedmanagement-gestionintegree/seismic-sismique/information-eng.asp

DFO (Department of Fisheries and Oceans Canada). (2007b). The Newfoundland Shelf - Climatology. Retrieved from http://www2.mar.dfo-mpo.gc.ca/science/ocean/nfld/nfld_hydro.html Accessed February 2014.

DFO (Fisheries and Oceans Canada) (2007c). National Plan of Action for the Conservation and Management of Sharks. Fisheries and Oceans Canada. 27 pp.

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

DFO (Department of Fisheries and Oceans Canada) (2008b). Status of basking sharks in Atlantic Canada. Canadian Science Advisory Secretariat 2008/036

DFO (Department of Fisheries and Oceans Canada). (2009). Archived: Canadian Atlantic Swordfish and other tunas 2004-2006. http://www.dfo-mpo.gc.ca/fm-gp/peches-fisheries/ifmp-gmp/swordfish-espadon/swordfish-2004-espadon-eng.htm#sec3 March 3, 2014.

DFO (Department of Fisheries and Oceans Canada). (2010a). Occurrence, susceptibility to fishing, and ecological function of corals, sponges, and hydrothermal vents in Canadian waters. Canadian Science Advisory Secretariat 2010/041.

DFO (Department of Fisheries and Oceans Canada). (2010b). Aquatic species: Details for shortfin mako shark. Species Information. Retrieved Sept 9, 2013 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) (2010c). Recovery Strategy for the Northern Bottlenose Whale, Scotian Shelf population, in Atlantic Canadian Waters. .Species at Risk Act Recovery Strategy Series. Fisheries and Oceans Canada. vi + 61p.

DFO (Department of Fisheries and Oceans Canada). (2010d). Snow Crab – Newfoundland and Labrador – 2009 – 2011. Retrieved from: http://www.dfo-mpo.gc.ca. November 10, 2013.

DFO (Department of Fisheries and Oceans Canada). (2010e). Northern Shrimp - Shrimp Fishing Areas (SFAs) 0-7 and the Flemish Cap. Retrieved from: http://www.dfo-mpo-gc.ca. October 6, 2013.

DFO (Department of Fisheries and Oceans Canada) (2010f). Integrated Fisheries Management Plan: Snow Crab (*Chionoecetes opilio*) - Newfoundland and Labrador - 2009-2011. Retrieved from: http://www.dfo-mpo.gc.ca/fm-gp/peches-fisheries/ifmp-gmp/snow-crab-neige/snow-crab-neiges2009-eng.htm#n1.5. February 27, 2014

DFO (Department of Fisheries and Oceans Canada) (2010g). Integrated Fisheries Management Plan: Northern shrimp (SFAs) 0-7 and the Flemish Cap. http://www.dfo-mpo.gc.ca/fm-gp/peches-fisheries/ifmp-gmp/shrimp-crevette/shrimp-crevette-2007-eng.htm#n8. February 27, 2014

DFO (Fisheries and Oceans Canada) (2010h). Assessment of Redfish Stocks (*Sebastes fasciatus* and *S. mentella*) in Units 1 and 2 in 2009.. DFO Canadian Science Advisory Secretariat Science Advisory Report. 2010/037.

DFO (Department of Fisheries and Oceans Canada). (2011a). Recovery potential assessment of redfish (*Sebastes mentella and S. fasciatus*) in the northwest Atlantic. Canadian Science Advisory Secretariat 2011/044.

DFO (Department of Fisheries and Oceans Canada) (2011b). Marine Areas Managed by Fisheries and Oceans Canada that Benefit Benthic Environments. Retrieved from: http://www.dfo-mpo.gc.ca. October 15, 2013.

DFO (Department of Fisheries and Oceans Canada) (2011c). 2011 – 2015 Integrated Fisheries Management Plan for Atlantic Seals. Retrieved from: http://www.dfo-mpo.gc.ca. October 8, 2013.

DFO (Department of Fisheries and Oceans Canada) (2011d). Assessment of Atlantic Halibut on the Scotian Shelf and the Southern Grand Banks (NAFO Divisions 3NOPs3VWX5ZC). DFO Canadian Science Advisory Secretariat Science Advisory Report. 2011/001.11 pp.

DFO (Department of Fisheries and Oceans Canada) (2011e). Stock Assessment of Atlantic halibut of the Gulf of St. Lawrence (NAFO Divisions 4RST) for 2009 and 2010. DFO Canadian Science Advisory Secretariat Science Advisory Report. 2011/012. 20 pp.

DFO (Department of Fisheries and Oceans Canada) (2011f). Fisheries Management Decisions: Arctic Surf clam – Grand bank. http://www.dfo-mpo.gc.ca/decisions/fm-2011-gp/atl-036-eng.htm. March 3, 2014

DFO (Department of Fisheries and Oceans Canada). (2011g). Capelin (*Mallotus villosus*) Newfoundland & Labrador Region 2J3KLPs. Integrated Fisheries Management Plan. 35 pp.

DFO (Department of Fisheries and Oceans Canada). (2012a). Recovery Strategy for the beluga whale (*Delphinapterus leucas*) St. Lawrence Estuary population in Canada. Species at Risk Act Recovery Strategy Series. Fisheries and Oceans Canada, Ottawa. 88 pp + X pp.

DFO (Department of Fisheries and Oceans Canada). (2012b). Using satellite tracking data to define important habitat for leatherback turtles in Atlantic Canada. DFO Can. Sci. Advis. Sec. Sci. Advis. Rep. 2012/036.

DFO (Department of Fisheries and Oceans Canada). (2012c). A Federal – Provincial Strategy for the Rebuilding of Atlantic Cod Stocks. Retrieved from: http://www.dfo-mpo.gc.ca. November 10, 2013.

DFO (Department of Fisheries and Oceans Canada) (2012d). Fisheries Management Decisions: Northern Shrimp Fishing Areas (SFAs) 0, 1, and 7. http://www.dfo-mpo.gc.ca/decisions/fm-2013-gp/atl-001-eng.htm. February 27, 2014

DFO (Department of Fisheries and Oceans Canada) (2012e). Reference points for redfish (*Sebastes mentella* and *Sebastes fasciatus*). DFO Canadian Science Advisory Secretariat Science Advisory Report. 2012/004. (Erratum: June 2013).

DFO (Department of Fisheries and Oceans Canada) (2012f). Fisheries Management Decisions: Atlantic halibut in the Gulf of St. Lawrence (4RST). http://www.dfo-mpo.gc.ca/decisions/fm-2012-gp/atl-033-eng.htm. February 28, 2014

DFO (Fisheries and Oceans Canada) (2012g). Fisheries Management Decisions: Bluefin Tuna – Atlantic Canada. http://www.dfo-mpo.gc.ca/decisions/fm-2012-gp/atl-037-eng.htm. March 3, 2014.

DFO (Department of Fisheries and Oceans Canada). (2012h). Assessment of the Northern Gulf of St. Lawrence (3Pn, 4RS) cod stock in 2011. Retrieved from: http://www.dfo-mpo.gc.ca/csas-sccs/Publications/SAR-AS/2012/2012_005-eng.pdf. March 10, 2014.

DFO (Department of Fisheries and Oceans Canada) (2013a). Report on the Progress of Implementation of the Recovery Strategy for Northern Wolffish (*Anarhichas denticulatus*) and Spotted Wolffish (*Anarhichas minor*), and Management Plan for Atlantic Wolffish (*Anarhichas lupus*) in Canada for the Period 2008-2013. Species at Risk Act Recovery Strategy Report Series. Fisheries and Oceans Canada, Ottawa. vi + 16 pp.

DFO (Department of Fisheries and Oceans Canada). (2013b). Identification of additional ecologically and biologically significant areas (EBSAs) within the Newfoundland and Labrador Shelves Bioregion. Canadian Science Advisory Secretariat 2013/048.

DFO (Department of Fisheries and Oceans Canada). (2013c). Report on the Progress of Recovery Strategy Implementation for the Leatherback Sea Turtle (*Dermochelys coriacea*) in Canada for the Period 2007-2012. Species at Risk Act Recovery Strategy Report Series. Fisheries and Oceans Canada, Ottawa.

DFO (Department of Fisheries and Oceans Canada) (2013d). Landings. Retrieved from: http://www.dfo-mpo.gc.ca. November 10, 2013.

DFO (Department of Fisheries and Oceans Canada) (2013e). Facts on Canadian fisheries: Snow crab. http://www.dfo-mpo.gc.ca/fm-gp/sustainable-durable/fisheries-peches/snow-crab-eng.htm. February 27, 2014

DFO (Department of Fisheries and Oceans Canada) (2013f). Fisheries Management Decisions: Snow Crab Fishing Areas 2J, 3KLNO, 3Ps, 4R3Pn - Season 2013 Retrieved from: http://www.dfo-mpo.gc.ca/decisions/fm-2013-gp/atl-003-eng.htm. February 27, 2014

DFO (Department of Fisheries and Oceans Canada) (2013g). Facts on Canadian fisheries: Shrimp. http://www.dfo-mpo.gc.ca/fm-gp/sustainable-durable/fisheries-peches/shrimp-crevette-eng.htm. February 27, 2014

DFO (Department of Fisheries and Oceans Canada) (2013h). Fisheries Management Decisions: Northern Shrimp Fishing Areas (SFAs) 2-6. http://www.dfo-mpo.gc.ca/decisions/fm-2013-gp/atl-013-eng.htm. February 27, 2014

DFO (Department of Fisheries and Oceans Canada) (2013i). Assessment of Capelin in SA2 + Div. 3KL in 2013. Canadian Advisory Secretariat Science Advisory Report. 2013/011:1-18.

DFO (Department of Fisheries and Oceans Canada) (2013j). Fisheries Management Decisions: 2J3KLPs Capelin – Newfoundland and Labrador. http://www.dfo-mpo.gc.ca/decisions/fm-2013-gp/atl-018-eng.htm. February 27, 2014

DFO (Department of Fisheries and Oceans Canada) (2013k). Fisheries Management Decisions: 3Ps Groundfish Newfoundland and Labrador (2013-2014). http://www.dfo-mpo.gc.ca/decisions/fm-2013-gp/atl-008-eng.htm. February 27, 2014

DFO (Department of Fisheries and Oceans Canada) (2013l). Fisheries Management Decisions: Newfoundland and Labrador Recreational Groundfish Fishery. http://www.dfo-mpo.gc.ca/decisions/fm-2013-gp/atl-015-eng.htm. February 27, 2014

DFO (Department of Fisheries and Oceans Canada) (2013m). Subdivision 3Ps offshore whelk: A preliminary assessment of male size at maturity. Canadian Science Advisory Secretariat Science Advisory Report. 2013/066. 8 pp.

DFO (Department of Fisheries and Oceans Canada) (2013n). The Grand Banks of Newfoundland: Atlas of Human Activities: Whelk Landings in the Newfoundland and Labrador Region (2000 – 2003). http://www.nfl.dfo-mpo.gc.ca/e0007402. February 27, 2014

DFO (Department of Fisheries and Oceans Canada). (2013o). Facts on Canadian Fisheries: Swordfish. http://www.dfo-mpo.gc.ca/fm-gp/sustainable-durable/fisheries-peches/swordfish-espadon-eng.htm. March 3, 2014.

DFO (Department of Fisheries and Oceans Canada). (2013p). Integrated Fisheries Management Plans: Canadian Atlantic Swordfish and Other Tunas. http://www.dfo-mpo.gc.ca/fm-gp/peches-fisheries/ifmp-gmp/swordfish-espadon/swordfish-2013-espadon-eng.htm. March 3, 2014

DFO (Department of Fisheries and Oceans Canada). (2013q) Assessment of Nova Scotia (4VWX) snow crab. Canadian Science Advisory Secretariat Science Advisory Report. 2013/060. pp 27.

DFO (Department of Fisheries and Oceans Canada). (2013r). Snow Crab Fishing Area N-ENS (formerly CFA 20-22): Eastern Cape Breton, Maritimes Region. Retrieved from http://www.dfo-mpo.gc.ca/decisions/fm-2013-gp/atl-004-eng.htm. March 10, 2014.

DFO (Department of Fisheries and Oceans Canada). (2013s). Snow Crab Fishing Area S-ENS (CFA 23 and 24) - Eastern Cape Breton, Maritimes Region. Retrieved from http://www.dfo-mpo.gc.ca/decisions/fm-2013-gp/atl-005-eng.htm. March 10, 2014.

DFO (Department of Fisheries and Oceans Canada). (2013t). Fisheries Management Decisions: Cod in the Northern Gulf of St. Lawrence (3Pn4RS). Retrieved from http://www.dfo-mpo.gc.ca/decisions/fm-2013-gp/atl-014-eng.htm. March 10, 2014.

DFO (Department of Fisheries and Oceans Canada). (2013u). Northern Cod Stewardship / By-catch Fishery 2J3KL. http://www.dfo-mpo.gc.ca/decisions/fm-2013-gp/atl-016-eng.htm. February 27, 2014.

DFO (Department of Fisheries and Oceans Canada). (2013v). Zonal review of Emera Newfoundland and Labrador Maritime Link Environmental Assessment Report. Canadian Science Advisory Secretariat Science Response. 2013/015: 31 pp.

DFO (Department of Fisheries and Oceans Canada). (2014a). Aquatic Invasive Species. Retrieved February 13, 2014 from http://www.inter.dfo-mpo.gc.ca/nl/AIS/Aquatic-Invasive-Species.

DFO (Department of Fisheries and Oceans Canada). (2014b). International Fisheries: Swordfish Management in Canada. http://www.dfo-mpo.gc.ca/international/tuna-thon/swordfish-espadon-eng.htm March 3, 2014.

DFO (Department of Fisheries and Oceans Canada) (2014c). International Fisheries: Bluefin Tuna management in Atlantic Canada.http://www.dfo-mpo.gc.ca/international/tuna-thon/bluefin-mgt-gestion-rouge-eng.htm March 3, 2014.

DFO (Department of Fisheries and Oceans Canada) (2014d). Species Quota Report, Newfoundland and Labrador Region Crab, Queen/Snow. Retrieved from http://www.nfl.dfo-mpo.gc.ca/publications/reports_rapports/Crab_Crabe_2013_eng.htm. March 11, 2014.

DFO (Department of Fisheries and Oceans Canada) (2014e). Species Quota Report, Newfoundland and Labrador Region Preliminary Data Turbot/Greenland Halibut. Retrieved from http://www.nfl.dfo-mpo.gc.ca/publications/reports_rapports/Halibut_Turbot_2012_eng.htm. March 10, 2014.

Di Iorio, L. and Clark, C.W. (2010). Exposure to seismic survey alters blue whale acoustic communication. Biology Letters. 6(1):51-54.

DND (Department of National Defence) (2014). Unexploded Explosive Ordinance. Retrieved from: http://www.forces.gc.ca. Accessed February 25, 2014.

Doherty, P. and Horsman, T. (2007). Ecologically and Biologically Significant Areas of the Scotian Shelf and Environs: A Compilation of Scientific Expert Opinion. Canadian Technical Reports in Fisheries and Aquatic Sciences 2774: 57 + xii pp.

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

Drinkwater, K.F. (2005). The response of Atlantic cod (*Gadus morhua*) to future climate change. ICES Journal of Marine Science. 62(7): 1327-1337.

Drinkwater, K.F. (2006). The regime shift of the 1920s and 1930s in the North Atlantic. Progress in Oceanography 68: 134-151.

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

Dunnet, G.M. and Ollason, J.C. (1978). The Estimation of Survival Rate in the Fulmar, *Fulmarus glacialis*. Journal of Animal Ecology 47(2):507-520

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.

e-Bird. (2014). e-Bird database interactive range maps. http://ebird.org/ebird/map/. Accessed 15 January 2014.

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.

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.

Engen, F., and Folstad, I. (1999). Cod courtship song: a song at the expense of dance? Canadian Journal of Zoology 77: 542-550.

EC (Environment Canada) (2006). Recovery Strategy for the Red Crossbill, percna subspecies (*Loxia curvirostra percna*), in Canada. Species at Risk Act Recovery Strategy Series. Environment Canada, Ottawa. vii + 29 pp.

EC (Environment Canada) (2007). Management Plan for the Harlequin Duck (*Histrionicus histrionicus*) Eastern Population, in Atlantic Canada and Québec. Species at Risk Act Management Plan Series. Environment Canada. Ottawa. vii + 32 pp.

EC (Environment Canada) (2009). Atlantic Canada Shorebird Surveys Site Catalogue. Environment Canada. Atlantic Region. viii + 253 pp.

EC (Environment Canada) (2011). Status of Birds in Canada – 2011: Status of Landbirds, Shorebirds, Waterbirds (excluding Waterfowl). Available online at: http://www.ec.gc.ca/soc-sbc/index-eng.aspx?sL=eandsY=2011. Accessed 12 September 2013.

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

EC (Environment Canada) (2013). Newfoundland and Labrador Migratory Birds Hunting Regulations, 2013-2014. Retrieved February 25, 2014 from http://www.ec.gc.ca/rcom-mbhr

EC-CWS (Environment Canada-Canadian Wildlife Service) (2013). Environment Canada, Canadian Wildlife Service, Atlantic Canada Colonial Waterbird database. Information provided by EC-CWS in response to data request, 17 September 2013.

ECSAS (Eastern Canada Seabirds at Sea) (2014). Eastern Canada Seabirds at Sea sightings database. Environment Canada - Canadian Wildlife Service, Atlantic Canada.

Endangered Species and Biodiversity Section. (2010). Management Plan for the Gray-cheeked Thrush (*Catharus minimus*) in Newfoundland and Labrador. Wildlife Division, Department of Environment and Conservation, Government of Newfoundland and Labrador, Corner Brook, Canada. iii + 19 pp.

Engås, A, S. Løkkeborg, E. O., and Soldal, A.V. (1996). Effects of seismic shooting on local abundance and catch rates of cod (*G. morhua*) and haddock (*M. aeglefinus*). Canadian Journal of Fisheries and Aquatic Sciences. 53(10):2238-2249.

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.

Fader, G.B., Cameron, G.D.M. and Best, M.A. (1989). Geology of the Continental Margin of Eastern Canada, Geological Survey of Canada, Map 1705A.

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

Finneran, J.J., Schlundt, C.E., Carder, D.A., Clark, J.A., Young, J.A., Gaspin, J.B. and Ridgway, S.H. (2000). Auditory and behavioural responses of bottlenose dolphins (*Tursiops truncatus*) and a beluga whale (*Depphinapterus leucas*) to impulsive sounds resembling distant signatures of underwater explosions. Journal of the Acoustical Society of America, 108(1): 417-431.

Finneran, J.J., Schlundt, C. E., Dear, R., Carder, D.A., and Ridgway, S. H. (2002). Temporary shift in masked hearing thresholds in odontocetes after exposure to single underwater impulses from a seismic watergun. The Journal of the Acoustical Society of America. 111(6): 2929.

Finneran, J.J., Carder, D. A., Schlundt, C. E., and Dear, R. L. (2010). Temporary threshold shift in a bottlenose dolphin (*Tursiops truncatus*) exposed to intermittent tones. The Journal of the Acoustical Society of America. 127(5):3267-72.

FAO (Food and Agriculture Organization of the United Nations). (2009). International Guidelines for the Management of Deep-Sea Fisheries in the High Seas. FAO, Rome. 73 pp.

Forney, K. A. and Wade, P. (2006). Worldwide distribution and abundance of killer whales. Pages 145-162 in J. A. Estes, R. L. Brownell, Jr., D. P. DeMaster, D. F. Doak, and T. M. Williams (eds). Whales, whaling, and ocean ecosystems. University of California Press, Berkeley, California.

FAO (Food and Agriculture Organization of the United Nations). (2013). Species fact sheets: *Thunnus obesus* (Lowe, 1839). Retrieved Sept 9, 2013 from http://www.fao.org/fishery/species/2498/en.

Frank, K.T., Perry, R.I., and Drinkwater, K.F. (1990). Predicted response of northwest Atlantic invertebrate and fish stocks to CO2-induced climate change. Transactions of the American Fisheries Society 119: 353-365.

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.

Freese, J.L. (2001) Trawl-induced damage to sponges observed from a research submersible. Marine Fisheries Review. 63(3): 7-13.

Fuentes-Yaco, C., Koeller, P.A., Sathyendranath, S. and Platt, T. (2007). Shrimp (*Pandalus borealis*) growth and timing of the spring phytoplankton bloom on the Newfoundland-Labrador Shelf. Fisheries Oceanography 16: 116-129.

Garland, S. and Thomas, P. (2009). Recovery Plan for Red Knot, rufa subspecies (*Calidris canutus rufa*), in Newfoundland and Labrador. Wildlife Division, Department of Environment and Conservation, Government of Newfoundland and Labrador, Corner Brook, NL. iv + 12 pp.

Garrison, B.A. (1999). Bank Swallow (*Riparia riparia*), The Birds of North America Online (A. Poole, Ed.). Ithaca: Cornell Lab of Ornithology; Retrieved from the Birds of North America Online: http://bna.birds.cornell.edu/bna/species/414

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.

Gaston, A.J. and Hipfner, J.M. (2000). Thick-billed Murre (*Uria lomvia*), The Birds of North America Online (A. Poole, Ed.). Ithaca: Cornell Lab of Ornithology; Retrieved from the Birds of North America Online: http://bna.birds.cornell.edu/bna/species/497

Gausland, L. (1993). Impact of offshore seismic on marine life. 55th Meeting of the European Association of Exploration Geophysicists, Stavanger.

Gauthreaux, S.A. and Belser, C.G. (2006). Effects of artificial night lighting on migrating birds. Pages 67-93 in C. Rich and T. Longcore (Eds). Ecological Consequences of Artificial Night Lighting. Island Press, Washington D.C.

Gedamke, J., Gales, N., and Frydman, S. (2011). Assessing risk of baleen whale hearing loss from seismic surveys: the effect of uncertainty and individual variation in Journal of the Acoustical Society of America. 129(1):496-506.

Gentry, R.L. (2000). Mass Stranding of Beaked Whales in the Galapagos Islands, April 2000. Retrieved from http://www.NMFS.NOAA.gov/prot_res/PR2/Health_and_Stranding_Response_Program / Mass_Galapagos_Islands.htm.

Geraci, J.R. (1990). Cetaceans and oil: physiologic and toxic effects. In J.R. Geraci and D.J. St. Aubin (Eds.), Sea mammals and oil: confronting the risks (pp. 167-197). San Diego, CA: Academic Press.

Gero, S., Williams, R., Bejder. L., Calambokidis. J, Kraus. S, Lusseau, D., Read, A., and Robbins, J. (2011). Underestimating the Damage: Interpreting Cetacean Carcass Recoveries in the Context of the Deepwater Horizon/BP Incident. Conservation Letters, Wiley-Blackwell.

Gilkinson, K. and Edinger, E. (2009). The ecology of deep-Sea corals of Newfoundland and Labrador waters: biogeography, life history, biogeochemistry, and relation to fishes. Canadian Technical Report of Fisheries and Aquatic Sciences 2830.

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

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.

Gjerdrum, C., Head, E. J. H., and Fifield, D. A. (2008). Monitoring Seabirds at Sea in Eastern Canada. Atlantic Zone Monitoring Program, 52-58.

Gochfeld, M., Burger, J., and Nisbet, I.C. (1998). Roseate Tern (*Sterna dougallii*), The Birds of North America Online (A. Poole, Ed.). Ithaca: Cornell Lab of Ornithology; Retrieved from the Birds of North America Online: http://bna.birds.cornell.edu/bna/species/370

Goetting, K. (2010). Is the Newfoundland Redifsh Fishery Sustainable? Modelling Recovery Strategies for Two Redfish Stocks. M.Sc. Thesis. Memorial University, St. John's.

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

Goodall, C, Chapman, C., and Neil, D. (1990). The acoustic response threshold of the Norway lobster,*Nephrops norvegicus* (L.) in a free sound field. In Frontiers in Crustacean Neurobiology (ed. K. Wiese, W.-D. Krenz, J. Tautz, H. Reichert and B. Mulloney), pp. 106–113. Basel, Boston, Berlin: Birkhäuser Verlag.

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

Gordon, J.D.M and Mauchline J. (1996) The Distribution and Diet of the Dominant, Slope-Dwelling Eel, *Synaphobranchus kaupii*, Of the Rockall Trough. Journal of the Marine Biological Association of the United Kingdom. 76: 493-503.

Gorsline, J., Holmes, W.N., and Cronshaw, J. (1981). The Effects of Ingested Petroleum on the Naphthalene-metabolizing Properties of Liver Tissue in Seawater-adapted Mallard Ducks (Anas platyrhynchos). Environmental Research, 24, 377-390.

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

Gosselin, J.F., Lesage, V., and Robillard, A. (2001). Population index estimate for the beluga of the St. Lawrence Estuary in 2000. Department of Fisheries and Oceans Canada, Canadian Science Advisory Secretariat, Research Document 2001/049. 13p. + tables + figures.

Government of Newfoundland and Labrador. (2009). Press release: "Lawn Islands Archipelago Established as Provisional Ecological Reserve". Dated 20 July 2009. Available online at http://www.env.gov.nl.ca/env/LawnIslands_Reserve.pdf; accessed 10 October 2013.

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.

Haedrich, R.L., and Merrett, N.R. (1990). Little evidence for faunal zonation or communities in deep Study demersal fish faunas. Progress in Oceanography 24: 239–250.

Hain, J.H.W., Hyman, M.A.M., Kenney, R.D., and Winn, H.E. (1985). The role of cetaceans in the shelf-edge region of the northeastern United States. Marine Fisheries Review 47:13-17.

Hamel J.-F. and Mercier A. (2008) Precautionary management of *Cucumaria frondosa* in Newfoundland and Labrador, Canada. In: V. Toral-Granda, A. Lovatelli and M. Vasconcellos (eds) Sea Cucumbers. A Global Review of Fisheries and Trade. Rome: FAO Fisheries and Aquaculture Technical Paper 516, pp. 293–306.

Hammill, M.O. and Stenson, G.B. (2000). Estimated Prey Consumption by Harp seals (*Phoca groenlandica*), Hooded seals (Cystophora cristata), Grey seals (*Halichoerus grypus*) and Harbour seals (*Phoca vitulina*) in Atlantic Canada. Journal of Northwest Fishery Sciences. 26:1-23

Hammond, P.S., Bearzi, G., Bjørge, A., Forney, K., Karczmarski, L., Kasuya, T., Perrin, W.F., Scott, M.D., Wang, J.Y., Wells, R.S. and Wilson, B. (2008a). Delphinus delphis. In: IUCN 2013. IUCN Red List of Threatened Species. Version 2013.2. <www.iucnredlist.org>

Hammond, P.S., Bearzi, G., Bjørge, A., Forney, K., Karczmarski, L., Kasuya, T., Perrin, W.F., Scott, M.D., Wang, J.Y., Wells, R.S. and Wilson, B. (2008b). Lagenorhynchus acutus. In: IUCN 2013. IUCN Red List of Threatened Species. Version 2013.2. <www.iucnredlist.org>.

Hammond, P.S., Bearzi, G., Bjørge, A., Forney, K., Karczmarski, L., Kasuya, T., Perrin, W.F., Scott, M.D., Wang, J.Y., Wells, R.S. and Wilson, B. (2008c). Stenella coeruleoalba. In: IUCN 2013. IUCN Red List of Threatened Species. Version 2013.2. <www.iucnredlist.org>.

Hammond, P.S., Bearzi, G., Bjørge, A., Forney, K., Karczmarski, L., Kasuya, T., Perrin, W.F., Scott, M.D., Wang, J.Y., Wells, R.S. and Wilson, B. (2008d). Phocoena phocoena. In: IUCN 2013. IUCN Red List of Threatened Species. Version 2013.2. <www.iucnredlist.org>.

Hammond, P.S., Bearzi, G., Bjørge, A., Forney, K.A., Karkzmarski, L., Kasuya, T., Perrin, W.F., Scott, M.D., Wang, J.Y. , Wells, R.S. and Wilson, B. (2012a). Tursiops truncatus. In: IUCN 2013. IUCN Red List of Threatened Species. Version 2013.2. <www.iucnredlist.org>.

Hammond, P.S., Bearzi, G., Bjørge, A., Forney, K.A., Karkzmarski, L., Kasuya, T., Perrin, W.F., Scott, M.D., Wang, J.Y. , Wells, R.S. and Wilson, B. (2012b). Lagenorhynchus albirostris. In: IUCN 2013. IUCN Red List of Threatened Species. Version 2013.2. <www.iucnredlist.org>.

Han, G. and Kulka, D.W. (2007). Dispersion of eggs, larvae and pelagic juveniles of White hake (*Urophycis tenuis*, Mitchill 1815) on the Grand banks of Newfoundland in relation to subsurface currents. NAFO Scientific Council Research Document. 07/21, Serial No. N5372. 27 p.

Hartung. R. (1995). Assessment of the Potential for Long-term Toxicological Effects of the Exxon Valdez Oil Spill on Birds and Mammals. In P.G. Wells, J.N. Butler, and J.S. Hughes (Eds.), Exxon Valdez oil spill: fate and effects in Alaskan waters (pp. 693-725). Philadelphia, PA: American Society for Testing and Materials.

Hartung, R. and Hunt, G.S. (1966). Toxicity of Some Oils to Waterfowl. Journal of Wildlife Management. 30:564-570.

Hasemann, C., and Soltwedel, T. (2011). Small-scale heterogeneity in deep-sea nematode communities around biogenic structures. PLoS One, 6: e29152.

Hassel, A., Knutsen, T., Dalen, J., Løkkeborg, S., Skaar, K., Østensen, Ø., Haugland, E.K., Fonn, M., Høines, Å., and Misund, M.A. (2003). Reaction of sandeel to seismic shooting: A field experiment and fishery statistics study. Institute of Marine Research, Bergen, Norway.

Hastings, M. C. (1990). Effects of Underwater Sound on Fish. Document No. 46254-900206-01IM, Project No. 401775-1600, ATandT Bell Laboratories.

Hatch, J.J. and Weseloh, D.V. (1999). Double-crested Cormorant (*Phalacrocorax auritus*), The Birds of North America Online (A. Poole, Ed.). Ithaca: Cornell Lab of Ornithology; Retrieved from the Birds of North America Online: http://bna.birds.cornell.edu/bna/species/441

Hatch, J.J., Brown, K.M., Hogan, G.G., and Morris, R.D. (2000). Great Cormorant (*Phalacrocorax carbo*), The Birds of North America Online (A. Poole, Ed.). Ithaca: Cornell Lab of Ornithology; Retrieved from the Birds of North America Online: http://bna.birds.cornell.edu/bna/species/553

Hatch, J.J. (2002). Arctic Tern (*Sterna paradisaea*), The Birds of North America Online (A. Poole, Ed.). Ithaca: Cornell Lab of Ornithology; Retrieved from the Birds of North America Online: http://bna.birds.cornell.edu/bna/species/707

Hawkins, A.D. and Amorin, M.C. (2000). Spawning sounds of the male haddock, *Melanogrammus aeglefinus*. Environmental Biology of Fishes, 59: 29-41

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

Head, E.J.H. and Sameoto, D.D. (2007). Inter-decadal variability in zooplankton and phytoplankton abundance on the Newfoundland and Scotian shelves. Deep Study Research Part II: Topical Studies in Oceanography 54: 2686-2701.

Hedd, A., Montevecchi, W. A., McFarlane Tranquilla, L., Burke, C. M., Fifield, D. A., Robertson, G. J., Phillips, R. A., Gjerdrum, C. and Regular, P. M. (2011), Reducing uncertainty on the Grand Bank: tracking and vessel surveys indicate mortality risks for common murres in the North-West Atlantic. Animal Conservation, 14: 630–641.

Higdon, J. (2007). Status of knowledge on killer whales *Orcinus orca* in the Canadian Arctic. Canadian Science Advisory Secretariat Research Document 2007/ 048.

Himmelman, J.H., and Hamel, J.-R. (1993). Diet, behaviour and reproduction of the whelk *Buccinum undatum* in the northern Gulf of St. Lawrence, eastern Canada. Marine Biology. 116:423-430.

Hirst, A.G. and Rodhouse, P.G. (2000). Impacts of geophysical seismic surveying on fishing success. Reviews in Fish Biology and Fisheries. 10:113-118.

Holt, M. M., Noren, D. P., Veirs, V., Emmons, C. K., and Veirs, S. (2009). Speaking up: Killer whales (*Orcinus orca*) increase their call amplitude in response to vessel noise. The Journal of the Acoustical Society of America, 125(1), EL27-32.

Hooker, S. K. and Baird, R. W. (1999). Deep-diving behaviour of the northern bottlenose whale, *Hyperoodon ampullatus* (Cetacea: Ziphiidae). Proceedings of the Royal Society of London B Biological Sciences 266: 671-676.

Hooper, R.G. (1986). A spring breeding migration of the snow crab, *Chionoecetes oilio* (O. Fabr.) into shallow water in Newfoundland. Crustaceana 50: 257-264.

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.

Huntington, C.E., Butler, R.G., and Mauck, R.A. (1996). Leach's Storm-Petrel (*Oceanodroma leucorhoa*), The Birds of North America Online (A. Poole, Ed.). Ithaca: Cornell Lab of Ornithology; Retrieved from the Birds of North America Online: http://bna.birds.cornell.edu/bna/species/233

Hurley, G.V. (2009) Environmental Assessment Biophysical Data Gap Study – Petroleum Exploration Activities on the Offshore Scotian Shelf and Slope. Consultant report prepared by Hurley Environment Ltd. for the Canada-Nova Scotia Petroleum Board. March, 31 2009. 122 pp.

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 (2014). Important Bird Areas of Canada. Available online at: http://www.ibacanada.ca/. Accessed 15 January 2014.

Ings, D.W., Gregory, R.S., and Schneider, D.C. (2008). Episodic downwelling predicts recruitment of Atlantic cod, Greenland cod and white hake to Newfoundland coastal waters. Journal of Marine Research 66: 529-561.

ICCAT (International Commission for the Conservation of Atlantic Tuna). (2013a). Statistical Bulletin. Volume 41(2). Retrieved from http://www.iccat.int/ March 11 2014.

ICCAT (International Commission for the Conservation of Atlantic Tuna). (2013b). Report of the 2013 Atlantic Swordfish Stock Assessment Session. Document No. SCI-046/2013. Retrieved from http://www.iccat.int/ March 10, 2014.

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

IMM (Intertek Moody Marine). (2013). Clearwater Grand Bank Arctic Surfclam Fishery: Assessment Report. Report prepared for Clearwater Seafoods Limited Partnership. Project No. 82351. 162 pp.

IWC (International Whaling Commission). (2001). Report on the workshop on status and trends of western North Atlantic right whales. J. Cetacean Res. Manage. (Spec.Iss.) 2: 61-87.

IWC (International Whaling Commission) (2002). Report of the subcommittee on the Comprehensive Assessment of North Atlantic humpback whales. Journal of Cetcaean Research and Management. 4:230-260.

Jefferson, T.A., Karkzmarski, L., Laidre, K., O'Corry-Crowe, G., Reeves, R., Rojas-Bracho, L., Secchi, E., Slooten, E., Smith, B.D., Wang, J.Y. and Zhou, K. (2012). *Delphinapterus leucas*. In: IUCN 2013. IUCN Red List of Threatened Species. Version 2013.2. <www.iucnredlist.org>.

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

Jones, J. and Francis, C. M. (2003). The effects of light characteristics on avian mortality at lighthouses. Journal of Avian Biology. 34:328–333.

Katona, S.K., and Beard, J.A. (1990). Population size, migrations and feeding aggregations of the humpback whale (*Megaptera novaeangliae*) in the western North Atlantic Ocean. Rep. int. Whal. Commn, 295-305.

Kearley, W. 2012. Here's the catch: The fish we harvest from the Northwest Atlantic. Boulder Publications: Portugal Cove-St. Phillips. 163 pp.

Keen, M.J., Adams, J., Moran, K., Piper, D.J.W. and Reid, I. (1990). Earthquakes and Seismicity, in M.J. Keen and G.L. Williams, eds., Geology of the Continental Margin of Eastern Canada, Geology of Canada, No. 2: Geological survey of Canada, p 793-798

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.

Kenney, R.D. (2001). Anomalous 1992 spring and summer right whale (*Eubalaena glacialis*) distributions in the Gulf of Maine. Journal of Cetacean Research and Management. Spec. Iss. 2:209-223.

Khan, R. A. and Ryan, P. (1991).Long term effects of crude oil on Common Murres (*Uria aalge*) following rehabilitation. Bulletin of Environmental and Contaminant Toxicology. 46:216-222.

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.

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.

Kingsley, M.C.S. and Reeves, R.R. (1998). Aerial surveys of cetaceans in the Gulf of St. Lawrence in 1995 and 1996. Canadian Journal of Zoology. 76:1529-1550.

Knudby, A., Lirette, C., Kenchington, E., and Murillo, F.J. (2013). Species distribution models of black corals, large gorgonian corals and sea pens in the NAFO regulatory area. NAFO SCR Doc. 13/078.

Knudsen, F.R., Enger, P.S., and Sand, O. (1992). Awareness reactions and avoidance responses to sound in juvenile Atlantic salmon. Journal of Fisheries Biology 40(4): 523-534.

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.

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.

Kosheleva, V. (1992). The impact of air guns used in marine seismic explorations on organisms living in the Barents Sea. Contr. Petro Piscis II `92 Conference F-5, Bergen, 6-8 April, 1992.

Konstantinov, K.G., Turuk, T.N., and Plekhanova, N.A. (1985). Food links of some fishes and invertebrates on Flemish Cap. North Atlantic Fisheries Organization Scientific Council Studies. 8: 39-48.

Kostyuchenko, L.P. (1973). Effects of elastic waves generated in marine seismic prospecting on fish eggs in the Black Sea. Hydrobiologia. 9:45-48.

Kovacs, K.M. (2002). Hooded seal *Cystophora cristata*. pp. 580-582. In: W.F. Perrin, B. Würsig and J.G.M. Thewissen (eds.), Encyclopedia of Marine Mammals. Academic Press, San Diego, CA.

Kovacs, K. (IUCN SSC Pinniped Specialist Group) 2008a. *Pagophilus groenlandicus*. In: IUCN 2013. IUCN Red List of Threatened Species. Version 2013.2. <www.iucnredlist.org>.

Kovacs, K. (IUCN SSC Pinniped Specialist Group) 2008b. *Cystophora cristata*. In: IUCN 2013. IUCN Red List of Threatened Species. Version 2013.2. <www.iucnredlist.org>.

Kulka, D.W. (1998a). SPANdex - SPANS geographic information system process manual for creation of biomass indices and distributions using potential mapping. (98/60). DFO Atlantic Fisheries Research Document.

Kulka, D.W. (1998b). Spatial analysis of northern Atlantic cod distribution with respect to bottom temperature and estimation of biomass using potential mapping in SPANS (98/13). DFO Atlantic Fisheries Research Document.

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. (2009). Spatial Analysis of Plaice and Cod Bycatch in the Yellowtail Flounder Fishery on the Grand Bank. WWF Technical Report.

Kulka, D.W., Wroblewskie, J.S., and Narayanan, S. (1995). Recent changes in the winter distribution and movements of northern Atlantic cod (*Gadus morhua* Linnaeus, 1758) on the Newfoundland-Labrador Shelf. ICES Journal of Marine Science 52: 889-902.

Kulka, D.W., Frank, K., and Simon, J. (2002). Barndoor skate in the Northwest Atlantic off Canada: Distribution in relation to temperature and depth based on commercial fisheries data. Canadian Science Advisory Secretariat Research Document. 2002/073. 17 pp.

Kulka D. W., Antle, N.C., and Simms, J.M. (2003a). Spatial Analysis of 18 Demersal Species in Relation to Petroleum Licence Areas on the Grand Bank (1980-2000). (2473). Canadian Technical Report of Fisheries and Aquatic Sciences.

Kulka, D.W., Simpson, M.R. and Inkpen, T.D. (2003b). 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., Simpson, M.R., and Hooper, R.G. (2004). Changes in distribution and habitat associations of Wolffish (Anarhichadidae) in the Grand Banks and Labrador Shelf. DFO. Can. Sci. Advis. Sec. Res. Doc. 04/113. 48 pp.

Kulka, D.W., Miri C.M. and Simpson M.R. (2005) Distribution and aspects of Life History of White Hake (*Urophycis tenuis*, Mitchill 1815) on the Grand Banks of Newfoundland. NAFO Res. Doc. 05/60 Ser. No. 5146 58 p.

Kulka, D.W., Swain, D., Simpson, M.R., Miri, C.M., Simon, J., Gauthier, J., McPhie, R., Sulikowski, J., and Hamilton, L. (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. 93: iv + 136 p.

Kulka, D.W., Hood, C., and Huntington, J. (2007). Recovery Strategy for Northern Wolffish (*Anarhichas denticulatus*) and Spotted Wolffish (*Anarhichas minor*), and Management Plan for Atlantic Wolffish (*Anarhichas lupus*) in Canada. St. John's, NL: Department of Fisheries and Oceans Canada: Newfoundland and Labrador Region.

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.

Lavers, J.J., Hipfner, M., and Chapdelaine, G. (2009). Razorbill (*Alca torda*), The Birds of North America Online (A. Poole, Ed.). Ithaca: Cornell Lab of Ornithology; Retrieved from the Birds of North America Online: http://bna.birds.cornell.edu/bna/species/635

Lavigne, D. M. and Kovacs, K. M. (1988). Harps and hoods: ice-breeding seals of the northwest Atlantic. University of Waterloo Press, Ontario, Canada.

Lawler, G.C., Loong, W., and Laseter, J.L. (1978). Accumulation of Aromatic Hydrocarbons in Tissues of Petroleum-exposed Mallard Ducks (*Anas platyrhynchos*). Environmental Science and Technology Research. 12:51-54.

Laws, R. (2012). Cetacean hearing-damage zones around a seismic source. Advances in Experimental Medicine and Biology. 730:473-476.

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.

Lee, D.S. and Haney, J.C. (1996). Manx Shearwater (*Puffinus puffinus*), The Birds of North America Online (A. Poole, Ed.). Ithaca: Cornell Lab of Ornithology; Retrieved from the Birds of North America Online: http://bna.birds.cornell.edu/bna/species/257

Leeuw, T., Newburg, S.O., Boss, E.S., Slade, W.H., Soroka, M.G., Pederson, J., Chryssostomidis, C., and Hover, F.S. (2013). Remote identification of the invasive species tunicate *Didemnum vexillum* using reflective spectroscopy. Applied Optics 52: 1758-1763.

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. Canadian Science Advisory Secretariat, Science Advisory Report 2007/046.

LGL (LGL Limited). (2003). Orphan Basin Strategic Environmental Assessment. Report Prepared for Canada-Newfoundland Offshore Petroleum Board, St. John's, NL.

LGL (LGL Limited). (2005). Western Newfoundland and Labrador Offshore Area – Strategic Environmental Assessment. Report Prepared for Canada-Newfoundland Offshore Petroleum Board, St. John's, NL.

LGL (LGL Limited). (2010). Southern Newfoundland Strategic Environmental Assessment. Report Prepared for Canada-Newfoundland Offshore Petroleum Board, St. John's, NL.

LGL (LGL Limited). (2012). Orphan Basin Exploration Drilling Program Environmental Assessment: Update 2012. Report Prepared for Canada-Newfoundland Offshore Petroleum Board, St. John's, NL.

LGL (LGL Limited). 2013. Environmental Assessment of HMDC's 2D/3D/4D Seismic Projects 2013-Life of Field, Newfoundland Offshore Area. LGL Rep. SA1207. Report Prepared for Canada-Newfoundland Offshore Petroleum Board, St. John's, NL.

LGL (LGL Limited) and MAI (Marine Acoustic Inc). (2011). Environmental Assessment of Marine Vibroseis. LGL Rep. TA4604-1; JIP contract 22 07-12. Rep. from LGL Ltd., environ. res. assoc., King City, Ont., Canada,

and Marine Acoustics Inc., Arlington, VA, U.S.A., for Joint Industry Programme, EandP Sound and Marine Life, Intern. Assoc. of Oil and Gas Producers, London, U.K. 207 p.

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.

Lilly, G.R., Parsons, D.G. and Kulka, D.W. (2000). Was the increase in shrimp biomass on the northeast Newfoundland Shelf a consequence of a release in predation pressure from cod? Journal of Northwest Fisheries Science 27: 45-61.

Logan, J. M., Toppin, R., Smith, S., Galuardi, B., Porter, J., and Lutcavage, M. (2013). Contribution of cephalopod prey to the diet of large pelagic fish predators in the central North Atlantic Ocean. Deep Sea Research Part II: Topical Studies in Oceanography, 95, 74-82.

Lokkeborg, S. (1991). Effects of geophysical survey on catching success in longline fishing. Paper presented at the International Council for the Exploration of the Sea (ICES) Annual Science Conference. ICES. 40: 1-9.

Lokkeborg, S. and Soldal, A.V. (1993). The influences of seismic exploration on cod (*Gadus morhua*) behavior and catch rates. International Council for the Exploration of the Sea (ICES) Marine Science Symposium 196: 62-67.

Lokkeborg, S., Ona, E., Vold, A. and Salthaug, A. (2012). Sounds from seismic air guns: gear - and species-specific effects on catch rates and fish distribution. Canadian Journal of Fisheries and Aquatic Sciences. 69:1278-1291.

Lorance, P. Bergstad, O.A., Large, P.A. and Gordon, J.D.M. (2008). Grenadiers of the Northeast Atlantic – Distribution, Biology, Fisheries, and their Impacts, and Developments, in Stock Assessment and Management. In American Fisheries Society Symposium 63: 365-397.

Lowther, P.E., Diamond, A.W., Kress, S.W., Robertson, S.J., and Russell, K. (2002). Atlantic Puffin (*Fratercula arctica*), The Birds of North America Online (A. Poole, Ed.). Ithaca: Cornell Lab of Ornithology; Retrieved from the Birds of North America Online: http://bna.birds.cornell.edu/bna/species/709

Lucke, K., Siebert, U., Lepper, P. a, and Blanchet, M.-A. (2009). Temporary shift in masked hearing thresholds in a harbor porpoise (*Phocoena phocoena*) after exposure to seismic airgun stimuli. The Journal of the Acoustical Society of America. 125(6):4060-4070.

Madsen, P.T., Johnson, M., Miller, M., Aguilar de Soto, N. and Tyack, P. (2006). Quantitative measures of airgun pulses impinging on sperm whales using onboard tags and controlled exposures. Journal of the Acoustic Society of America. 120:2366-2379.

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.

Malakoff, S. (2002). Following ties whale deaths to research cruise. Science. 298:722-723.

Mallory, M.L., Hatch, S.A., and Nettleship, D.N. (2012). Northern Fulmar (*Fulmarus glacialis*), The Birds of North America Online (A. Poole, Ed.). Ithaca: Cornell Lab of Ornithology; Retrieved from the Birds of North America Online: http://bna.birds.cornell.edu/bna/species/361

Mallory, M.L., Stenhouse, I.J., Gilchrist, G., Robertson, G., Haney, J.C., and Macdonald, S.D. (2008). Ivory Gull (*Pagophila eburnea*), The Birds of North America Online (A. Poole, Ed.). Ithaca: Cornell Lab of Ornithology; Retrieved from the Birds of North America Online: http://bna.birds.cornell.edu/bna/species/175

MAI (Marine Atlantic Incorporated) (2013). Marine Atlantic. Retrieved from: http://www.marine-atlantic.ca. September 9, 2013.

Marine Turtle Specialist Group (1996). *Lepidochelys kempii*. In: IUCN 2012. IUCN Red List of Threatened Species. Version 2012.1. <www.iucnredlist.org>. Downloaded on 22 September 2012.

Martin, S.G. and Gavin, T.A. (1995). Bobolink (*Dolichonyx oryzivorus*), The Birds of North America Online (A. Poole, Ed.). Ithaca: Cornell Lab of Ornithology; Retrieved from the Birds of North America Online: http://bna.birds.cornell.edu/bna/species/176

Matishov, G.G. (1992). The reaction of bottom-fish larvae to airgun pulses in the context of the vulnerable Barents Sea ecosystem. Fisheries and Offshore Petroleum Exploitation 2nd International Conference, Bergen, Norway, 6-8 April 1992.

Matheson, K. (2013). The Marine Aquatic Invasion Continues. The Osprey. 44(1):8-11

Matkin, C. O., Saulitis, E. L., Ellis, G. M., Olesiuk, P., and Rice, S. D. (2008) Ongoing population-level impacts on killer whales *Orcinus orca* following the 'Exxon Valdez' oil spill in Prince William Sound, Alaska. Marine Ecology Progress Series. 356:269–281.

McCauley, R.D., Fewtrell, J., Duncan, A.J., Jenner, C., Jenner, M.-N., Penrose, J.D., McCabe, K. (2000a). Marine seismic surveys: Analysis of airgun signals; and effects of air gun exposure on humpback whales, sea turtles, fishes and squid (Report prepared for Australian Petroleum Production Association, Sydney, Australia). Perth, Australia: Centre for Marine Science and Technology, Curtin University.

McCauley, R.D., Fewtrell, J., Duncan, A.J., Jenner, M.-N., Jenner, C., Prince, R.I.T. and Murdoch, J. (2000b). Marine seismic surveys - a study of environmental implications. APPEA (Australian Petroleum Production and Exploration Association) Journal, 40, 692-708.

McCauley, R.D., Fewtrell, J., Duncan, A.J., Jenner, M.-N., Jenner, C., Prince, R.I.T. and Popper, A.N. (2003). High intensity anthropogenic sound damages fish ears. Journal of the Acoustical Society of America. 113(1):638-642.

McEwan, E.H. and Whitehead, P.M. (1980). Uptake and Clearance of Petroleum Hydrocarbons by the Glaucous-winged Gull (*Laras glaucescens*) and the Mallard Duck (*Anas platyrhynchos*). Canadian Journal of Zoology. 58:723-726.

McKenzie, C.H., Han, G., He, M., Wells, T., and Maillet, G. (2010). Alternate ballast water exchange zones for the Newfoundland and Labrador region — an aquatic invasive species risk assessment based on oceanographic modelling, ecologically and biologically significant areas and the sustainability of fisheries and aquaculture. DFO Canadian Scientific Advisory Secretariat ReseStudyrch Document. 2010/087. viii+39 p.

McClintock, J. (2010). The Fall 2007 NAFO Subdivision 3Ps GEAC Survey: Catch Results for Atlantic Cod (*Gadus morhua*), American Plaice (*Hippoglossoides platessoides* F.), Witch Flounder (*Glyptocephalus cynoglossus* L.), and Haddock (*Melanogrammus aeglefinus*). Canadian Science Advisory Secretariat Research Document. 2010/056: 37 pp. Erratum July 2011.

McClintock, J. and Teasdale, M. (2009). Redfish Catch Results from the Summer 2007 Survey in Unit 2. DFO Canadian Science Advisory Secretariat Research Document. 2009/094. IV + 23 p.

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.

Mercier, A., Sun, Z., and JHamel, J.-F. (2011). Reproductive periodcity, spawning and development of the deep-Study scleractinian coral *Flabellum angulare*. Marine Biology 158: 371-380.

Methven, D.A. and McKevlie D.S. (1986). Distribution of *Phycis chesteri* (Pisces: Gadidae) on the Grand Bank and Labrador Shelf. Copeia. 4:886-891.

Miller, J.D. (1997). Reproduction in sea turtles. In: Lutz, P.L., Musick, J.A. (Eds.), The Biology of Sea Turtles. CRC Press, Boca Raton, pp. 51– 81.

Miller, P.J.O , Johnson, M.P., Madsen, P.T., Biassoni, N., Quero, M., and Tyack, P.L. (2009). Using at-sea experiments to study the effects of airguns on the foraging behaviour of sperm whales in the Gulf of Mexico. Deep-Sea Research I. 56(7):1168-1181.

Miller, P.J.O., Biassoni, N., Samuels, A., and Tyack, P. L. (2000). Whale songs lengthen in response to sonar. Nature. 405:903-904.

Mitchell, E.D. and Chapman, D.G. (1977). Preliminary assessment of stocks of northwest Atlantic sei whales (*Balaenoptera borealis*). Report of the International Whaling Commission Special Issue 5:153-212.

Mitson R.B. (1995) Underwater noise of research vessels: review and recommendations. ICES Cooperative Research Report 209:61.

MMS (Minerals Management Service). (2004). Geological and Geophysical Exploration for Mineral Resources on the Gulf of Mexico Outer Continental Shelf: Final Programmatic Environmental Assessment. United States Department of the Interior, Gulf of Mexico Outer Continental Shelf Region.

MMS (Minerals Management Service - Pacific OCS Region). (2001). Delineation Drilling Activities in Federal Waters Offshore Santa Barbara County, California. Draft Environmental Impact Statement. Camarillo, CA: U.S. Department of the Interior Minerals Management Service.

Moein, S.E., Musick, J., Keinath, J., Barnard, A. , Lenhardt, M., and George, R. (1994). Evaluation of Seismic Sources for Repelling Sea Turtles from Hopper Dredges (Report prepared for US Army Corps of Engineers). Gloucester Point, VA: Virginia Institute of Marine Science.

Monson, D. H., Doak, D. H., Ballachey, B. E., and Bodkin, J. L. (2011). Could residual oil from the Exxon Valdez spill create a long-term population ''sink'' for sea otters in Alaska? Ecological Applications. 21(8):2917–2932.

Montevecchi, W.A. (2006). Influences of artificial light on marine birds. Chapter 5. In: C. Rich, and T. Longcore (eds.) Ecological Consequences of Artificial Night Lighting. Island Press, Washington, DC. 478 p.

Montevecchi, W.A. (2007). Binary dietary responses of northern gannets *Sula bassana* indicate changing food web and oceanographic conditions. Marine Ecology Progress Series 352: 213-220.

Montevecchi, W.A., Wiese, F.K., Davoren, G., Diamond, A.W., Huettmann, F., and Linke, J. (1999). Seabird Attraction to Offshore Platforms and Seabird Monitoring from Offshore Support Vessels and Other Ships: Literature Review and Monitoring Design. St. John's, NL: Canadian Association of Petroleum Producers.

Morales, C.E. (1999). Carbon and nitrogen fluxes in the oceans: the contribution by zooplankton migrants to active transport in the North Atlantic during the Joint Global Ocean Flux Study. Journal of Plankton Research 21: 1799-1808.

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.

Morley, E.L., Jones, G., and Radford, A.N. (2013). The importance of invertebrates when considering the impacts of anthropogenic noise. Proceeding of the Royal Society. 281:20132683.

Mosher, D.C., and Piper, D.J.W. (2007). Analysis of Multibeam Seafloor Imagery of the Laurentian Fan and the 1929 Grand Banks Landslide Area. In, V. Lykousis, D. Sakellariou, and J. Locat (Eds.), Submarine Mass Movements and Their Consequences: 3rd International Symposium. Springer Netherlands, pp. 77-88.

Mowbray, T.B. (2002). Northern Gannet (*Morus bassanus*), The Birds of North America Online (A. Poole, Ed.). Ithaca: Cornell Lab of Ornithology; Retrieved from the Birds of North America Online: http://bna.birds.cornell.edu/bna/species/693

Mullowney, D., Dawe, E., Skanes, K., Hynick, E., Coffey, W., O'Keefe, P., Fiander, D., Stansbury, D., Colbourne, E., and Maddock-Parsons, D. (2013). An assessment of Newfoundland and Labrador Snow Crab (*Chionoecetes opilio*) in 2011. DFO Canadian Science Advisory Secretariat Research Documents 2012/160.

MUN (Memorial University of Newfoundland). (1998). Society, Economy and Culture: Fisheries. Retrieved from: http://www.heritage.nf.ca. November 10, 2013.

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.

Murua, H. and de Cárdenas, E. (2005). Depth-distribution of deepwater species in Flemish Pass. Journal of Northwest Atlantic Fisheries Sciences. 37: 1-12.

Myrberg, A.A. (1980). Hearing in damsel fishes: An analysis of signal detection among closely related species. Journal of Comparative Physiology A, 140: 135-144.

NAFO (Northwest Atlantic Fisheries Organization). (2012). Annual Report 2012. Retrieved from http://www.nafo.int/index.html. March 10, 2014.

NAFO (Northwest Atlantic Fisheries Organization). (2013). 2013 NAFO conservation and enforcement measures. NAFO/FC Doc. 13/1.

Nakashima, B.S. (1992). Patterns in coastal migration and stock structure of capelin (*Mallotus villosus*). Canadian Journal of Fisheries and Aquatic Sciences. 49:2423-2429.

Natural Resources Canada. (2011). The 1929 'Grand Banks" Earthquake and Tsunami, Geological Survey of Canada, Geofacts, 2 pages.

Natural Resources Canada. (2013a). Simplified Seismic Hazard Map for Canada, http://www.earthquakescanada.nrcan.gc.ca/hazard-alea/simphaz-eng.php

Natural Resources Canada. (2013b). National Earthquake Database, http://www.earthquakescanada.nrcan.gc.ca/stndon/NEDB-BNDS/bull-eng.php

NCAR (National Research Council Canada). (2013). NRC-PERD Iceberg Sighting Database. October 2013

NCAR (National Center for Atmospheric Research, USA). (2014). International Comprehensive Ocean-Atmosphere Data Set (ICOADS). Retrieved from http://rda.ucar.edu Accessed February 2014.

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.

Nieukirk S. L, Stafford, K. M., Mellinger, D. K., Dziak, R.P., and Fox, C.G. (2004). Low-frequency whale and seismic airgun sounds recorded in the mid-Atlantic Ocean. Journal of the Acoustical Society of America. 115(4):1832-43.

Nieukirk, S.L., Mellinger, D.K., Moore, S.E., Klinck, K., Dziak, R.P., and Goslin, J. (2012). Sounds from airguns and fin whales recorded in the mid-Atlantic Ocean, 1999-2009. Journal of the Acoustical Society of America. 131(2):1102-1112.

Nisbet, I.C. (2002). Common Tern (*Sterna hirundo*), The Birds of North America Online (A. Poole, Ed.). Ithaca: Cornell Lab of Ornithology; Retrieved from the Birds of North America Online: http://bna.birds.cornell.edu/bna/species/618

NLDEC (Newfoundland and Labrador Environment and Conservation), (2013a). Newfoundland and Labrador Department of Environment and Conservation Species At Risk information sheets. Available online at: http://www.env.gov.nl.ca/env/wildlife/endangeredspecies/birds.html. Accessed 12 September, 2013.

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

NLDEC (Newfoundland and Labrador Department of Environment and Conservation) (2013c). Newfoundland and Labrador Hunting and Trapping Guide 2013-14.

NLDTW (Newfoundland and Labrador Department of Transportation and Works) (2013). Ferry Services. Retrieved from: http://www.tw.gov.nl.ca. September 9, 2013.

NLT (Newfoundland and Labrador Tourism) (2013a). 2013 Traveller's Guide. Lost and Found. Retrieved from: http://www.newfoundlandandlabrador.com. October 6, 2013.

NLT (Newfoundland and Labrador Tourism) (2013b). Hiking and Walking. Retrieved from http://www.newfoundlandandlabrador.com. September 27, 2013.

NMFS (National Marine Fisheries Service). (2000). Sperm whale (*Physeter macrocephalus*): North Atlantic stock. Stock Assessment Report. National Marine Fisheries Service.

NMFS (National Marine Fisheries Service), U.S. Fish and Wildlife Service, and SEMARNAT. (2010). Bi-National Recovery Plan for the Kemp's Ridley Sea Turtle (*Lepidochelys kempii*), Second Revision. National Marine Fisheries Service. Silver Spring, Maryland 155 pp. + appendices.

Nowacek, D.P., Thorne, L.H., Johnston, D.W. and Tyack, P.L. (2007). Responses of cetaceans to anthropogenic noise. Mammal Reviews. 37:81-115.

O'Hara, J., and Wilcox, J.R. (1990). Avoidance responses of loggerhead turtles, *Caretta caretta*, to low frequency sound. Copeia. 1990(2):564-567.

O'Hara, P. D., and Morandin, L. A. (2010) Effects of sheens associated with offshore oil and gas development on the feather microstructure of pelagic seabirds. Marine Pollution Bulletin. 60(5):672–678.

Oceanweather Inc. and Environment Canada. (2011). MSC50 Wind and Wave Climatologies. Available at: http://www.oceanweather.net/MSC50WaveAtlas/ then go to MSC50: Canadian East Coast Region, Wave Climate.

Ocearch. (2013). Shark Tracker. Available at http://ocearch.org. Accessed February 26, 2014.

Olesiuk, P. F., Bigg, M. A., Ellis, G. M., Crockford, S. J. and Wigen, R. J. (1990). An assessment of the feeding habits of harbor seals (*Phoca vitulina*) in the Strait of Georgia, British Columbia, based on scat analysis. Canadian Technical Report on Fisheries and Aquatic Sciences 1730: 135.

Olesiuk, P.F., Ellis, G.M., and Ford, J.K.B. (2005). Life history and population dynamics of northern resident killer whales *Orcinus orca* in British Columbia. Canadian Science Advisory Secretariat Research Document 2005/ 045. Accessed on September 15, 2007 at http://www.dfo-mpo.gc.ca/csas/Csas/DocREC/2005/RES2005_042_e.pdf

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.

Orr, D.C., Veitch, P.J., Sullivan, D.J., and Skanes, K. (2011). Northern Shrimp (*Pandalus borealis*) off Labrador and northeastern Newfoundland. DFO Canadian Science Advisory Secretariat Research Document 2011/004.

Ostrom, P. H., Lien, J. and Macko, A. (1993). Evaluation of the diet of Sowerby's beaked whale, *Mesoplodon bidens*, based on isotopic comparisons among northwestern Atlantic cetaceans. Canadian Journal of Zoology 71: 858-861

Ouellet, P., Fuentes-Yaco, C., Savard, L., Platt, T., Sathyendranath, S., Koeller, P., Orr, D., and Siegstad, H. (2011). Ocean surface characteristics influence recruitment variability of populations of northern shrimp (*Pandalus borealis*) in the Northwest Atlantic. – ICES Journal of Marine Science, 68: 737–744.

Overland, J. E. (1990). Prediction of vessel icing for near-freezing temperatures. Weather Forecasting, 5, 62-77.

Parks Canada. (2013). Terra Nova National Park Management Plan. Retrieved from: http://www.pc.gc.ca. October 2, 2013.

Parks, S.E., Clark, C., and Tyack, P. (2007). Short- and long-term changes in right whale calling behaviour : the potential effects of noise on acoustic communication. Journal of the Acoustical Society of America. 122:3725-3731.

Parry, G.D., and Gason, A. (2006). The effect of seismic surveys on catch rates of rock lobsters in western Victoria, Australia. Fisheries Research. 79:272-284.

Payne, J.F. (2004). Potential effect of seismic surveys on fish eggs, larvae and zooplankton (Research Document 2004/125.). DFO Canadian Science Advisory Secretariat.

Payne, J.F., Andrews, C., Fancey, L., White, D., and Christian, J. (2008). Potential effects of seismic energy on fish and shellfish: An update since 2003. Fisheries and Oceans Canada, Canadian Science Advisory Secretariat, Research Document 2008/060.

Peakall, D.B., Hallett, D.J., Bend, J.R., Foureman, G.L., and Miller, D.S. (1982). Toxicity of Prudhoe Bay crude oil and its aromatic fractions to nestling herring gulls. Environmental Resources. 27:206-215.

Peakall, D.B., Hallett, D.J., Miller, D.S., Butler, R.G., and Kinter, W.B. (1980). Effects of ingested crude oil on black guillemots: A combined field and laboratory study. Ambio. 9:28-30.

Pearson, W.H., Skalski, J.R., and Malme, C.I. (1992). Effects of sounds from a geophysical survey device on behavior of captive rockfish (*Sebastes* spp). Canadian Journal of Fisheries and Aquatic Sciences 49: 1343-1356.

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

Perrins, C. M., Harris, M.P., and Britton, C.K. (1973). Survival of Manx Shearwaters (*Puffinus puffinus*). Ibis 115:535-548.

Perry, S.L., DeMaster, D.P., and Silber, G.K. (1999). The Great Whales: History and status of six species listed as endangered under the U.S. Endangered Species Act of 1973. Marine Fisheries Review 61:1-74.

Pershing, A.J., Greene, C.H., Hannah, C., Sameoto, D., Head, E., Mountain, D.G., Jossie, J.W., Benfield, M.C., Reid, P.C., and Durbin, T.G. (2001). Oceanographic responses to climate in the Northwest Atlantic. Oceanography 14:76–82.

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.

Pickett, G.D., Eaton, D.R.M., Seaby, R.M.H., and Arnold, G.P. (1994). Results of Bass Tagging by Poole Bay During 1992. Laboratory Leaflet 74, Ministry of Agriculture, Fisheries and Food, Directorate of Fisheries Research.

Pierotti, R. J. and Good, T.P. (1994). Herring Gull (*Larus argentatus*), The Birds of North America Online (A. Poole, Ed.). Ithaca: Cornell Lab of Ornithology; Retrieved from the Birds of North America Online: http://bna.birds.cornell.edu/bna/species/124

Piper, D. J.W. (1991). Seabed geology of the Canadian eastern continental shelf. Continental Shelf Research. 11(8-10):1013-1035.

Piper, D.J.W., Cameron, G.D.M. and Best, M.A. (1988). Quaternary Geology of the Continental Margin of Eastern Canada, Geological Survey of Canada, Map 1711A.

Piper, D.J.W., Mudie, P.J., Fader, G.B., Josenhans, H.W., MacLean, B. and Vilks, G. (1990). Quaternary Geology; Chapter 10 in Geology of the continental margin off Eastern Canada, M.J. Keen and G.L. Williams (ed.), Geological Survey of Canada, Geology of Canada, no. 2, p 475-607.

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.

Placentia Bay / Grand Banks Large Ocean Management Area (PB/GBLOMA) (2013). Placentia Bay / Grand Banks Large Ocean Management Area. Retrieved from: http://www.pbgbloma.ca. October 7, 2013.

Plourde, S. and McQuinn, I.A. (2009). Zones d'importance écologique et biologique dans le golfe du Saint-Laurent : zooplancton et production secondaire. Secretariat canadien de consultatioin science du MPO Document de recherche 2009/104.

Poole, A. (ed). (2005). The Birds of North America Online: http://bna.birds.cornell.edu/BNA/. Cornell Laboratory of Ornithology, Ithaca, NY.

Popper, A.N. and Carlson, T.J., (1998). Application of sound and other stimuli to control fish behaviour. Trans. Am. Fish. Soc. 127(5):673-707.

Popper, A.N., Salmon, M., and Horch, K.W. (2001). Acoustic detection and communication by decapod crustaceans. Journal of Comparative Physiology 187: 83-89.

Popper A.N., Fay R.R., Platt C., Sand O. (2003) Sound detection mechanisms and capabilities of teleost fish. In Collin S.P. and Marshall N.J. (Eds.). Sensory Processing in Aquatic Environments (Springer-Verlag, New York) pp. 3–38 446 pp.

Popper, A.N., Smith, M.E., Cott, P.A., Hanna, B.W., MacGillivray, A.O., Austin, M.E., Mann, D.A. (2005). Effects of exposure to seismic airgun use on hearing of three fish species. Journal of the Acoustical Society of America. 117(6):3958-3971.

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.

Protasov, V.R. (1966). Bioaccoustics of fishes. Springfield, Vermont. NTIS, 214 pp.

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) (2013). The Ramsar Sites Database. Retrieved from: http://ramsar.wetlands.org. October 7, 2013.

Ramseier, R.O., Garrity, C., and Parsons, D.G. (2000). Influence of particulate organic carbon sedimentation within the seasonal sea-ice regime on the catch distribution of northern shrimp (*Pandalus borealis*). Journal of the Northwest Atlantic Fisheries Science 27: 35-44.

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

Reeves, R. R., Mitchell, E. and Whitehead, H. (1993). Status of the northern bottlenose whale, *Hyperoodon ampullatus*. Canadian Field-Naturalist 107: 490-508.

Reeves, R.R., Smeenk, C., Kinze, C.C., Brownell, Jr. R.L. and Lien, J. (1999). Atlantic white-sided dolphin *Lagenorhynchus acutus* Gray, 1828. pp. 31-56. In: S. H. Ridgway and R. J. Harrison (eds.), Handbook of Marine Mammals. Vol. 6. The Second Book of Dolphins and the porpoises. Academic Press, San Diego, CA.

Reeves, R.R., Stewart, B.S., Clapham, P.J. and Powell, J.A. (2002). Guide to Marine Mammals of the World, First edition. Alfred A. Knopf, Inc., New York, NY.

Reilly, S.B., Bannister, J.L., Best, P.B., Brown, M., Brownell Jr., R.L., Butterworth, D.S., Clapham, P.J., Cooke, J., Donovan, G.P., Urbán, J. and Zerbini, A.N. (2008a). *Megaptera novaeangliae*. In: IUCN 2013. IUCN Red List of Threatened Species. Version 2013.2. <www.iucnredlist.org>.

Reilly, S.B., Bannister, J.L., Best, P.B., Brown, M., Brownell Jr., R.L., Butterworth, D.S., Clapham, P.J., Cooke, J., Donovan, G.P., Urbán, J. and Zerbini, A.N. (2008b). *Balaenoptera musculus*. In: IUCN 2013. IUCN Red List of Threatened Species. Version 2013.2. <www.iucnredlist.org>

Reilly, S.B., Bannister, J.L., Best, P.B., Brown, M., Brownell Jr., R.L., Butterworth, D.S., Clapham, P.J., Cooke, J., Donovan, G.P., Urbán, J. and Zerbini, A.N. (2008c). *Balaenoptera borealis*. In: IUCN 2013. IUCN Red List of Threatened Species. Version 2013.2. <www.iucnredlist.org>.

Reilly, S.B., Bannister, J.L., Best, P.B., Brown, M., Brownell Jr., R.L., Butterworth, D.S., Clapham, P.J., Cooke, J., Donovan, G.P., Urbán, J. and Zerbini, A.N. (2008d). *Balaenoptera acutorostrata*. In: IUCN 2013. IUCN Red List of Threatened Species. Version 2013.2. <www.iucnredlist.org>.

Reilly, S.B., Bannister, J.L., Best, P.B., Brown, M., Brownell Jr., R.L., Butterworth, D.S., Clapham, P.J., Cooke, J., Donovan, G., Urbán, J. and Zerbini, A.N. (2012). *Eubalaena glacialis*. In: IUCN 2013. IUCN Red List of Threatened Species. Version 2013.2. <www.iucnredlist.org>.

Rice, D.W. (1989). Sperm whale *Physeter macrocephalus* Linnaeus, 1758. pp. 177-233. In: S.H. Ridgway and R. Harrison (eds.), Handbook of Marine Mammals. Vol. 4. River Dolphins and the Larger Toothed Whales. Academic Press, San Diego, CA.

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

Ridgway, S., Carder, D., Scholundt, C., Kamolnick, T., and Elsberry, W. (1997). Temporary shift in delphinoid masked hearing thresholds. Journal of the Acoustical Society of America. 102(5):3102.

Risch, D., Corkeron, P. J., Ellison, W. T., and Van Parijs, S. M.(2012) Changes in Humpback Whale Song Occurrence in Response to an Acoustic Source 200 miles Away. PLoS ONE, 7 (1). doi:10.1371/journal.Pone.0029741.

Robichaud, D. And Rose, G.A. (2004). Migratory behaviour and range in Atlantic cod: inference from a century of tagging. Fish and Fisheries 5: 185-214.

Roddick, D. (2013). Precautionary Approach Reference Points for Arctic Surf clams (*Mactromeris polynyma*). DFO Can. Sci. Advis. Sec. Res. Doc. 2013/007. v + 11 p.

Roddick, D., Brading, J., Carrigan, L., Davignon-Burton, T., Graham, S., and McEwen, C. (2011). Assessment of the Arctic Surf clam (*Mactromeris polynyma*) Stock on Grand Bank. DFO Canadian Science Advisory Secretariat Research Document. 2011/052: v + 55 p.

Rolland R. M., Parks, S. E., Hunt, K. E., Castellote, M.R., Corkeron, P. J., and Kraus, S. D. (2012). Evidence that ship noise increases stress in right whales. Proceedings of the Royal Society b. doi:10.1098/rspb.2011.2429.

Romano, T.A., Keogh, M.J., Kelly, C., Feng, P., Berk, l., Schlundt, C.E and Finneran, J.J. (2004) Anthropogenic sound and marine mammal health: measures of the nervous and immune systems before and after intense sound exposure. Canadian Journal of Fisheries and Aquatic Sciences, 61, 1124-1134. doi:10.1139 / f04-055.

Rose, G.A. (2004). Reconciling overfishing and climate change with stock dynamics of Atlantic cod (*Gadus morhua*) over 500 years. Canadian Journal of Fisheries and Aquatic Sciences 61: 1553-1557.

Rose, G.A. (2005). Capelin (*Mallotus villosus*) distribution and climate: a Study "canary" for marine ecosystem change. ICES Journal of Marine Science 62: 1524-1530.

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.

Rubega, M.A., Schamel, D., and Tracy, D.M. (2000). Red-necked Phalarope (*Phalaropus lobatus*), The Birds of North America Online (A. Poole, Ed.). Ithaca: Cornell Lab of Ornithology; Retrieved from the Birds of North America Online: http://bna.birds.cornell.edu/bna/species/538

Ruzzante, D.E., Taggart, C.T., Cook, D., and Goddard, S. (1996). Genetic differentiation between inshore and offshore Atlantic cod (*Gadus morhua*) off Newfoundland: microsatellite DNA variation and antifreeze level. Canadian Journal of Fisheries and Aquatic Sciences 53: 634-645.

Ruzzante, D.E., Taggart, C.T., and Cook, D. (1998). A nuclear DNA basis for shelf-and bank-scale population structure in northwest Atlantic cod (*Gadus morhua*): Labrador to Georges Bank. Molecular Ecology 7: 1663-1680.

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. (in Norwegian, with an English summary - full translation not published).

Saunders, J. and Dooling, R. (1974). Noise-Induced Threshold Shift in the Parakeet (*Melopsittacus undulatus*). Proceedings of the National Academy of Sciences of the United States of America 71(5):1962-1965

Schmelzer, I. (2005). A management plan for the Short-eared owl (*Asio flammeus flammeus*) in Newfoundland and Labrador. Wildlife Division, Department of Environment and Conservation. Corner Brook, NL.

Schmelzer, I. (2006). A management plan for Barrow's Goldeneye (*Bucephala islandica*; Easternpopulation) in Newfoundland and Labrador. Wildlife Division, Department of Environment and Conservation. Corner Brook, NL.

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

Schoenherr, J.R. (1991). Blue whales feeding on high concentrations of euphausiids around Monterey Submarine Canyon. Canadian Journal of Zoology 69:583-594.

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.

Schwartz, A.L. and Greer, G.L. (1984). Responses of Pacific herring, *Clupea harengus pallasi* to some under water sounds. Canadian Journal of Fisheries and Aquatic Sciences 41:1183-1192.

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

Sears, R., Williamson, J.M., Wenzel, F.N., Bérubé, M., Gendron, D., and Jones, P. (1990). Photographic identification of the blue whale (*Balaenoptera musculus*) in the Gulf of St. Lawrence, Canada. Report of the International Whaling Committee Spec. Iss. 12:335-342.

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.

Shirihai, H. and Jarrett, B. (2006). Whales Dolphins and Other Marine Mammals of the World. Princeton: Princeton Univ. Press. pp. 21–24.

Sibley, D.A. (2001). The Sibley Guide to Bird Life and Behavior. Random House, Toronto. 608 pp.

SIWG (Shrimp Industry Working Group). (2003). Shrimp Industry Working Group Report. Retrieved from http://www.ffaw.nf.ca/. March 10, 2014.

Skalski, J.R., Pearson, W.H., and Malme, C.I. (1992). Effects of sounds from a geophysical survey device on catch-per-unit-effort in a hook-and-line fishery for rockfish (*Sebastes* spp). Canadian Journal of Fisheries and Aquatic Sciences. 49:1357-1365.

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). Acoustic mapping of pelagic fish distribution and abundance in relation to a seismic shooting area off the Norwegian coast. Fisheries Research. 67:143-150.

Smultea, M.A. and Würsig, B. (1995). Behavioral reactions of bottlenose dolphins to the Mega Borg oil spill, Gulf of Mexico 1990. Aquatic Mammals. 21:171-181.

So, J. J., Hamel, J.-F., and Mercier, A. (2010). Habitat utilisation, growth and predation of *Cucumaria frondosa*: implications for an emerging sea cucumber fishery. Fisheries management and ecology, 17(6), 473-484.

Southall, B. L. (2005). Final Report of the International Symposium, 'Shipping Noise and Marine Mammals: A Forum for Science, Management, and Technology.' 18-19 May 2004 Arlington, Virginia, U.S.A. National Oceanic and Atmospheric Administration, National Marine Fisheries Service Technical report. Silver

Spring, MD: NOAA Fisheries Acoustics Program. Retrieved from http://www.nmfs.noaa.gov/pr/pdfs/acoustics/shipping_noise.pdf

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.

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.

Statistics Canada (2013). Shipping in Canada. Retrieved from: http://www.statscan.gc.ca. September 11, 2013.

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.

Stenhouse, I.J. (2004). Canadian management plan for the Ivory Gull (*Pagophila eburnea*). Canadian Wildlife Service, St. John's, NL.

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

Stige, L.C., Ottersen, G., Brander, K., Chan, K.-S., and Stenseth, N.C. (2006). Cod and climate: effect of the North Atlantic Oscillation on recruitment in the North Atlantic. Marine Ecology Progress Series 325: 227-241.

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.

Sun, Z., Hamel, J.-F., Edinger, E., and Mercier, A. (2010). Reproductive biology of the deep-Study octocoral *Drifa glomerata* in the Northwest Atlantic. Marine Biology. 157: 863-873.

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

Suncor Energy (2013). East Coast Canada. Retrieved from: http://www.suncor.com. September 19, 2013.

Taggart, C.T. (1997). Bank-scale migration patterns in northern cod. NAFO Science Council Studies 29: 51-60.

Taylor, B.L., Baird, R., Barlow, J., Dawson, S.M., Ford, J., Mead, J.G., Notarbartolo di Sciara, G., Wade, P. and Pitman, R.L. (2008a). *Hyperoodon ampullatus*. In: IUCN 2013. IUCN Red List of Threatened Species. Version 2013.2. <www.iucnredlist.org>.

Taylor, B.L., Baird, R., Barlow, J., Dawson, S.M., Ford, J., Mead, J.G., Notarbartolo di Sciara, G., Wade, P. and Pitman, R.L. (2008b). *Mesoplodon bidens*. In: IUCN 2013. IUCN Red List of Threatened Species. Version 2013.2. <www.iucnredlist.org>.

Taylor, B.L., Baird, R., Barlow, J., Dawson, S.M., Ford, J., Mead, J.G., Notarbartolo di Sciara, G., Wade, P. and Pitman, R.L. (2008c). *Globicephala melas*. In: IUCN 2013. IUCN Red List of Threatened Species. Version 2013.2. <www.iucnredlist.org>.

Taylor, B.L., Baird, R., Barlow, J., Dawson, S.M., Ford, J.K.B., Mead, J.G., Notarbartolo di Sciara, G., Wade, P. and Pitman, R.L. 2012. Grampus griseus. In: IUCN 2013. IUCN Red List of Threatened Species. Version 2013.2. <www.iucnredlist.org>.

Taylor, B.L., Baird, R., Barlow, J., Dawson, S.M., Ford, J., Mead, J.G., Notarbartolo di Sciara, G., Wade, P. and Pitman, R.L. (2013). *Orcinus orca*. In: IUCN 2013. IUCN Red List of Threatened Species. Version 2013.2. <www.iucnredlist.org>.

Teal, J.M. and Howarth, R.W. (1984). Oil spill studies: a review of ecological effects. Environmental Management. 8:27-44.

Templeman, W. (1985). Migrations of wolffishes, Anarhichas sp., from tagging in the Newfoundland area. Journal of Northwest Atlantic Fisheries Science 5: 93-97.

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.

Templeman, N.D. (2010). Ecosystem status and trends report for the Newfoundland and Labrador Shelf. Canadian Science Advisory Secretariat Research Document 2010/026.

This Fish. (2013). Harvesting profile: Atlantic halibut by small-boat longline. http://thisfish.info/fishery/atlantic-halibut-longline-nafo3pn/. February 28, 2014.

Thomas, P.W. (2008). Harlequin ducks in Newfoundland. Waterbirds. 31 (sp. 2): 44-49.

Thomas, P. W., McFarlane Tranquilla, L.A., Toms, B.E., Boyne, A.W., and Robertson, G.J. (2011). Second census of terns, gulls, kittiwakes and cormorants along the coast of insular Newfoundland, 2005-2007. Canadian Wildlife Service, Atlantic Region, Newfoundland. Draft Technical Report Series 999.

Thompson, D. and Härkönen, T. (IUCN SSC Pinniped Specialist Group) (2008a). *Phoca vitulina*. In: IUCN 2013. IUCN Red List of Threatened Species. Version 2013.2. <www.iucnredlist.org>.

Thompson, D. and Härkönen, T. (IUCN SSC Pinniped Specialist Group) (2008b). *Halichoerus grypus*. In: IUCN 2013. IUCN Red List of Threatened Species. Version 2013.2. <www.iucnredlist.org>.

Thomson, D.H., Lawson, J.W., and Muecke, A. (2000). Proceedings of a Workshop to Develop Methodologies for Conducting Research on the Effects of Seismic Exploration on the Canadian East Coast Fishery, Halifax, N.S., September 7-8, 2000 (Report No. 139). Calgary, AB: Environmental Studies Research Fund.

Tokranov, A.M., Orlov A.M. and Biryukov I.A. (2004) Distribution and size-weight composition of some rare fish species in Pacific waters off the northern Kurile Islands and southeast Kamchatka. Journal of Ichthyology. 44(3):175-185.

Tracy, D.M., Schamel, D., and Dale, J. (2002). Red Phalarope (*Phalaropus fulicarius*), The Birds of North America Online (A. Poole, Ed.). Ithaca: Cornell Lab of Ornithology; Retrieved from the Birds of North America Online: http://bna.birds.cornell.edu/bna/species/698

Trzcinski, M.K. den Heyer, C. Armsworthy, S., Whoriskey, S., Archambault, D., Treble, M., Simpson, M., and Mossman, J. 2011. Pre-COSEWIC Review of Atlantic Halibut (*Hippoglossus hippoglossus*) on the Scotian Shelf and Southern Grand Banks (Divs. 3NOPs4VWX5Zc), Gulf of St. Lawrence (Divs. 4RST), Newfoundland and Labrador, and Central and Arctic. DFO Canadian Science Advisory Secretariat Science Advisory Report. 2011/030. 77 pp.

Turnpenny, A. W. H., and Nedwell, J.R. (1994). The Effects on Marine Fish, Diving Mammals and Birds of Underwater Sound Generated by Seismic Surveys. Report to the UK Offshore Operators Association, Hans Crescent, London (No. FRR 089/94). Fawley, UK: Fawley Aquatic Research Laboratories Ltd.

Vold, A. Lokkeborg, S., and Tenningen, M.M. (2012). Using catch statistics to investigate effects of seismic activity on fish catch rates. Advances in Experimental Medicine and Biology. 730:411-413.

Vold, A., Lokkeborg, S., Tenningen. M., and Saltskar, J. (2009). Analysis of commercial catch data to study the effects of seismic surveys on the fisheries of Lofoten and Vesteralen summer of 2008. Fisken og Havet 5/2009, Havforskningsinstituttet, Bergen. (summary in English).

Wale M.A., Simpson, S.D. and Radford, A.N. (2013). Noise negatively affects foraging and antipredator behaviour in shore crabs. Animal Behaviour 86: 111 –118. (doi:10.1016/j.anbehav.2013.05.001)

Wale M.A., S.D. Simpson SD and A.N. Radford. (2013). Size dependent physiological responses of shore crabs to single and repeated playback of ship noise. Biology Letters 9: 20121194. (doi:10.1098/rsbl.2012.1194)

Wallace, B.P., Tiwari, M. and Girondot, M. (2013). *Dermochelys coriacea*. In: IUCN 2013. IUCN Red List of Threatened Species. Version 2013.2. <www.iucnredlist.org>.

Wardle, C.S., Carter, T.J., Urquhart, G.G., Johnstone, A.D.F., Ziolkowski, A.M., Hampson, G., and Mackie, D. (2001). Effects of seismic air guns on marine fish. Continental Shelf Research. 21(8-10):1005-1027.

Waring, G. T., Josephson, E., Fairfield, C. P. and Maze-Foley, K. (eds). (2006). U.S. Atlantic and Gulf of Mexico marine mammal stock assessments - 2005. NOAA Technical Memorandum NMFS-NE, pp. 346 pp

Warkentin, I. and Newton, S. (2009). Birds of Newfoundland. Boulder Publications, Portugal Cove-St. Philip's, NL, Canada. 237 pp.

Warwick, R.M. 1993. Environmental impact studies on marine communities: pragmatical considerations. Australian Journal of Ecology 18: 63-80.

Warren, P.J. and Sheldon, R.W. (1967). Feeding and migration patterns of the pink shrimp, *Pandalus montagui*, in the estuary of the River Crouch, Essex, England. Journal of the Fisheries Research Board of Canada. 24(3): 569-580.

Watanabe, S., Metaxas, A., Sameoto, J., and Lawton, P. (2009). Patterns in abundance and size of two deep-water gorgonion octocorals, in relation to depth and substrate features off Nova Scotia. Deep-Study Research Part I, 56: 2235-2248.

Webb, C.L.F. and Kempf, N.J. (1998). The impact of shallow water seismic in sensitive areas. Society of Petroleum Engineers Technical Paper, SPE 46722.

Weilgart, L.S. (2007). A brief review of known effects of noise on marine mammals. International Journal of Comparative Psychology. 20:159-168.

Weir, R.D. (1976). Annotated bibliography of bird kills at man-made obstacles: a review of the state of the art and solutions. Department of Fisheries and the Environment, Environmental Management Service, Canadian Wildlife Service, Ontario Region, Ottawa.

Weir, C.R. (2008). Overt responses of humpback whales (*Megaptera novaeangliae*), sperm whales (*Physeter macrocephalus*), and Atlantic spotted dolphins (*Stenella frontalis*) to seismic exploration off Angola. Aquatic Mammals. 34(1):71-83.

Weng, K.C., Boustany, A.M., Pyle, P., Anderson, S.D., Brown, A., and Block, B.A. (2007). Migration and Habitat of White Sharks (*Carharodon carcharias*) in the eastern Pacific Ocean. Marine Biology. 152:877-894.

Winn, H.E., Price, C.A., and Sorensen, P.W. (1986). The distributional biology of the right whale (*Eubalaena glacialis*) in the western North Atlantic. Rep. Int. Whal. Comm. (Spec. Iss.) 10:129-138.

WGEAFM (Working Group on Ecosystem Approaches to Fisheries Management). (2008). Scientific council meeting – June 2008. NAFO SCS Doc. 08/10.

WGEAFM (Working Group on Ecosystem Approaches to Fisheries Management). (2011). SC WG on the Ecosystem approach to fisheries management. NAFO SCS Doc. 11/22.

Wheeler, J.P. and Winters, G.H. (1984). Homing of Atlantic herring (*Clupea harengus harengus*) in Newfoundland waters as indicated by tagging data. Canadian Journal of Fisheries and Aquatic Sciences 41: 108-117.

Wiese, F.K. and Montevecchi, W. (2000). Marine Bird and Mammal Surveys on the Newfoundland Grand Banks from Offshore Supply Boats, 1999-2000. Report prepared for Husky Oil, St. John's, NL.

Wiese, F.K., Montevecchi, W.A., Davoren, G.K., Huettmann, F., Diamond, A.W., and Linke, J. (2001). Seabirds at risk around offshore oil platforms in the Northwest Atlantic. Marine Pollution Bulletin. 42(12):1285-1290.

Wiese, F.K. and Robertson, G.J. (2004). Assessing seabird mortality from chronic oil discharges at sea. Journal of Wildlife Management. 68:627-638.

Wiley, R.H. and Lee, D.S. (1998). Long-tailed Jaeger (*Stercorarius longicaudus*), The Birds of North America Online (A. Poole, Ed.). Ithaca: Cornell Lab of Ornithology; Retrieved from the Birds of North America Online: http://bna.birds.cornell.edu/bna/species/365

Wiley, R.H. and Lee, D.S. (1999). Parasitic Jaeger (*Stercorarius parasiticus*), The Birds of North America Online (A. Poole, Ed.). Ithaca: Cornell Lab of Ornithology; Retrieved from the Birds of North America Online: http://bna.birds.cornell.edu/bna/species/445

Wiley, R.H. and Lee, D.S. (2000). Pomarine Jaeger (*Stercorarius pomarinus*), The Birds of North America Online (A. Poole, Ed.). Ithaca: Cornell Lab of Ornithology; Retrieved from the Birds of North America Online: http://bna.birds.cornell.edu/bna/species/483

Williams, R., and O'Hara, P. (2010). Modeling ship strike risk to fin, humpback and killer whales in British Columbia, Canada Journal of Cetacean Research and Management.11:1-8.

Wisner, R.L. (1990) Scomberesocidae. p. 598-603. In J.C. Quero, J.C. Hureau, C. Karrer, A. Post and L. Saldanha (eds.) Check-list of the fishes of the eastern tropical Atlantic (CLOFETA). JNICT, Lisbon; SEI, Paris; and UNESCO, Paris. Vol. 2.

Wood, J., Southall, B.L. and Tollit, D.J. (2012). PG and E offshore 3-D Seismic Survey Project EIR – Marine Mammal Technical Draft Report. SMRU Ltd.

Woodruff, S.D., Diaz, H.F., Elms, J.D., and Worley, S.J. (1998). COADS Release 2 Data and Metadata Enhancements for Improvements of Marine Surface Flux Fields. Phys. Chem. Earth, 23, 517-527. (Available on-line at: http://icoads.noaa.gov/egs_paper.html)

Woodruff, S.D., Diaz, H.F., Worley, S.J., Reynolds, R.W., and Lubker, S.J. (2005). Early ship observational data and ICOADS. Climatic Change, 73, 169-194.

Worley, S.J., Woodruff, S.D., Reynolds, R.W., Lubker, S.J., and Lott, N. (2005) ICOADS Release 2.1 data and products. Int. J. Climatol. (CLIMAR-II Special Issue), 25, 823-842 (DOI: 10.1002/joc.1166).

Worm, B. and Myers, R.A. (2003). Mete-analysis of cod-shrimp interactions reveals top-down control in oceanic food webs. Ecology. 84: 162-173.

Wright, D. G. and Hopky, G. (1998). Guidelines for the use of explosives inside or near Canadian fisheries waters (2107). DFO Canadian Technical Report of Fisheries and Aquatic Sciences.

Wroblewski, J.S., Kulka, D.W., Narayanan, S., Oake, A.M., Collier, A.G., and McGrath, B.D. (1995). Winter distributions and movements of northern Atlantic cod (*Gadus morhua*) along the Newfoundland Labrador continental shelf edge derived from observations on commercial trawlers. Fisheries Oceanography. 4:128-146.

Wu, Y.S. and Tang, C.L. (2011). Atlas of ocean currents in eastern Canadian waters. Can. Tech. Rep. Hydrogr. Ocean Sci., No. 271: vi + 94 pp.

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

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APPENDIX A

Table of Concordance with C-NLOPB EA Scoping Document

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Environmental Assessment of GX Technology Canada Ltd's
GrandSPAN 2D Seismic, Gravity and Magnetic Survey
Table of Concordance with C-NLOPB EA Scoping Document

EA Scoping Document Sections / Requirements	Where / How Addressed in the EA Report
1 Purpose	
This document provides scoping information for the Environmental Assessment (EA) of the proposed seismic, gravity and magnetic program in the southern and eastern portions of the Newfoundland and Labrador Offshore Area and all other related activities (the Project). GX Technology Canada Ltd. (GXT) is proposing to undertake 2-Dimensional (2D) seismic, gravity and magnetic surveys in one or more years within the 2014 to 2018 timeframe. The primary objective of the Project is to acquire data to assess the presence of geological structures suitable for the containment and accumulation of hydrocarbons and to determine the hydrocarbon characteristics.	• Understood and acknowledged, and referenced in Section 3.1 of the EA Report.
Included in this document is a description of the scope of the project that will be assessed, the factors to be considered in the assessment, and the scope of those factors.	
This document has been developed by the Canada-Newfoundland and Labrador Offshore Petroleum Board (C-NLOPB) in consultation with federal and provincial fisheries and environmental departments[1].	
[1]Appendix 1 contains a list of the departments and agencies consulted during the preparation of the document.	
2 Regulatory Considerations	
The Project will require authorizations 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 (Accord Acts).	• Understood and acknowledged, and referenced in Sections 1.0, 1.3 and 3.1 of the EA Report.
The C-NLOPB formally delegates the responsibility for preparation of an acceptable environmental assessment report and any supporting documents to GX Technology Canada Ltd., the project proponent.	
3 Scope of the Project	
The project to be assessed consists of the following components:	• The scope of the Project for EA purposes is as specified here, as referenced and described in Sections 1.1, 2.1 to 2.9, 3.1 and throughout the EA Report. • The EA has been carried out for each of the Project components and activities listed here.
3.1 GXT is proposing to conduct a 2D (single streamer) marine geophysical survey to collect seismic, gravity and magnetic data. The planned program is a regional Basin Span survey. Although typical industry-standard equipment is used, GXT's special-purpose Basin Span surveys are designed to examine very deep geological formations over very broad (basin scale) areas and regions in order to deliver unique datasets. It is planned to occur sometime within the period May – December, potentially each year from 2014 to 2018. The 2D seismic survey involves a maximum of 14,000 km of seismic survey lines each year. The GrandSPAN lines will be widely spaced (except where they cross in some locations), typically 75 km – 150 km apart, ranging broadly. Water depths in the acquisition area range from approximately 70 m to 4,000 m.	
3.2 Operation of support craft associated with the above activities, including but not limited to standby/picket vessels and helicopters.	
4 Factors to be Considered	
The EA shall include a consideration of the following factors:	
4.1 The purpose of the project;	• Sections 2.2 and 6.0
4.2 The environmental effects of the Project, including those due to malfunctions or	• Chapters 3 and 5

EA Scoping Document Sections / Requirements	Where / How Addressed in the EA Report
accidents that may occur in connection with the Project and any change to the Project that may be caused by the environment. Environmental effect is defined as: any change that the project may cause in the environment, including any effect of any such change on health and socio-economic conditions, on physical and cultural heritage, on the current use of lands and resources for traditional purposes by aboriginal persons, or on any structure, site or thing that is of historical, archaeological, paleontological or architectural significance; and any change to the project that may be caused by the environment, whether any such change occurs within or outside Canada;	
4.3 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;	• Sections 3.4.6, 5.3.5, 5.4.4, 5.5.5, 5.6.5, 5.8.4
4.4 The significance of the environmental effects described in 4.2 and 4.3;	• Sections 3.4.2, 5.3, 5.4, 5.5, 5.6, 5.7, 5.8
4.5 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;	• Sections 2.8, 3.4,5, 5.2, 5.3, 5.4, 5.5, 5.6, 5.7, 5.8
4.6 The significance of adverse environmental effects following the employment of mitigative measures, including the feasibility of additional or augmented mitigative measures; and	• Sections 3.4.2, 5.3, 5.4, 5.5, 5.6, 5.7, 5.8 • The mitigation measures outlined and considered (integrally) throughout the environmental effects assessment will be implemented to avoid or reduce adverse environmental effects, and all are considered to be technically and economically feasible.
4.7 Report on consultations and communications with other relevant jurisdictions undertaken by GXT with interested other ocean users who may be affected by program activities and/or the general public respecting any of the matters described above.	• Section 3.2
5 Scope of the Factors to be Considered	
GXT will prepare and submit to the C-NLOPB an EA for the above-described physical activity, and as described in "*GXT GrandSPAN 2014-2018 Marine 2D, Seismic, Gravity and Magnetic Survey*" (December, 2013). The EA will address the factors listed above; the issues identified in Section 5.2 (following), and document any issues and concerns that may be identified by the proponent through regulatory, stakeholder, and public consultation.	• Addressed throughout the EA Report
Program activities are proposed for the southern and eastern portions of the Newfoundland and Labrador Offshore Area which has been studied in a number of recent EAs and the Southern Newfoundland Strategic Environmental Assessment (SEA) (LGL 2010), *http://www.cnlopb.nl.ca/environment/snseac.shtml* . For the purposes of this assessment, the information provided in the EA documents can be used in support of the EA for the proposed seismic program.	• Relevant information from other EAs and SEAs has been incorporated into the EA Report, and referenced appropriately
It is recommended that the "valued environmental component" (VEC) approach be used to focus its analysis. A definition of each VEC (including components or subsets thereof) identified for the purposes of environmental assessment, and the rationale for its selection, shall be provided.	• The VEC approach has been used, as described in Section 3.3 and as illustrated throughout Chapter 5
The scope of the factors, to be considered in the EA, will include the components	• These concepts and

EA Scoping Document Sections / Requirements	Where / How Addressed in the EA Report
identified in Section 5.2 - Summary of Potential Issues, setting out the specific matters to be considered in assessing the environmental effects of the project and in developing environmental plans for the project, and the "Spatial Boundaries" identified below (Section 5.1). Considerations relating to definition of "significance" of environmental effects are provided in the following sections.	requirements are addressed throughout the EA Report
Discussion of the biological and physical environments should consider the data available for the Project and Study Areas. Where data gaps exist, the EA should clearly identify the lack of data available.	• The information sources used are described and referenced throughout the EA Report. • In some cases, a lack of environmental baseline information for certain environmental components is referenced (e.g., in Fish and Fish Habitat). • Although there are examples of less than complete baseline information on some aspects of the environment, no data gaps have been identified which have prevented the assessment and evaluation of environmental effects and the identification and proposal of mitigation for this Project and its EA.
5.1 Boundaries	
The EA shall consider the potential effects of the proposed seismic survey program within spatial and temporal boundaries that encompass the periods and areas during and within which the project may potentially interact with, and have an effect on, one or more VECs. These boundaries may vary with each VEC and the factors considered, and should reflect a consideration of: • the proposed schedule/timing of the seismic survey program; • the natural variation of a VEC or subset thereof; • the timing of sensitive life cycle phases in relation to the scheduling of seismic survey activities; • interrelationships/interactions between and within VECs; • the time required for recovery from an effect and/or return to a pre-effect condition, including the estimated proportion, level, or amount of recovery; and • the area within which a VEC functions and within which a project effect may be felt.	• The EA study areas (spatial and temporal) are clearly defined, including general and VEC-specific boundaries, and the rationale for them is described (see Sections 3.4.2, 5.3.1, 5.4.1, 5.5.1, 5.6.1, 5.8.1). • This includes consideration of each of the factors listed here, as referenced in Section 3.4.2
The proponent shall clearly define, and provide the rationale for the spatial and temporal boundaries that are used in its EA. The EA report shall clearly describe the spatial boundaries (e. g. Study Area, Project Area) and shall include figures, maps and the corner-point coordinates. Boundaries should be flexible and adaptive to enable adjustment or alteration based on field data. The Study Area will be described based on consideration of potential areas of effects as determined by the scientific literature, and project-environment interactions. A suggested categorization of spatial boundaries follows.	• The EA study areas (spatial and temporal) are clearly defined, including general and VEC-specific boundaries, and the rationale for them is described (see Sections 3.4.2, 5.3.1, 5.4.1, 5.5.1, 5.6.1, 5.8.1). • The Project Area and Study Area are illustrated in Figures in Chapters 1 and 3, including

EA Scoping Document Sections / Requirements	Where / How Addressed in the EA Report
	corner point coordinates (Figure 1.1).
5.1.1 Spatial Boundaries	
<u>Project Area</u> The area in which seismic survey activities are to occur, including the area of the buffer zone normally defined for line changes.	• Each of these types of study areas are defined for each VEC (see Sections 3.4.2, 5.3.1, 5.4.1, 5.5.1, 5.6.1, 5.8.1).
<u>Study Area</u> The area which could potentially be affected by project activities beyond the "Project Area".	
<u>Regional Area</u> The area extending beyond the "Study Area" boundary. The "Regional Area" boundary will also vary with the component being considered (e.g., boundaries suggested by bathymetric and/or oceanographic considerations).	
5.1.2 Temporal Boundaries The temporal scope should describe the timing of project activities. Scheduling of project activities should consider the timing of sensitive life cycle phases of the VECs in relation to physical activities.	• Temporal boundaries are defined for each VEC, which include consideration of each of these factors (see Sections 3.4.2, 5.3.1, 5.4.1, 5.5.1, 5.6.1, 5.8.1).
5.2 Summary of Potential Issues	
The EA report for the proposed seismic surveys should contain descriptions of the biological and physical environments, as identified below. Where applicable, information may be summarized from existing environmental assessment reports for the southern and eastern portions of the Newfoundland and Labrador Offshore Area. The EA report should provide only summary descriptions of those biological and physical parameters. However, where new information is available, (*e.g.*, fisheries data) for any of the following factors, the new data and/or information should be provided. If information is not updated, justification must be provided. Where information is summarized from existing EA reports, it should be properly referenced; with specific reference to those sections of the existing EA report summarized.	• Relevant information from other EAs and SEAs has been incorporated into (and summarized in) this EA Report, and referenced appropriately.
The EA shall contain descriptions and definitions of EA methodologies employed in the assessment of effects. Where information is summarized from existing EA reports, the sections referenced should be clearly indicated. Effects of relevant Project activities on those VECs most likely to be in the defined Study Area shall be assessed. Discussion of cumulative effects within the Project area and with other relevant marine projects shall be included. Issues to be considered in the EA shall include, but not be limited to, the following:	• The EA methods used are described in detail in Section 3.4. • Project effects are assessed in Chapter 5
<u>Physical Environment</u>	
5.2.1 The EA shall provide a brief summary description of the meteorological and oceanographic characteristics, including extreme conditions, and any change to the Project that may be caused by the environment.	• Sections 4.1 and 2.9
<u>Marine Resources</u>	
5.2.2 *Marine and/or Migratory Birds*	
The EA shall provide a summary description, where applicable, of the information presented in existing environmental reports for the southern and eastern portions of the Newfoundland and Labrador Offshore Area. New or updated information should be provided, where applicable, to address any changes to the following:	• See above

EA Scoping Document Sections / Requirements	Where / How Addressed in the EA Report
• Spatial and temporal species distributions (observations from prior programs should be included);	• Section 4.2.2
• Species habitat, feeding, breeding, and migratory characteristics of relevance to the Study Area;	• Section 4.2.2
• Noise disturbance from seismic equipment including both direct effects (physiological), or indirect effects (foraging behaviour, prey species, adult attendance at the nest);	• Section 5.5.4.2
• Physical displacement as a result of vessel presence (e.g. disruption of foraging activities);	• Section 5.5.4.1
• Attraction of, and increase in, predator species as a result of waste disposal practices (i.e., sanitary and food waste);	• Section 5.5.4.1, 5.5.4.3
• Nocturnal disturbance from light (e.g. increased opportunities for predators, attraction of birds to vessel lighting and subsequent collision, disruption of incubation);	• Section 5.5.4
• Procedures for handling birds that may become stranded on survey vessels;	• Section 5.2.5 and 5.5.4
• Means by which bird mortalities associated with project operations may be documented and assessed;	• Section 5.2.5, 5.5.4, 5.5.6
• Effects of hydrocarbon spills from accidental events, including fluid loss from streamers and operational discharges (e.g. deck drainage, gray water, black water);	• Section 5.5.4.3
• Means by which potentially significant adverse effects upon birds may be mitigated through design and/or operational procedures; and	• Sections 5.2.5 and 5.5.4
• Environmental effects due to the Project, including cumulative effects.	• Section 5.5
5.2.3 Marine Fish and Shellfish	
The EA shall provide a summary description, where applicable, of the information presented in existing environmental reports for the southern and eastern portions of the Newfoundland and Labrador Offshore Area. New or updated information should be provided, where applicable, to address any changes to the following:	• See above
• Distribution and abundance of marine fish and invertebrate species utilizing the Study Area with consideration of critical life stages (e.g., spawning areas, overwintering, juvenile distribution, migration);	• Section 4.2.1
• Description, to the extent possible, of location, type, diversity and areal extent of marine fish habitat in the Study Area. In particular, those indirectly or directly supporting traditional, aboriginal, historical, present or potential fishing activity, and including any essential (e.g. spawning, feeding, overwintering) habitats;	• Section 4.2.1
• The means by which potentially significant adverse effects upon fish (including critical life stages) and commercial fisheries may be mitigated through design, scheduling, and/or operational procedures; and	• Sections 5.2 and 5.3
• Environmental effects due to the Project, including cumulative effects	• Section 5.3
5.2.4 Marine Mammals and Sea Turtles	
The EA shall provide a summary description, where applicable, of the information presented in existing environmental reports for the southern and eastern portions of the Newfoundland and Labrador Offshore Area. New or updated information should be provided, where applicable, to address any changes to the following:	• See above
• Spatial and temporal distribution;	• Section 4.2.3
• Description of marine mammal and sea turtle life stages/life histories relevant to the Study Area;	• Section 4.2.3

EA Scoping Document Sections / Requirements	Where / How Addressed in the EA Report
• Disturbance to/displacement of marine mammals and sea turtles due to noise and the possibility of ship strikes;	• Section 5.6
• Means by which potentially significant adverse effects upon marine mammals and sea turtles (including critical life stages) may be mitigated through design, scheduling, and/or operational procedures; and	• Sections 5.2 and 5.6
• Environmental effects due to the Project, including cumulative effects.	• Section 5.6
5.2.5 Species at Risk (SAR)	
Provide a summary description, where applicable, of the information presented in existing environmental reports for the southern and eastern portions of the Newfoundland and Labrador Offshore Area. New or updated information should be provided, where applicable, to address any changes to the following:	• See above
• A description of SAR as listed in Schedule 1 of the *Species at Risk Act (SARA)*, and those under consideration by COSEWIC in the Study Area, including fish, marine mammal, sea turtles, and seabird species. It is advised that the SARA Registry and COSEWIC website be referred to for the most recent information;	• Sections 4.2.1, 4.2.2.5, 4.2.3.5. 5.7
• A description of critical habitat (as defined under SARA), if applicable, to the Study Area;	• Sections 4.2.1, 4.2.2.5, 4.2.3.5. 5.7
• Monitoring and mitigation, consistent with recovery strategies/action plans (endangered/threatened) and management plans (special concern);	• Sections 5.2, 5.3, 5.5, 5.6, 5.7
• A summary statement stating whether project effects are expected to contravene the prohibitions of SARA (Sections 32(1), 33, 58(1));	• Section 5.7.6
• Means by which adverse effects upon SAR and their critical habitat may be mitigated through design, scheduling, and/or operational procedures; and	• Sections 5.2, 5.3, 5.5, 5.6, 5.7
• Assessment of effects (adverse and significant) on SAR and critical habitat, including cumulative effects.	• Sections 5.3, 5.5, 5.6, 5.7
5.2.6 “Sensitive” Areas	
The EA shall provide a summary description, where applicable, of the information presented in existing environmental reports for the southern and eastern portions of the Newfoundland and Labrador Offshore Area. New or updated information should be provided, where applicable, to address any changes to the following:	• See above
• A description, to the extent possible, of any ‘Sensitive” Areas in the Study Area deemed important or essential habitat to support any of the marine resources identified;	• Sections 4.2.1.8, 4.2.2.6, 4.2.3.6, and 4.2.4
• Environmental effects due to the project, including cumulative effects, on those “Sensitive” Areas identified; and	• Section 5.8
• Means by which adverse effects upon “Sensitive” Areas may be mitigated through design, scheduling and/or operational procedures.	• Sections 5.2, 5.3, 5.4, 5.5, 5.6, 5.7, 5.8
Marine Use	
5.2.7 Noise/Acoustic Environment	
The EA shall provide a summary description, where applicable, of the information presented in existing environmental reports for the southern and eastern portions of the Newfoundland and Labrador Offshore Area. New or updated information should be provided, where applicable, to address any changes to the following:	• See above
• Disturbance/displacement of VECs and SAR associated with seismic survey activities;	• Sections 5.1, 5.2, 5.3.4, 5.4.3, 5.5.4. 5.6.4, 5.7, 5.8.3
• Means by which potentially significant effects may be mitigated through design, scheduling and/or operational procedures; and	• Sections 5.1, 5.2, 5.3.4, 5.4.3, 5.5.4. 5.6.4, 5.7, 5.8.3
• Effects of seismic activities (direct and indirect) including cumulative	• Sections 5.1, 5.2, 5.3.4, 5.4.3,

EA Scoping Document Sections / Requirements	Where / How Addressed in the EA Report
effects, on the VECs and SAR identified within the EA. Critical life stages should be included.	5.5.4. 5.6.4, 5.7, 5.8.3
5.2.8 Presence of Seismic Survey Vessel(s)	
The EA shall provide a summary description, where applicable, of the information presented in existing environmental reports for the southern and eastern portions of the Newfoundland and Labrador Offshore Area. New or updated information should be provided, where applicable, to address any changes to the following:	• See above
• Description of project-related traffic, including routings, volumes, scheduling and vessel types;	• Section 2.6
• Effects upon access to fishing grounds;	• Sections 5.2, 5.4
• Effects upon general marine traffic/navigation, including fisheries research surveys, and mitigations to avoid research surveys;	• Sections 5.2, 5.4
• Means by which potentially significant effects may be mitigated through design, scheduling and/or operational procedures; and	• Sections 5.2, 5.3, 5.4, 5.5, 5.6, 5.7, 5.8
• Environmental effects assessment, including cumulative effects.	• Sections 5.2, 5.3, 5.4, 5.5, 5.6, 5.7, 5.8
5.2.9 Fisheries and Other Ocean Users	
Provide a summary description, where applicable, of the information presented in existing environmental reports for the southern and eastern portions of the Newfoundland and Labrador Offshore Area. New or updated information should be provided, where applicable, to address any changes to the following:	• See above
• A description of fishery activities (including traditional, existing and potential commercial, recreational and aboriginal/subsistence and foreign fisheries) in the Project Area;	• Section 4.3.1
• Consideration of underutilized species and species under moratoria that may be found in the Study Area as determined by analyses of past DFO research surveys and Industry GEAC survey data, with emphasis on those species being considered for future potential fishers, and species under moratoria;	• The current species moratoria are described in Section 4.3.1, with additional discussion of potential future fisheries, to the degree possible.
• Traditional historical fishing activity, including abundance data for certain species in this area, prior to the severe decline of many fish species (e.g., a general overview of survey results and fishing patterns in the survey areas for the last 20 years);	• An overview of past fisheries and the changes in and evolution of the Study Area's fishery in recent decades is provided in Section 4.3.1.2, as background and context for the EA.
• An analysis of the effects of Project operations and accidental events upon the foregoing. The analysis should include consideration of recent scientific literature on effects of seismic activity on invertebrate species, including identified data gaps;	• Sections 5.3 and 5.4
• Fisheries liaison/interaction policies and procedures;	• Sections 5.2 and 5.4
• Program(s) for compensation of affected parties, including fisheries interests, for accidental damage resulting from project activities;	• Section 5.2 and 5.4
• Means by which adverse effects upon commercial fisheries may be mitigated through design and/or operational procedures; and	• Sections 5.2 and 5.4
• Environmental effects due to the Project, including cumulative effect	• Section 5.4
5.2.10 Accidental Events	
• Discussion on the potential for spill events related to the use and maintenance of streamers.	• Sections 2.7, 2.8, Chapter 5
• Environmental effects of any accidental events arising from streamers or	• Sections 2.7, 3.4.6, 5.2, 5.3.5,

EA Scoping Document Sections / Requirements	Where / How Addressed in the EA Report
accidental releases from the seismic and/or support vessels (e.g., loss of product from streamers). Cumulative effects in consideration of other oil pollution events (e.g., illegal bilge disposal) should be included.	5.4.4, 5.6.5, 5.8.4
• Mitigations to reduce or prevent such events from occurring.	• Sections 2.7, 5.2, 5.3, 5.4, 5.5, 5.6, 5.7, 5.8
• Contingency plans to be implemented in the event of an accidental release.	• Sections 2.7, 5.2, 5.3, 5.4, 5.5, 5.6, 5.7, 5.8
Environmental Management	
5.2.11 The EA shall outline GXT's environmental management system and its components, including, but not limited to:	
• Pollution prevention policies and procedures;	• Sections 2.7, 5.2, 5.3, 5.4, 5.5, 5.6, 5.7, 5.8
• Fisheries liaison/interaction policies and procedures;	• Sections 2.7, 5.2, 5.4
• Program(s) for compensation of affected parties, including fishery interests, for accidental damage resulting from project activities; and	• Sections 2.7, 5.2, 5.4
• Emergency response plan(s).	• Sections 2.7, 5.2, 5.3, 5.4, 5.5, 5.6, 5.7, 5.8
Biological and Follow-up Monitoring	
5.2.12 Discuss the need for and requirements of a follow-up program (as defined in Section 2 of the CEA Act) and pursuant to the SARA. The discussion should also include any requirement for compensation monitoring (compensation is considered mitigation).	• Sections 3.4.7, 5.2, 5.3.6, 5.4.5, 5.5.6, 5.6.6, 5.8.5
Details regarding the monitoring and observation procedures to be implemented regarding marine mammals, sea turtles and seabirds (observation protocols should be consistent with the C-NLOPB "Geophysical, Geological, Environmental and Geotechnical Program Guidelines" (January 2012).	• Sections 5.2.5, 5.3, 5.5, 5.6, 5.7
5.3 Significance of Adverse Environmental Effects	
The Proponent shall clearly describe the criteria by which it proposes to define the "significance" of any residual adverse environmental effects that are predicted by the EA. This definition should be consistent with the November 1994 CEAA reference guide "*Determining Whether a Project is Likely to Cause Significant Adverse Environmental Effects*", and be relevant to consideration of each VEC (including components or subsets thereof) that is identified. SARA species shall be assessed independent of non-SARA species. The effects assessment methodology should clearly describe how data gaps are considered in the determination of significance of effects.	• Sections 3.4.2, 5.3.1, 5.4.1, 5.5.1, 5.6.1, 5.8.1 • The definition and determination of significance is consistent with the referenced guide. • Individual assessments and environmental effects conclusions are provided for each *SARA* listed species in Section 5.7. • Mitigation measures and significance definitions for SARA listed species in Section 5.7 are the same as for the Marine Fish and Fish Habitat, Marine / Migratory Birds and marine Mammals and Sea Turtles VECs themselves. • No data gaps have been identified which have prevented the assessment and evaluation of environmental effects and the identification and proposal of mitigation for this Project and its

EA Scoping Document Sections / Requirements	Where / How Addressed in the EA Report
	EA, nor which would lead to a conclusion that the Project is likely to cause significant adverse environmental effects.
5.4 Cumulative Effects	
The assessment of cumulative environmental effects should be consistent with the principles described in the February 1999 CEAA "*Cumulative Effects Assessment Practitioners' Guide*" and in the November 2007 CEAA operational policy statement "*Addressing Cumulative Environmental Effects under the Canadian Environmental Assessment Act*". It should include a consideration of environmental effects that are likely to result from the proposed project in combination with other projects or activities that have been or will be carried out. These include, but are not limited to: proposed oil and gas activities under EA review (listed on the C-NLOPB Public registry at www.cnlopb.nl.ca); other seismic activities; fishing activities, including Aboriginal fisheries; other oil and gas activities; and marine transportation. The C-NLOPB website list all current and active offshore petroleum activity within the NL offshore area.	• Sections 3.4.6, 5.3.5, 5.4.4, 5.5.5, 5.6.5, 5.8.4 • The cumulative effects assessment approach and methods are consistent with the referenced guides • Each of the noted "other projects and activities" have been considered in the cumulative effects assessment.
6 Projected Timelines for the Environmental Assessment Process	
The following are estimated timelines for completing the EA process. The timelines are offered based on experience with recent environmental assessments of similar project activities.	

ACTIVITY	TARGET	RESPONSIBILITY
EA review upon receipt from Proponent	6 weeks	C-NLOPB & Expert Departments and Agencies
Compile comments on EA	1 week	C-NLOPB
Review of EA Addendum/Response Document (*if necessary*)	2 weeks	C-NLOPB & Expert Departments and Agencies
Determination of Significance of Project Effects	3 weeks	C-NLOPB
Total	12 weeks	

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APPENDIX B

Emergency Response Plan

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GrandSPAN Emergency Response Plan 2014

Contact MCTS Centre (24-Hours)

St. John's	**709-772-2083**
Placentia	**709-227-2181**
St. Anthony	**709-454-3852**
Labrador	**709-896-2252**
Port Aux Basques	**709-695-2167**

<u>All Project Vessels Contact an MCTS Centre</u>

Twice Daily

By: GMDSS OR Phone (above)

If Contact Is Not Made 1 hour After The Scheduled Time

Then MCTS Centre Contact GXT

Dean Kennedy 1 709-682-2336
OR
Tim Dudley 1 832-344-6755

GXT conducts A Communications Search for the Vessel Until Contact is Established

If contact cannot be made with the vessel then activate

Halifax SRR
1 800-563-2444
OR
1 902-427-8200

VESSEL MASTER ORDERS MEDICAL EVACUATION

Vessel Contact Halifax SRR

1 800-563-2444
1 902-427-8200

OPTPION ONE

SAR HELICOPTER

Vessel Transit within range of Helicopter

OPTION TWO

Vessel Transit to Nearest Port with Airport Facilities

Conduct Company Emergency Call Outs

All PROJECT VESSELS

FIRE
COLLISION
BLACKOUT
ABANDON SHIP
STEERING LOSS
ADVERSE WEATER
MAN OVERBOARD
POLLUTION

↓

<u>CAPTAIN Contact HALIFAX SRR</u>

1 800-563-2444

1 902-427-8200

↓

Follow Vessel Emergency Response Manual Instructions

Conduct Company Call Out Plan

GX TECHNOLOGY

POLLUTION

Follow Vessel Specific Maritime ISM Contingencies Pollution Manual

IF SOURCE IS OIL REFER TO:

SHIPBOARD OIL POLLUTION EMERGENCY PLAN

Vessel Specific Marine Operation Procedures

CONTACT Halifax SRR

1 800-563-2444
1 902-427-8200

CONTACT

GXT Management
Vessel Owners/Operators
C-NLOPB

Follow Office SOPEP Manual/Procedures for Vessel Oil Spills

Oil Spill
Wildlife Involved

↓

CONTACT LEAD FIELD BIOLOGIST
On Seismic Vessel

↓

<u>Lead Biologist to coordinate activities designed to keep wildlife (particularly seabirds) from entering the oiled area.</u>

Measures Include Hazing Using:
Small boats
Ships whistles and Sirens
Flare Guns
Other sound making device

[Note – no attempting to retrieve oiled birds]

↓

Lead Biologist Contact :

GXT Shore Manager
GXT Contact C-NLOPB

GX TECHNOLOGY

HARVESTER ENCOUNTER

Master / FLOs / GXT Representative PROCEDURES

(1) STOP production and move away from Harvester

(2) Record how the Harvester was noticed / how contact was made and by whom

(3) Record exact time, location, sea conditions, and any other pertinent information about the event

(4) If the FLOs are able to communicate with the Harvester, identity who it is and whether there are any other Harvesters in the area.

(5) Note what the seismic vessel had been doing before the encounter

(6) Note any other vessels that you are aware of in your vicinity before/during the encounter.

Note: FLOs To Communicate with Harvester where possible

Vessel Contact GXT

GXT Project Manager Contact

GXT Management
C-NLOPB