

GXT SOUTHWEST GREENLAND 2D BASIN SPAN SEISMIC SURVEY

ENVIRONMENTAL IMPACT ASSESSMENT NON-TECHNICAL SUMMARY

This is a non-technical summary of the Environmental Impact Assessment (EIA) for GX Technology's (GXT) proposed two-dimensional (2D) seismic survey offshore southwest Greenland in June to November 2013. The non-technical summary provides an overview of the regulatory requirements, a description of the Project, an overview of the environmental setting, the methods used to assess impacts, proposed mitigation measures, predicted impacts of seismic noise and other Project activities; it also identifies data gaps and uncertainties. The full EIA report is available in English and Greenlandic.

1 Regulatory, Policy and Administrative Framework

The EIA was prepared to meet appropriate Greenlandic legislation and regulatory requirements, incorporate relevant international standards and scientific knowledge, and follow GXT's environmental policies. Key guidance documents used to prepare this EIA include:

- Bureau of Minerals and Petroleum (BMP) Guidelines for application, execution, and reporting of offshore hydrocarbon exploration activities (excluding drilling) in Greenland, December 2011 (BMP 2011).
- Guidelines to environmental impact assessment of seismic activities in Greenland waters, 3rd revised edition, December 2011 (Kyhn et al. 2011).

As required in the BMP Guidelines, Best Available Technology (BAT) and Best Environmental Practice (BEP; e.g., NORSOK, OSPAR, and MARPOL) were considered and incorporated into the Project where possible. GXT's Health, Safety, and Environment (HSE) plans and policies are also incorporated into the Project and the EIA.

2 Purpose

The purpose of GXT's proposed program is to conduct a deep Basin Span seismic survey in the southwest Greenland offshore area, part of a larger Span program that will extend south and west into Canadian waters. GXT's world-wide Span surveys are specially designed to examine very broad and deep geological formations in and around petroleum areas using advanced technology and program design. They provide scientific information about how the petroleum resources formed and where they may be located over large areas, which is important knowledge for geologists and for oil and gas companies that are working in or might be interested in a region. The information GXT collects in its span programs is very different from typical surveys by other seismic companies. This can be seen in the layout of GXT's lines, which usually bend and turn, following earth formations, rather than a simple grid design, the long time it listens between sound pulses, and the special methods it uses to interpret the data. The results will add significantly to the understanding of the offshore region and its future resource potential.

The 2013 survey is part of GXT's northern Span programs conducted previously in the ocean off Alaska, western Canada, Russia and Norway. In northeast Greenland in 2009, 2010 and 2011, GXT conducted three successful marine seismic Span programs. There were no environmental incidents recorded during any of these surveys.

GXT is a branch of ION Geophysical Corporation (ION), a leading provider of geophysical technology, equipment and specialized data services for the global oil and gas industry. (www.iongeo.com) with offices in petroleum centres throughout the United States, Canada, Latin America, Europe, Africa, Russia, China, and the Middle East. The company has a particular focus and experience working successfully in challenging environments including the Arctic.

3 Project Overview

GXT is proposing to conduct a (2D) (single streamer) marine basin survey to collect 4,800 line km of seismic, gravity and magnetic data in open (ice-free) waters in Greenland's southwestern offshore area (Figure 1). Water depths in the Project Area range from about 40 m to 3500 m.

One seismic ship (*M/V Harrier Explorer*) will be used to collect the data. This ship will tow behind it one airgun array (with a total volume of 6300 in³) at about 11 m depth. The airguns emit short pulses of intense sound that are directed downward into the seafloor. The sound that echoes back is recorded on hydrophones located in a 9-km long solid-core streamer (cable) towed just below the sea surface behind the seismic ship. The array size is matched to the purpose of the Span program in southwest Greenland, to "see" down under the ocean floor as far as possible (40 km or more) to map deep structures that are not well known at present. The seismic ship moves at about 9 km an hour when surveying.

The seismic vessel will be accompanied by a support vessel (*M/V Polar Prince*), a medium-class icebreaker, though it is not planned to use the ship for breaking ice. Its main task is re-supply, re-fuelling, and transfers of personnel. The seismic vessel will have a total of about 47 crew members. The crew on the support vessel totals 16.

Most of the 11 individual seismic lines are long (ranging from 143 km to 1,163 km), bending, and widely spaced (typically >75 km apart), except where lines cross at several locations (see Figure 1). It is anticipated that GXT will be surveying in Greenland for 40 to 60 days within the period between June and November, depending on weather, the timing of the Canadian part, and other factors. Because the seismic lines are so long and widely spaced, the survey will only be in any particular area for a short time until it moves on along the line or to a new line.

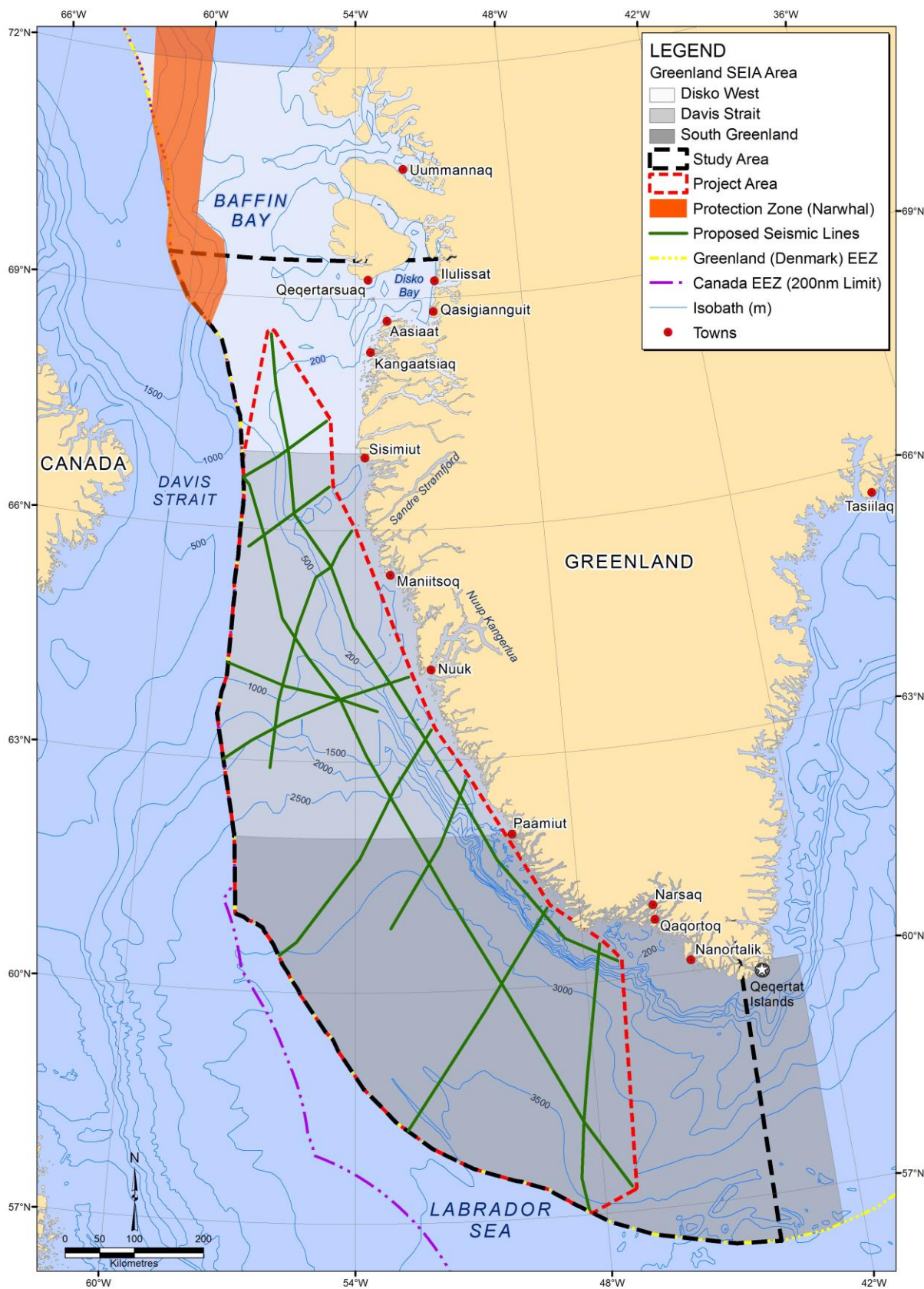


FIGURE 1. Location of the proposed GXT 2D Greenland seismic program in 2013 including the Project Area, Study Area, and proposed seismic lines.

4 Environmental Setting

The EIA provides a general overview of the baseline conditions in and near the area where GXT proposes to collect seismic data. The Strategic Environmental Impact Assessments (SEIAs) prepared for the Davis Strait (Merkel et al. 2012), South Greenland (Frederiksen et al. 2012), and Disko West (Mosbech et al. 2007) assessment areas by the Danish Centre for Environment and Energy (DCE) were key sources of information. Emphasis in GXT's EIA is on the biological, social and economic components that could be affected by Project activities. Information on fish, invertebrates, seabirds, marine mammals, commercial fisheries, subsistence fisheries and subsistence hunting was reviewed. As part of the review, the conservation status of species occurring in and near the Project Area as assessed in Greenland (Red List) and internationally was determined. Existing (baseline) conditions were reviewed, particularly the distribution and abundance of species and their activities (i.e., breeding, migrating, feeding), in and near the Study Area.

Twenty-three species of marine mammals occur in the GXT Study Area. According to the Greenland Red List, four of the species (beluga, narwhal, North Atlantic right whale, and harbour seal) are considered Critically Endangered, the walrus (West Greenland population) is considered Endangered, the bowhead whale (Baffin Bay/Davis Strait population) is considered Near Threatened, and the polar bear is considered Vulnerable (Boertmann 2008). Five of these listed species—the beluga, narwhal, walrus, bowhead whale, and polar bear—are commonly observed in the Study Area but primarily during the ice-covered season. North Atlantic right whales and harbour seals are considered rare in the Study Area. There is a remnant harbour seal population located at Qeqertat that is more than 30 km from the Study Area. Most baleen whales, including the humpback whale, are considered common summer visitors to the Study Area. Marine mammals (most notably seals, narwhals, belugas, and minke whales) are hunted in coastal areas of the Study Area and are considered an important part of the Greenlandic culture.

Many seabird species are known to occur regularly in the Study Area. The proposed Project timing overlaps with several important stages in the annual life cycle of seabirds, i.e., late spring migration (early June), breeding season (June-August), moulting season (July–September), autumn migration (July–October) and the beginning of the wintering season (October–November). The coast of southwest Greenland (Disko Bay to Cape Farewell) supports many seabird breeding colonies of varying size with the largest in the north at Disko Bay. The open-water areas of the coast of southwest Greenland contain important sites for large numbers of wintering seabirds originating from the Canadian Arctic, Iceland, Svalbard and Greenland (Boertmann et al. 2004, 2006). The offshore zone supports Northern Fulmar, Great Shearwater and Black-legged Kittiwake in the summer and King Eider, Little Auk and Thick-billed Murre in winter. Seabirds (e.g., Thick-billed Murre, Common Eider) are hunted in coastal areas of the Study Area and are also considered important to Greenlandic culture.

Many shellfish and fish species commonly occur in the Study Area. The two most notable shellfish are northern shrimp and snow crab. The most notable fish in the Study Area include Greenland halibut, Atlantic cod, lumpsucker, Atlantic salmon, capelin, sandeels, redfishes, wolffishes, American plaice, and thorny skate. Several of these species are important to the commercial fisheries, which represent the most important export industry in Greenland. Overall, the most important commercial species in the Study Area are shrimp, Greenland halibut, snow crab, Atlantic cod and lumpsucker. Subsistence and recreational fisheries also occur in the Study Area and are typically conducted in inshore waters in spring and summer.

5 Impact Assessment Methods

The methods used to assess the impacts of the Project were based in part on those used in the SEIAs prepared by the DCE. Key aspects of the environment, typically called Valued Ecosystem Components (VECs) in EIAs, were selected for assessment including several marine mammals (narwhal, beluga whale, humpback whale, walrus, ringed seal, harp seal, and polar bear), seabirds, fish and invertebrates as well as their eggs and larvae. Commercial fisheries (mostly Greenland halibut and shrimp), subsistence fisheries, and the marine mammal subsistence hunt were considered VECs as well.

The primary aspect of the proposed activity causing concern is the underwater noise created by the airgun array and the impacts that such noise could have on marine mammals. To understand the effect of this noise, GXT conducted modelling of the airgun array to estimate how far and at what levels this sound will travel. The modelling results along with previous studies of how VECs respond to noise, allowed for predictions of whether the Project could have negligible, minor, moderate, or major impacts (magnitude); the size or spatial extent (km²) of the impact; and how long an impact could occur (duration). Each impact prediction also has a level of confidence. Measures were identified to reduce or lessen (mitigate) the possible impacts. All of these factors were used to assess whether the proposed Project could seriously (significantly) affect a VEC.

In this EIA, a significant impact is defined as having a major magnitude for any time, anywhere; or having a moderate magnitude for more than one year over more than 100 km². The magnitude of impacts can be rated as:

Major: An impact on a VEC is rated major if it is judged to result in a 10%, or greater, change in the size or health of a species population or the ability of its habitat to support it, or affect a food/material (subsistence) resource to an extent that is not accepted by people who use it. A change in a population can result from an absolute reduction in population size or from making animals leave the area.

Moderate: An impact on a VEC is rated moderate if it is judged to result in a 1–10% change in the size or health of a population or its habitat, or noticeably affect the subsistence resource involved; impacts would be tolerated by the people who use the species.

Minor: An impact on a VEC is rated minor if it is judged to result in a <1% change in the size or health of the population or habitat, or only slightly affect the subsistence resource involved.

Negligible: Negligible impacts would result in no or very small effects on a VEC.

6 Summary of Potential Impacts and Mitigation Measures

The main Project activity of concern is the underwater noise emitted by the airgun array and this was the chief focus of the EIA for each VEC. Particular emphasis was given to marine mammals, and the impacts of noise on their hearing and behaviour. Other Project activities like routine discharges of grey water (showers, wash water) and black water (treated sewage), and the physical presence of vessels were also assessed but are not included in this non-technical summary because all impacts were considered negligible.

6.1 Mitigation Measures

As required by BMP, an Environmental Management Plan was prepared that includes the monitoring and mitigation measures planned to reduce impacts. Mitigation measures incorporate BEP and BAT and as a minimum follow appropriate BMP guidelines and legislation; mitigation measures are summarized in Table 1.

Table 1. Summary of key mitigation measures

Airgun Array Noise
Avoid all Protection Zones for marine mammals
Avoid surveying in the northern portion of the Project Area in June and November to minimize overlap with bowhead whales and narwhals/belugas, respectively.
Use of two Marine Mammal and Seabird Observers (MMSOs) on the seismic vessel
Ramp up of the array
Delay ramp up if full safety zone (area within 500 m of the array) is not visible
Delay of ramp up for marine mammals seen inside or approaching safety zone (500 m)
Shutdown of airguns for marine mammals seen inside or approaching safety zone (500 m) (This is larger than the zone (200 m) recommended in the BMP Seismic Guidelines).
Shutdown of airguns during line changes
Maintain a minimum separation distance of 30 km from any other active seismic vessels
Fisheries Interactions
Use of a Greenlandic-speaking Fisheries Liaison Officer (FLO) if requested by BMP
Priority given to fishing activities if encountered
Good communication with fishers
General Ship Operations
Vessels will steer a straight course and maintain a constant speed whenever possible. Vessel speeds will not exceed 14 knots.
Reduce vessel lighting whenever it is safe and possible to do so to reduce chances of attracting seabirds
Rescue and release any ship-stranded seabirds
Project vessel crews will keep a log of sightings and contacts with fishing (and other) vessels
Emissions and Discharges
Project vessels will only use diesel and gasoil with a sulphur content of less than 1.5% (weight)
Vessels will meet international regulations and standards (MARPOL) for vessel discharges and emissions
Unplanned Events
Emergency Response, Spill Response (include refuelling procedures)
Oil spill drills and oil spill kits
Use of a solid streamer
Refuelling of seismic vessel in offshore waters. Avoidance of important bird areas.
Communications
GXT will be available to meet with stakeholders, including communities to provide information about the Project and the findings of the marine mammal and seabird monitoring program before and during the program
Notification of the seismic survey timing (entry) details to BMP, Danish Maritime Safety Administration (Farvandsvæsenet), the Island Command Greenland/MRCC Grønøed, the Danish Maritime Authority and Greenland Fisheries Licence Control, Royal Greenland A/S, shipping and harbour authorities, and hunter associations before the start of the survey

Establish a mechanism that offers various ways (e.g., telephone, email, personal contact) for local stakeholders to contact GXT directly during the survey
Start-up Meeting at the ship to ensure all Project personnel fully understand environmental issues, commitments and mitigations
GXT will consult the DCE prior to survey start to ensure that its monitoring and mitigation plan for marine mammals and seabirds meets DCE protocols and that the MMOs are qualified
GXT will communicate with other oil and gas operators planning marine activities near the survey (i.e., TGS-NOPEC) during the planning and operation phases

6.2 Remaining Impacts

A thorough review of previous studies on seismic noise effects for all VECs was conducted for the EIA and was used to predict impacts. After inclusion of the above-noted mitigation measures, there are no significant remaining (residual) impacts predicted for the proposed 2D seismic program (Table 2). All of the potential impacts (for routine activities, potential accidental spills of fuel, and airgun array noise) considered for VECs have a magnitude rating of *negligible*, *negligible to minor*, or *minor*. The level of confidence in predictions for impacts of airgun array noise is ranked as medium for some marine mammals because of limited information available on the impacts of airgun array noise. More specifically, there are data gaps about how marine mammal hearing is affected by exposure to many airgun pulses and how species like narwhals respond to airgun array noise. Also, there is a lack of information on marine mammal distribution and abundance in areas beyond 200 km from the Greenland coast. Similarly, a confidence level of medium was given for fish and invertebrates because of limited information available on the impacts of airgun array noise.

Table 2. Summary of impact predictions for VECs and airgun array noise.

Project Activity / VEC	Impact Magnitude	Significance	Level of Confidence
Airgun Array Noise			
Narwhals/Belugas: hearing impacts	Negligible	Not Significant	High
Narwhals/Belugas: behaviour impacts	Minor	Not Significant	Medium
Baleen whales: hearing impact	Negligible to Minor	Not Significant	Medium
Baleen whales: behaviour impact	Minor	Not Significant	Medium
Seals: hearing impact	Negligible to Minor	Not Significant	Medium
Seals: behaviour impact	Minor	Not Significant	High
Walrus/Polar bears: hearing impacts	Negligible	Not Significant	High
Walrus/Polar bears: behaviour impacts	Negligible to Minor	Not Significant	High
Seabirds	Negligible	Not Significant	High
Marine mammal hunt	Negligible to Minor	Not Significant	High
Fish and invertebrates (including eggs and larvae): physical impacts	Minor	Not Significant	Medium-High
Fish and invertebrates (including eggs and larvae): behaviour	Minor	Not Significant	Medium

Project Activity / VEC	Impact Magnitude	Significance	Level of Confidence
impacts			
Commercial fisheries	Negligible to Minor	Not Significant	Medium
Subsistence fishery	Negligible	Not Significant	Medium

6.3 Cumulative Impacts

The potential for cumulative impacts from all activities proposed was also assessed. In addition to GXT's proposed 2D seismic survey, TGS-NOPEC is proposing to conduct a 2D grid-type seismic survey in southwest Greenland (information provided by BMP). The GXT and TGS-NOPEC survey areas overlap substantially in the southern half of GXT's Project Area. Temporal overlap between the two seismic programs could occur from 1 June to 15 October. GXT is proposing that a Simultaneous Operations Plan be developed that includes the specific procedures for maintaining at least a 30 km separation between the two seismic vessels.

Based on the minimum 30 km separation distance between active seismic programs, it is highly unlikely that the cumulative impact of the two 2D seismic programs would affect 10% or more (i.e., the standard for assigning an impact rating of "major") of VECs, including marine mammal populations. Cumulative residual effects were therefore assessed as *not significant* for all VECs.

7 Conclusions

GXT's EIA provides a thorough review of available information, including the Strategic EIAs prepared by the DCE, about the marine environment in the area where GXT is proposing to conduct a 2D seismic survey. Scientific studies on the effects of airgun array noise were also reviewed (these reviews are provided as appendices to this EIA) and this information was used along with modelling of the airgun array sound levels, to predict how seismic surveying may affect marine mammals, fish and invertebrates, seabirds, commercial fisheries, and subsistence harvesting. It is acknowledged that there are gaps in knowledge about some aspects of the marine environment as well as how some marine species are affected by seismic noise. These gaps were taken into consideration in the assessment and numerous precautionary assumptions were used when making the impact predictions.

As required in the BMP Guidelines, GXT has developed an Environmental Management Plan that details the mitigations and monitoring procedures that will be put in place to reduce or eliminate effects of its proposed seismic program on the marine environment (Table 1 provides a summary). Enhanced mitigations (relative to those in the BMP Seismic Guidelines) have been put in place to further minimize the effects of airgun array sound, particularly on marine mammals. With these mitigations in place, it is predicted that the effects of GXT's 2D seismic program on the marine environment will be *not significant*.