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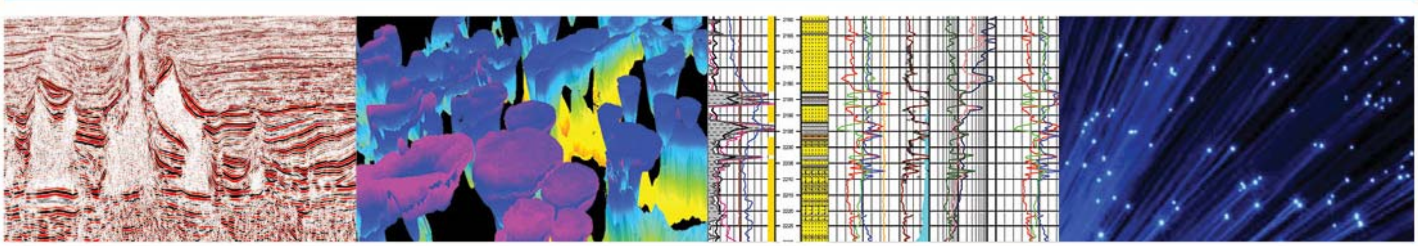
2013 CHUKCHI SEA 2D SEISMIC SURVEY
ENVIRONMENTAL EVALUATION DOCUMENT

Prepared for:
TGS
2500 CityWest Boulevard
Suite 2000
Houston, TX 77042 USA
Tel: +1 713 860 2100
Fax: +1 713 334 3308
www.tgs.com

Steve Whidden, P. Geophysist
TGS Program Manager
Tel: + 1 403 852 6115

Prepared by:
ASRC Energy Services, Alaska Inc.
3900 C Street, Suite 700
Anchorage, Alaska 99503
Tel: +1 907 339 6200
Fax: +1 907 339 5475



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ACRONYMS AND ABBREVIATIONS

<	less than
>	greater than
°C	degrees Celsius
°F	degrees Fahrenheit
µm	micrometers
2D	two-dimensional
3D	three-dimensional
AASM	airgun array source model
ADF&G	Alaska Department of Fish & Game
AEWC	Alaska Eskimo Whaling Commission
AFMP	Arctic Fishery Management Plan
ANSC	Alaska Native Science Commission
ASAMM	Aerial Surveys of Arctic Marine Mammals
BOEM	Bureau of Ocean Energy Management
BOEMRE	Bureau of Ocean Energy Management, Regulation and Enforcement
BOWFEST	Bowhead Whale Feeding Ecology Study
BWASP	Bowhead Whale Aerial Survey Project
BWCA	Barrow Whaling Captains Association
CAA	Clean Air Act, amended 1990
CFR	Code of Federal Regulations
CHAOZ	Chukchi Acoustic Oceanographic and Zooplankton
cm^3	cubic centimeter(s)
Com Center	Communication Center
COMIDA	Chukchi Offshore Monitoring in Drilling Area
ConocoPhillips	ConocoPhillips Alaska, Inc.
CSESP	Chukchi Sea Environmental Studies Program
CSPA	Chukchi Sea Planning Area
CWA	Clean Water Act
dB re 1 µPa @1m	decibel referenced to 1 microPascal at 1 meter
EA	Environmental Assessment
EED	Environmental Evaluation Document
EFH	Essential Fish Habitat
EIS	Environmental Impact Statement
EJ	Environmental Justice
EO	Executive Order
EPA	US Environmental Protection Agency
ESA	Endangered Species Act of 1973
FM	frequency modulation
FONSI	Finding of No Significant Impact
ft	foot/feet
G&G	Geological and Geophysical
HNS	hazardous and noxious substances
Hz	Hertz
IBCAO	International Bathymetric Chart of the Arctic Ocean
IHA	Incidental Harassment Authorization
IMO	International Maritime Organization

in^3	cubic inch(es)
ITR	Incidental Take Regulation
IWC	International Whaling Commission
kHz	kilohertz
km	kilometer(s)
km^2	square kilometer(s)
LBCHU	Ledyard Bay Critical Habitat Unit
LME	Large Marine Ecosystem
LOA	Letter of Authorization
m	meter(s)
m/s	meter(s) per second
M/V	Marine Vessel
MARPOL	International Convention for the Prevention of Pollution from Ships
METAREAS	meteorological areas
mi	mile(s)
mi^2	square mile(s)
MMPA	Marine Mammals Protection Act of 1972
MMS	Minerals Management Service
MONM	Marine Operations Noise Model
mph	miles per hour
NAAQS	National Ambient Air Quality Standards
NAVAREAS	navigational areas
NEPA	National Environmental Policy Act of 1969
nm	nautical miles
NMFS	National Marine Fisheries Service
NMML	National Marine Mammal Laboratory
NO_x	nitrogen oxide
NPRA	National Petroleum Reserve - Alaska
NSB	North Slope Borough
OC	Olgoonik Corporation
OCS	Outer Continental Shelf
OCSLA	Outer Continental Shelf Lands Act of 1953
OPRC	Oil Pollution Preparedness, Response, and Cooperation
POC	Plan of Cooperation
PSO	Protected Species Observer
rms	root-mean-square
Shell	Shell Western E&P Inc.
SPL	sound pressure levels
SSV	sound source verification
Statoil	Statoil USA
sVGP	Small Vessel General Permit
TK	Traditional Knowledge
TTS	temporary threshold shift
USCG	US Coast Guard
USFWS	US Fish and Wildlife Service
VGP	Vessel General Permit
WMO	World Meteorological Organization
Y-K Delta	Yukon–Kuskokwim Delta

Executive Summary

This Environmental Evaluation Document (EED) assesses the potential effects TGS's proposed 2013 Chukchi Sea two-dimensional (2D) seismic survey may have on the physical, biological, and socioeconomic environment.

Project Description

TGS's proposed seismic survey activities are located in US and international waters of the Chukchi Sea between about 70–77°N and 154–165°W. The nearest North Slope community is Point Lay, Alaska, which is 55 miles (mi) (88.5 kilometers [km]) from the eastern edge of the survey boundary. TGS proposes to begin seismic survey activities between mid-July and early August 2013, after leaving Dutch Harbor, and to conclude by October 31, 2013. TGS plans to survey US waters first, with seismic operations occurring over a period of about 45–60 days. When the US waters seismic survey is complete, TGS plans to conduct up to about 33 days of seismic operations in international waters to the north and west of the US waters (time-, weather-, and ice-contingent).

TGS proposes to use two vessels for the 2013 open-water 2D seismic survey: a yet-to-be-determined seismic survey vessel and a smaller scout/monitoring vessel. TGS currently has not contracted specific vessels for the seismic survey project. However, TGS tentatively intends to use the marine vessel (M/V) *Aquila Explorer* or a similar vessel. TGS will provide full vessel specifications after contracts for the two vessels are completed. TGS will use a solid (non-kerosene-filled) streamer, thus eliminating the chance of a potential leak and spill. Upon completion of seismic survey data acquisition, all vessels will demobilize to Dutch Harbor with an estimated return transit of five days.

The project does not include any exploratory drilling or any other disturbance to the seabed and subsurface geology. In addition, the project vessels will perform no ice management activity. Refueling, if necessary, will be done at Nome or nearshore Wainwright. TGS will not employ aircraft, except in the case of an emergency.

Purpose of the Environmental Evaluation Document

The purpose of the EED is to provide the federal regulatory agencies with supporting data and information for use in preparing their National Environmental Policy Act of 1969 (NEPA) evaluation and permit decisions:

- Geological and Geophysical (G&G) permit from the Bureau of Ocean Energy Management (BOEM)
- Incidental Harassment Authorization (IHA) from the National Marine Fisheries Service (NMFS)
- Letter of Authorization (LOA) from the US Fish and Wildlife Service (USFWS)

The EED describes the scope of the seismic survey activity, the regulatory and environmental setting within which the activity will occur, potential effects, stakeholder outreach, and proposed mitigation and monitoring.

Regulatory Setting

Each federal agency must evaluate the proposed survey activity and prepare an Environmental Assessment (EA) per the requirements of NEPA.

Bureau of Ocean Energy Management (BOEM) will prepare an EA as part of their review and approval of TGS's G&G permit application. Historically, BOEM's predecessor agencies, the Minerals Management Service (MMS) and the Bureau of Ocean Energy Management, Regulation and Enforcement (BOEMRE), issued EAs for Outer Continental Shelf (OCS) seismic survey activity. NMFS and USFWS will prepare EAs for non-lethal, incidental take authorizations of whales and ice seals; and Pacific walruses and polar bears, respectively, under their authority in implementing the Marine Mammal Protection Act of 1972 (MMPA) and the Endangered Species Act of 1973 (ESA).

The environmental analysis presented in this EED tiers off and incorporates by reference many of the analyses presented in previous MMS and BOEM NEPA review documents, including the Chukchi Sea Planning Area Oil and Gas Lease Sale and Seismic Surveying Activities in the Chukchi Sea Environmental Impact Statement (EIS) (MMS 2207), and the Final Supplemental EIS (BOEMRE 2011). TGS anticipates that BOEM, NMFS, and USFWS will use the environmental information contained in this EED and the previous Chukchi Sea NEPA reviews in preparing their respective EAs and accompanying Findings of No Significant Impact (FONSIs).

Community Outreach and Stakeholder Engagement

TGS began community outreach and stakeholder engagement for this project in October 2012 and will continue community outreach and stakeholder engagement activity throughout the project life cycle. On October 25, 2012, TGS presented the project to the North Slope Borough (NSB) Planning Commission meeting, and met with the NSB Planning Director and other Barrow leadership. In December 2012, TGS met with Chukchi Sea community leaders at the tribal, city, regional, and corporate levels in Barrow, Point Hope, Point Lay, Kotzebue, and with Olgoonik Corporation in Wainwright. TGS introduced their seismic project to the Alaska Eskimo Whaling Commission (AEWC) during the AEWC 4th Quarter meeting in Anchorage, Alaska, on December 13–14, 2012. TGS held Plan of Cooperation (POC) meetings in Barrow, Kotzebue, Point Hope, Point Lay, and Wainwright in January and February 2013. TGS attended the AEWC Convention in Barrow on February 7–8, 2013. TGS met with USFWS in Anchorage February 6, 2013, to discuss the LOA permit process and mitigation and monitoring requirements. Finally, TGS will actively participate in the NMFS Open Water Meetings in Anchorage in March 2013 to present their seismic project. TGS will also participate in the NMFS Open Water Meeting in 2014 to present their marine mammal sightings and results of their marine mammal monitoring and mitigation activities. TGS will return to the North Slope communities post-season to discuss activity and obtain feedback and lessons learned.

Mitigation and Monitoring

Potential effects of the proposed 2D seismic survey project on biological resources are expected to be minimal and temporary. TGS has designed their seismic survey project to minimize potential effects on marine mammal species and subsistence hunting activities by:

- Operating at a distance of at least 55 mi (88 km) from shore, limiting interactions with marine mammals and subsistence vessels that operate in coastal waters.

- Surveying southern-most transects south of 72°N first (July–August) while bowhead whales are in the Beaufort Sea, if conditions allow, thus avoiding potential effects on bowhead whales and subsistence hunting efforts.
- Surveying northward and away from the primary fall migration path of bowhead whales as sea ice recedes (September and October).

Vessel-based mitigation measures include ramp-up procedures while initiating seismic operations, and power-down and/or shut-down procedures if a marine mammal is detected approaching or within designated distances (i.e., exclusion zones) from the sound source. These distances have been determined by acoustic propagation modeling, provided by JASCO Applied Sciences. Actual distances to each exclusion zone will be measured using sound source verification (SSV) and adjusted accordingly at the beginning of the field season.

A single 60-cubic-inch (-in^3) (98-cubic-centimeter [-cm^3]) (or smaller) airgun in the seismic source array will be used as a mitigation seismic source to continuously produce a small amount of sound into the environment to alert marine mammals of the presence of a sound source in the environment.

TGS will consult and coordinate with Lease Sale 193 leaseholders proposing 2013 operations (i.e., Shell) to define an operational safety radius between activities. TGS will make every effort to acquire the lines that are located nearest to any projected drilling locations before the arrival of a drilling vessel. If a drilling vessel is occupying a location before the acquisition of the seismic line, TGS will maintain an agreed-upon (with the operator of the drilling vessel) safety radius from the drilling vessel.

TGS will coordinate with other 2013 operators and the AEWC to define appropriate Communication Centers (Com Centers) participation.

Protected Species Observers (PSOs) will be placed onboard the seismic and scout/monitoring vessels to implement mitigation measures minimizing exposure of marine mammals to the seismic sound source.

Biological, Physical, Socioeconomic, and Subsistence Resources Effects

TGS has designed its 2D seismic survey that will have minimal to zero effect on the biological and subsistence resources in the project vicinity. TGS will implement a monitoring and mitigation program that fulfills the requirements of the IHA and LOA.

TGS seismic survey activities will have minimal to zero effect on the physical environment. The TGS vessels will comply with the International Maritime Organization (IMO) International Convention for the Prevention of Pollution from Ships (MARPOL) to prevent pollution from sewage, oil, and garbage emissions, and wastewater discharges. TGS will comply with other IMO international conventions to control and manage ballast water and sediments. TGS will operate in ice-free waters only and ice management is not proposed. The TGS two-vessel seismic survey fleet (seismic vessel and second, smaller scout vessel) will move away from concentrations of sea ice toward more-open water. TGS will use a solid streamer, thereby eliminating the potential risk of a leak and spill of kerosene into the water column. The TGS vessels will be refueled, if refueling is necessary, at Nome or nearshore Wainwright. Thus, the risk of a diesel spill is significantly reduced. The TGS seismic survey project will consist of no sediment-impairing activity, thus archaeological resources will not be adversely affected.

The TGS seismic survey project will have no measurable effect on the socioeconomic resources, aside from employing PSOs and communication center operators. No onshore facilities are proposed. Potential crew change is currently planned to originate out of Wainwright.

The TGS seismic survey project will not adversely affect subsistence resources because of the survey project timing, the project location, and project distance from Chukchi Sea coastal villages and traditional subsistence hunting areas. Any impact to marine mammals will be minimal and temporary and will not adversely affect the marine mammal species populations or deflect the animals away from traditional subsistence hunting areas or inhibit subsistence hunting activities.

1.0 Introduction

TGS proposes to conduct 2D seismic survey activities during the 2013 open-water period in Alaska and international waters of the Chukchi Sea. TGS plans to survey Alaska waters first, with seismic operations occurring over a period of about 45–60 days. When the Alaska seismic survey is complete, TGS plans to conduct up to about 33 days of seismic operations in international waters (time-, weather- and ice-contingent).

The TGS seismic survey activities will require three federal permits/authorizations: a G&G permit from BOEM, an IHA from NMFS, and an LOA from USFWS.

1.1 Purpose and Organization of the Environmental Evaluation Document

This EED has been prepared to assist the federal regulatory agencies – BOEM, NMFS, and USFWS – in their review and approval process, specifically to comply with their respective requirements under NEPA, that the TGS seismic survey project will not have significant impact to the environment. Based on this review and finding, the agencies will prepare an EA and are expected to issue a FONSI.

The following elements are included:

- Project description
- Stakeholder engagement
- Regulatory framework
- Physical and biological environment baseline conditions in the project area and potential effects from the seismic survey project
- Socioeconomic and subsistence resources and potential effects from this project
- Cumulative effects
- Mitigation measures

1.2 2013 Chukchi 2D Seismic Survey Project Description

TGS proposes to conduct approximately 5,965 mi (9,600 km) of 2D marine seismic surveys along pre-determined lines in Alaska and international waters of the Chukchi Sea (Figure 1.2-1) during the 2013 open water season (operations cannot be conducted in unbroken ice and pack ice will be avoided). The purpose of the proposed seismic program is to gather geophysical data, the results of which will be used to identify and map potential hydrocarbon-bearing formations and the geologic structures that surround them.

TGS plans to enter Alaska waters sometime between July 15 and August 5, 2013. Approximately 35 days of seismic operations are expected to occur over a period of about 45–60 days in Alaska waters. In addition, up to 33 days of seismic operations may occur in international waters (depending on ice and weather conditions). Seismic operations are proposed to occur along pre-determined track lines at speeds of about 4 to 5 knots. Seismic operations will be conducted up to 24 hours per day as possible, except as potentially needed for shut-down mitigation for marine mammals. The full 3,280 in^3 (53,750 cm^3) sound source will only be run during seismic acquisition operations on and near the end and start of survey lines; during turns and transits between seismic lines, a single "mitigation" airgun (60 in^3 [983 cm^3] or smaller) is proposed to be operated as a mitigation measure, as described for other NMFS-approved seismic operations in the Arctic and elsewhere.

Seismic operations must be conducted in ice-free open waters in order to safely tow the hydrophone solid streamer. Furthermore, the two proposed vessels do not have ice-breaking capabilities. Thus, TGS's seismic operations are contingent on the availability and locations of ice-free waters within the project area. To avoid pack ice conditions, TGS will employ the scout vessel, satellite imagery, and consultations with ice expertise to plan the survey. The survey will progress with ice-free areas acquired first.

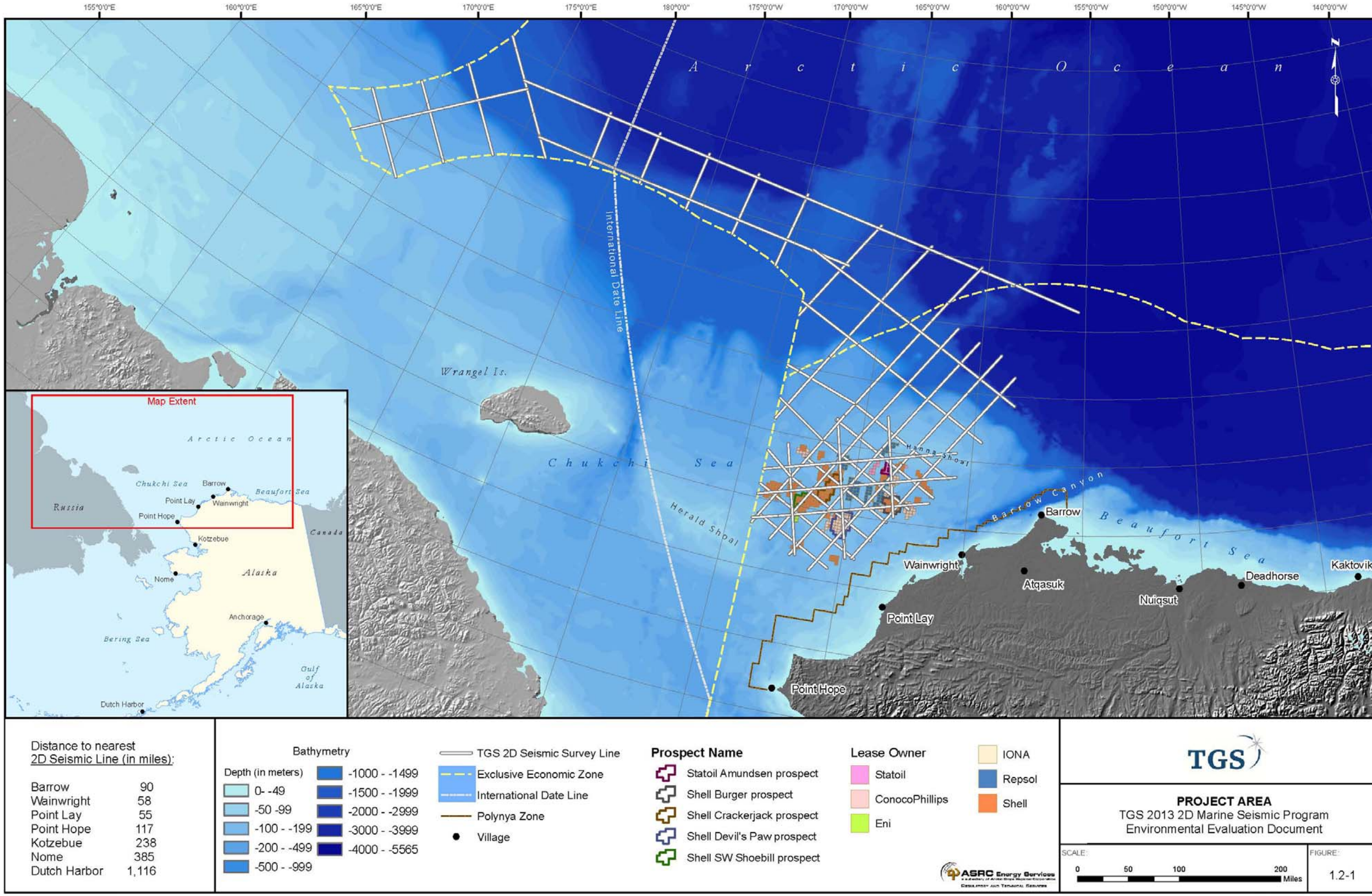

Figure 1.2-1. Project Area

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Additional information about the seismic survey project dates and duration, region of activity, and project components, respectively, is presented below in Sections 1.2.1, 1.2.2, and 1.2.3.

1.2.1 Seismic Survey Project Dates and Duration

Specific proposed dates and durations of survey activities are listed below in proposed chronological order, but are contingent on weather and ice.

1. The two TGS project vessels plan to depart Dutch Harbor in the Bering Sea sometime between July 10 and July 21, 2013, and arrive at the Chukchi Sea project area around five days later (depending on ice and weather conditions).
2. Upon arriving at the project area, SSV measurements will be collected to validate modeled radii for marine mammal monitoring, potentially as early as July 15, 2013, (see Section 8, Mitigation Measures).
3. Seismic line operations are proposed to begin sometime between July 15 and August 5, 2013, depending on duration of SSV measurements and weather and ice conditions. The survey will progress with ice-free areas acquired first.
4. TGS plans on surveying Alaska waters first. This would involve approximately 35 days of seismic operations over a period of about 45–60 days.
5. When the Alaska seismic surveys are complete, TGS plans to conduct up to about 33 days of seismic operations in international waters (weather and ice contingent).
6. It is possible, though not anticipated or planned, that seismic operations would start in international waters if Alaska waters are not “ice-free”. Subsequent seismic lines would be selected based on proximity to ice-free areas.
7. Upon completion of data acquisition, all vessels will demobilize to Dutch Harbor with an estimated return transit of five days.
8. Given the uncertainty in ice and water conditions, TGS requests all federal permits/authorizations (the BOEM G&G permit, the NMFS IHA, and the USFWS LOA) provide authorization through October 31, 2013.

1.2.2 Seismic Survey Project Region of Activity

The seismic operations are proposed to occur in US and international waters of the Chukchi Sea between about 70-77°N and 154-165°W (Figure 1.2-1). Of the total proposed seismic survey project area, 62 percent is in US waters; with the remaining 38 percent in international waters. The closest survey point to the nearest community is 55 mi (88 km) west of Point Lay, Alaska (see Figure 1.2-1 for table of distances to other Alaska communities). Most of the 5,965 mi (9,600 km) survey occurs in water 131–328 feet (ft) (40–100 meters [m]) deep (82 percent or 4,903 mi [7,890 km]), followed by waters greater than 328 ft (100 m) deep (14 percent or 820 mi [1,320 km]) and waters less than 131 ft (40 m) deep (4 percent or 242 mi [390 km]).

1.2.3 Seismic Survey Project Components

1.2.3.1 Vessels

Two vessels will be used during the survey: (1) a seismic operations vessel that will tow the seismic source array and a single 26,575-ft [8,100-m] –long hydrophone solid streamer, and (2) a smaller vessel that will be used to search for marine mammals and scout for ice and other navigation hazards ahead of the seismic vessel. Currently, TGS is in the process of selecting the vessels and when contracts for the two vessels are secured, TGS will provide the agencies full vessel specifications.

The seismic survey vessel will tow a compressed-air seismic source array of 28 Bolt 1900 LLXT airguns with a total discharge volume of 3,280 in^3 (53,750 cm^3). The airguns range in volume from 40 to 300 in^3 (102 to 762 cm^3) and are arranged in a geometric layout of four sub-arrays (see the IHA) that will be towed approximately 656 ft (200 m) behind the vessel at a depth of 20 ft (6 m). The seismic vessel will also tow a 26,575-ft (8,100-m) -long hydrophone solid streamer at a depth of 33 ft (10 m). Additional details regarding seismic acquisition parameters are provided in the G&G Permit Application.

Echosounders

Both vessels will use industry-standard echosounder/fathometer instruments to continuously monitor water depth for navigation purposes while underway. These instruments are the same as those used aboard all large vessels to obtain information about water depths and potential navigation hazards for vessel crews during routine navigation operations. Navigation echosounders direct a single, high-frequency acoustic signal that is focused in a narrow beam directly downward to the sea floor. The reflected sound energy is detected by the echo-sounder instrument, which then calculates and displays water depth to the user. Typical source levels of these types of navigational echosounders are generally 180–200 decibels (dB) relative to one microPascal at one meter depth (dB re 1 µPa) at 1 m (1 µPa@1m) root-mean-square (rms) (Richardson, et al. 1995).

1.2.3.2 Sound Propagation Modeling

The acoustic source level of the proposed 3,280 in^3 (53,750 cm^3) seismic source array was predicted using JASCO's Airgun Array Source Model (AASM) based on data collected from three sites chosen in the project area by JASCO. Water depths at the three sites were 56, 131, and 328 ft (17, 40, and 100 m). JASCO applied its Marine Operations Noise Model (MONM) to estimate acoustic propagation of the proposed seismic source array and the associated distances to the 190, 180, and 160 dB re: 1 µPa (rms) isopleths relative to standard NMFS mitigation and monitoring requirements for marine mammals. The resulting isopleths modeled for the 180 and 190 dB re: 1 µPa (rms) exclusion zone distances for cetaceans and pinnipeds, respectively, differed with the three water depths. An additional 10 percent distance buffer was added by JASCO to these originally modeled distances to provide larger, more conservative exclusion zone radii distances that will be adhered to during the project (see the IHA). The 160 dB re: 1 µPa (rms) monitoring zone was modeled to monitor for groups of whales and walruses.

The estimated distances to the 190, 180, and 160 dB re: 1µPa (rms) isopleths for the single 60 in^3 (152 cm^3) airgun (the largest single airgun that would be used as a "mitigation" gun) were measured by JASCO during a monitoring SSV study conducted for Statoil USA (Statoil) in the Chukchi Sea during the 2010 open-water season (Blees, et al. 2010). Results indicated that the distance to the 190-dB isopleth was 43 ft (13 m), to the 180 dB isopleth distance was 223 ft (68 m), and to the 160 dB isopleth was 4,921 ft (1,500 m) (all dB re: 1 µPa [rms]).

1.3 Community Outreach and Stakeholder Engagement

TGS began community outreach and stakeholder engagement for this project in October 2012 and will continue community outreach and stakeholder engagement activity throughout the project life cycle. On October 25, 2012, TGS presented the project to the NSB Planning Commission meeting, and met with the

NSB Planning Director and other Barrow leadership. In December 2012, TGS met with Chukchi Sea community leaders at the tribal, city, regional, and corporate levels in Barrow, Point Hope, Point Lay, Kotzebue, and with Olgoonik Corporation in Wainwright. TGS introduced their seismic project to the AEWC during the AEWC 4th Quarter meeting in Anchorage, Alaska, on December 13–14, 2012. TGS held POC meetings in Barrow, Kotzebue, Point Hope, Point Lay, and Wainwright in January and February 2013. TGS attended the AEWC Convention in Barrow on February 7–8, 2013. TGS met with USFWS in Anchorage February 6, 2013, to discuss the LOA permit process and mitigation and monitoring requirements. Finally, TGS will actively participate in the NMFS Open Water Meetings in Anchorage in March 2013 to present their seismic project. TGS will also participate in the NMFS Open Water Meeting in 2014 to present their marine mammal sightings and results of their marine mammal monitoring and mitigation activities. TGS will return to the North Slope communities post-season to discuss activity and obtain feedback and lessons learned.

Table 1.3-1 lists the 2012–2013 outreach TGS conducted with North Slope leadership and Chukchi Sea communities.

Table 1.3-1. 2012–2013 Leadership and Community Meetings

Stakeholder Entity	Date	Location(s)	Notes
North Slope Borough (NSB) Planning Commission	October 25, 2012	Barrow	TGS presented the proposed project to the NSB Planning Commission. Representatives of the NSB Planning Department were present.
Leadership Meetings	December 3–7, 2012	Barrow Kotzebue Point Hope Point Lay Wainwright	TGS presented the proposed project to the community leadership. Entities invited included: • City of Barrow • Native Village of Barrow • Ukpeaġvik Iñupiat Corporation • City of Wainwright • Native Village of Wainwright • Olgoonik Corporation • Native Village of Point Lay • Cully Corporation • City of Point Hope • Native Village of Point Hope • Tikiġaq Corporation • Native Village of Kotzebue • City of Kotzebue • Kikiktagruk Iñupiat Corporation • Northwest Arctic Borough
Alaska Eskimo Whaling Commission (AEWC) 4th Quarter Meeting	December 13–14, 2012	Anchorage	TGS presented the proposed project to the AEWC.
Leadership Meetings	January 28–30, 2013	Kotzebue Wainwright	• Native Village of Kotzebue • City of Wainwright • Native Village of Wainwright

Table 1.3-1. 2012–2013 Leadership and Community Meetings

Stakeholder Entity	Date	Location(s)	Notes
Plan of Cooperation Meetings	January–February 2013	Barrow Kotzebue Point Hope Point Lay Wainwright	TGS presented the proposed project to the affected communities.
USFWS	February 6, 2013	Anchorage	Discussed LOA and proposed revisions to regulations for the Chukchi Sea in 2013.
AEWC Convention	February 7–8, 2013	Barrow	Conflict Avoidance Agreement discussed.
National Marine Fisheries Service (NMFS) Open Water Meeting	March 5-7, 2013	Anchorage	TGS will present the proposed project at the 2013 Open Water Meeting.
NMFS Open Water Meeting	March 2014	Anchorage	TGS will report on 2013 program activities.
Post-season Community Meetings	Winter 2013/2014	Various communities	To discuss activity and obtain feedback and lessons learned.

AEWC = Alaska Eskimo Whaling Commission
NMFS = National Marine Fisheries Service
NSB = North Slope Borough
USFWS = US Fish and Wildlife Service

TGS plans to continue to engage with the affected subsistence communities regarding its Chukchi Sea activities. TGS will present its data about marine mammal sightings, and the results of our marine mammal monitoring and mitigation, as part of our 90-day Report to the NMFS and USFWS, and will participate in the 2013 and 2014 Open Water Meetings. TGS will present an overview of the survey activities to the NSB and the Chukchi Sea communities at the conclusion of activities.

1.4 Chukchi Sea Marine Mammal Baseline Studies

The Alaska oil and gas industry has supported and participated in Chukchi Sea environmental programs over several decades. These programs were designed to research the existing environment and evaluate potential effects of associated exploration, production, and development on biological resources. Studies began with marine mammals as the primary focus, but since have become multidisciplinary. This section provides an overview of marine mammal baseline surveys that have occurred, or are still occurring, in the Chukchi Sea.

1.4.1 1989–1991 Shell Western E&P Inc. Monitoring Program

Between 1989 and 1991, Shell Western E&P Inc. (Shell) funded monitoring programs of marine mammals in the Chukchi Sea, focusing on the Klondike, Burger, Popcorn, Diamond, and Crackerjack prospects (Figure 1.4-1). These three single-year studies (1989, 1990, and 1991) aimed to monitor marine mammals and their responses to oil and gas industry activities.

The 1989 program focused on walrus monitoring (Brueggeman, et al. 1990) to determine their response to drilling and/or ice management operations. Aerial surveys were conducted and acoustic measurements were taken to measure sound levels of drilling operations and ambient conditions. The program observed that the walruses displayed high preference for sea-ice habitat, and that drilling operations had little effect on distribution. In contrast, during icebreaking activities, about 69 percent of walruses exhibited avoidance reactions. They did not show avoidance responses when the icebreaker was anchored or drifting during drilling operations. The walruses did not appear to be affected by drilling operation sounds once the icebreaking activity stopped. It was estimated that 2.5 percent of the total Pacific walrus population occurred in the vicinity of the active prospects in 1989.

The 1990 program focused on walrus monitoring, with the addition of some reporting on polar bears (Brueggeman, et al. 1991). Aerial and vessel-based surveys were conducted. Walruses and polar bears were observed to be closely linked with the pack ice. Pack ice was near the prospects for only a short period of time and held few walruses or polar bears. There was no icebreaking conducted that coincided with walrus presence, so behavior during icebreaking activities could not be compared. The little ice that did pass near the prospects contained few animals. It was estimated that less than 1 percent of the total Pacific walrus population passed near an active prospect in 1990.

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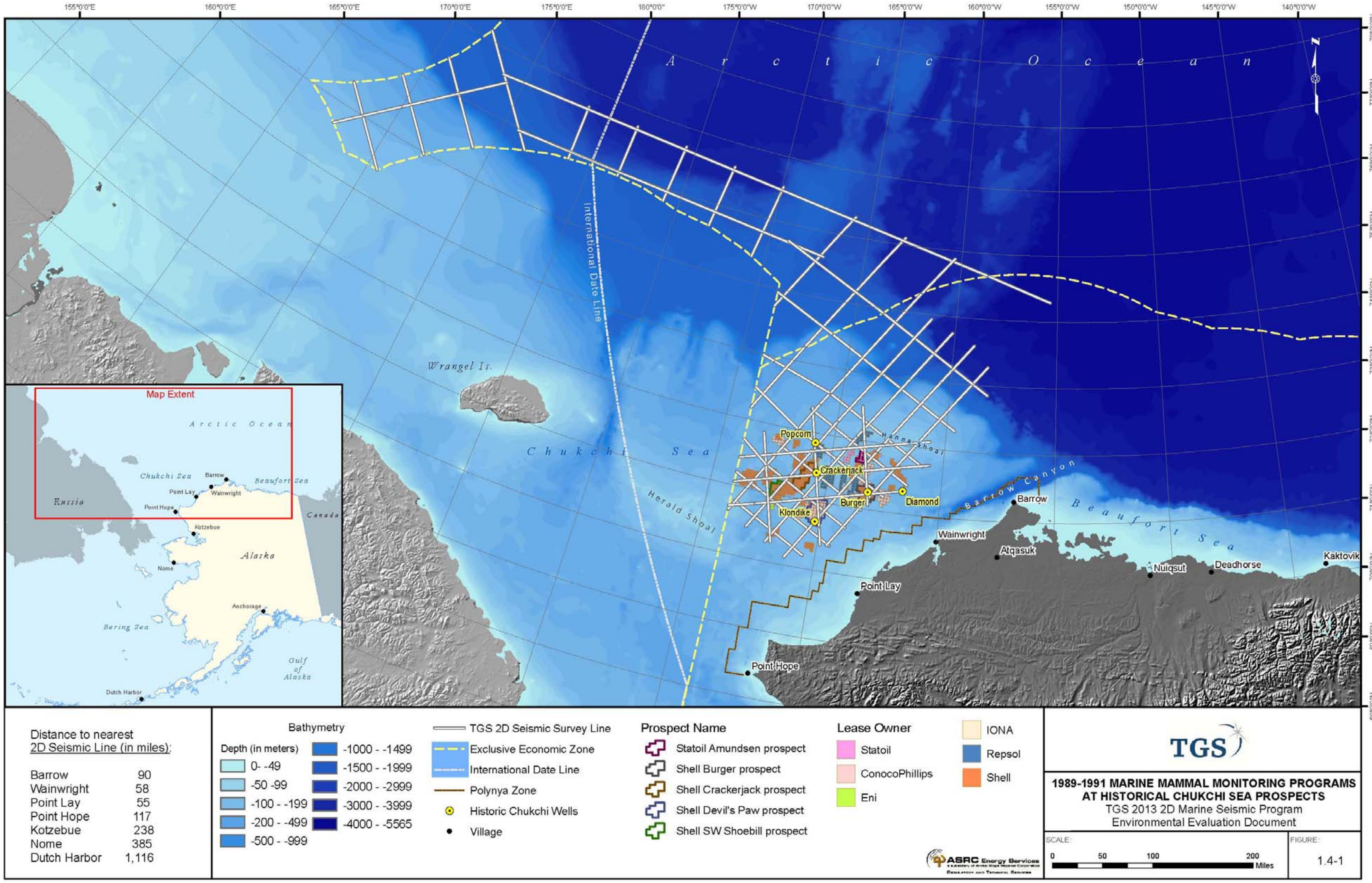

Figure 1.4-1. 1989–1991 Marine Mammal Monitoring Programs at Historical Chukchi Sea Prospects

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The 1991 program resulted in two studies, one which focused on walruses and polar bears, (Brueggeman, et al. 1992a), and the other focused on whales and seals (Brueggeman, et al. 1992b). Aerial and vessel-based surveys were conducted. Walrus and polar bear presence were closely linked with the pack ice. Similar to 1989, walruses showed little response to drilling activities, but avoided active ice management activities. Polar bears were found to adjust to, be attracted to, or be repelled from activity. Whales were observed in the prospects, but too few were observed to conclude any response to activities. The few whales that were observed did not show any obvious avoidance reactions. Most seals did not respond to ice management activities, but a few displayed short-term, localized avoidance behavior. These effects were thought to be short-term because seals were encountered almost daily throughout the prospects during the operating season. Limited acoustic measurements were also taken as part of the environmental monitoring program.

1.4.2 1979–2012 Aerial Surveys of Arctic Marine Mammals, Bowhead Whale Aerial Survey Project, and Chukchi Offshore Monitoring in Drilling Area Projects

Bowhead Whale Aerial Survey Project (BWASP) – BOEM and its precursors (BOEMRE and MMS) funded the BWASP annually from 1979–2007. This project targeted the fall westward migration of bowhead whales from the Beaufort Sea to the Chukchi Sea. Although the project targeted bowhead whales, information about all marine mammal sightings was collected. This project still exists, but is now part of the Aerial Surveys of Arctic Marine Mammals (ASAMM) project, which is funded in part by BOEM and coordinated by the National Marine Mammal Laboratory (NMML) (Clarke, et al. 2011b).

Chukchi Offshore Monitoring in Drilling Area (COMIDA) – MMS funded contractors from 2008–2010 to participate in the COMIDA project. The COMIDA aerial surveys for Arctic marine mammals were conducted in the Chukchi Sea Planning Area (CSPA) during the open-water season (June through November). Like BWASP, this program has now become part of the ASAMM project, is funded by BOEM, and coordinated through NMML (Clarke, et al. 2011a).

Aerial Surveys of Arctic Marine Mammals (ASAMM) – The ASAMM is a continuation of the BWASP and COMIDA projects. The overall goal is to document the distribution and abundance of marine mammals in areas of oil and gas exploration, development, and production activities in the Alaska Beaufort and Chukchi seas. Objectives of ASAMM include: describing annual and long-term migrations of bowhead whales; document abundance, distribution, and behavior of marine mammals; provide near-real-time data to BOEM and NMFS; and provide an objective dataset to assist managers in understanding marine mammal ecology in the Alaska Arctic (NMML 2012).

1.4.3 2006–2010 Joint Industry Monitoring Program

Industry operators participate in monitoring programs, which result in reports that are submitted in compliance with IHAs and LOAs, issued by the NMFS and the USFWS. A Joint Monitoring Program in the Chukchi and Beaufort seas took place from 2006–2010, funded by Shell, ConocoPhillips Alaska, Inc. (ConocoPhillips), and Statoil USA E&P Inc. (Statoil). Studies included aerial- and vessel-based mitigation and monitoring programs and passive acoustic monitoring. These data were collected to provide an understanding of the abundance and distribution of marine mammals in the Chukchi and Beaufort seas, and to assess the potential effects of seismic and other offshore industry activities on these marine mammals (Funk, et al. 2007, 2010, 2011; Ireland, et al. 2008).

1.4.4 2007–2011 Bowhead Whale Feeding Ecology Study

In 2007, the Bowhead Whale Feeding Ecology Study (BOWFEST) commenced through an inter-agency agreement between BOEM (formerly MMS) and NMML. Contracts were awarded to scientists at several research institutes or schools, as well as employees at NMML. Fieldwork for the study was coordinated with the NSB, AEWC, Barrow Whaling Captains Association (BWCA), Alaska Department of Fish & Game (ADF&G), and BOEM. The objective of this program was to investigate summer oceanography and prey densities relative to bowhead whale distribution near Barrow. Aerial and vessel-based surveys were conducted, along with acoustic monitoring and oceanographic and zooplankton sampling. This five-year project concluded its final year in 2011 (Sheldon and Mocklin 2012).

1.4.5 2010–2012 Chukchi Acoustic Oceanographic and Zooplankton Study

In 2010, BOEM and NMML entered into an inter-agency agreement for NMML to conduct a multiyear study of the distribution and abundance of marine mammals in the CSPA and relate any variations to oceanographic conditions, prey densities, and anthropogenic activities. This program is known as the Chukchi Acoustic Oceanographic and Zooplankton (CHAOZ) study, and the marine mammal component of this project uses passive acoustic moorings to detect occurrences of marine mammals in the CSPA year-round. Additionally, marine autonomous recorders are being used to characterize the inter-annual ambient sound conditions in the region (Guerra, et al. 2013). The CHAOZ program is currently ongoing (Berchok, et al. 2012).

1.4.6 2006–2012 Alaska Department of Fish & Game Satellite Tagging of Bowhead Whales

From 2006 forward, the ADF&G has used satellite tags on bowhead whales to analyze the stock's structure, migration patterns, feeding and diving behavior, and interaction with development activities. The tagging data indicates that Barrow and a large portion of the Russian Chukchi Sea coastline are important areas for bowhead whales. One bowhead whale came within 5.7 mi (9.1 km) of an active seismic survey, and then deflected away from the sound source. This was outside the monitoring radius for bowhead whales, so mitigation measures were not needed (ADF&G 2009).

1.4.7 2008–2012 Chukchi Sea Environmental Studies Program

The Chukchi Sea Environmental Studies Program (CSESP) was conducted from 2008–2012 and was sponsored by ConocoPhillips, Shell, and Statoil. It may continue in 2013 and beyond, dependent on funding from Chukchi Sea oil and gas operators. This is a multidisciplinary study of the Chukchi Sea marine ecosystem focusing on physical oceanography, chemical oceanography, plankton ecology, benthic ecology, seabird ecology, marine mammal ecology, fish ecology, and the hydro-acoustic environment (CSESP 2012).

The CSESP acoustic monitoring program uses autonomous moored acoustic buoys to measure underwater ambient sounds and industrial sound levels. Additionally, it detects and classifies marine mammal vocalizations in the area. Some acoustic recorders are deployed only in the summer months, while others record throughout the winter (CSESP 2012).

The CSESP marine mammal ecology studies are used to increase the understanding of marine mammal abundance and distribution in the Chukchi Sea. In this vessel-based survey, observers record all marine mammals sighted along transect lines, in addition to their behavior, distance, and movement relative to the vessel. These data are combined with the acoustic detections, physical oceanography, and benthic ecology to better understand the relationship between Chukchi Sea marine mammals and their environment (CSESP 2012). Reports from each year of the CSESP are available online at www.chukchiscience.com.

1.4.8 2012–2016 Hanna Shoal Ecosystem Study

Beginning in 2012, BOEM is funding a four-year project to study the Hanna Shoal region in the Chukchi Sea. Objectives are to identify and measure physical and biological processes that contribute to high concentrations of marine life in the area. The investigation team consists of researchers from several universities across the US. Study efforts will include documenting physical and oceanographic features, ice conditions, and information concerning local species. Fieldwork will be conducted each summer from 2012–2016 (BOEM 2012a).

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2.0 Regulatory Framework

2.1 US Regulatory Framework

The statutory and regulatory framework for oil and natural gas exploration activities, including seismic surveys in federal waters, includes multiple statutes, regulations, policies, presidential executive orders, and guidance documents. Relevant federal laws governing environmental and natural resource protection for Chukchi Sea OCS oil and natural gas seismic exploration activity include:

- Outer Continental Shelf Lands Act of 1953 (OCSLA)
- NEPA
- MMPA
- ESA
- Executive Order (EO) 12898, 1994, Environmental Justice (EJ)

Maritime-related requirements include the MARPOL, which is applicable to both US and international waters and discussed in Section 2.4.

2.1.1 Outer Continental Shelf Lands Act of 1953

The OCSLA established federal jurisdiction over the OCS and granted authority to the Secretary of the Interior to manage OCS resources. The BOEM authorizes oil and gas exploration activities, including seismic surveys, in federal OCS waters. Chukchi Sea Lease Sale 193, which encompasses a portion of the TGS project area within federal waters, was conducted in February 2008 under the MMS OCS Oil and Gas Five Year Leasing Program: 2007–2012. The MMS, now replaced by BOEM, prepared a Final EIS and Record of Decision for Lease Sale 193 (MMS 2007).

2.1.2 National Environmental Policy Act

NEPA requires federal agencies consider potential impacts to the environment that may be caused by their proposed actions, provide any reasonable alternatives to the proposed action, and provide a process for implementing these goals. There are three levels of analysis, depending on whether or not proposed activities could significantly affect the environment: (1) Categorical Exclusion for activities that have been determined to have no significant impact, (2) EA/FONSI for analysis and determination that the project has no significant impact, or (3) an EIS if there is significant environmental impact.

Agencies are encouraged to tier NEPA documents to eliminate repetitive discussions of the same issues and focus on the decisions that are made at each level of environmental review. For example, if a broad EIS has been prepared for a major federally permitted action (e.g., a programmatic EIS for a lease sale), the subsequent NEPA document (EA or EIS) can summarize the issues discussed in the broad environmental document and must discuss in detail only those issues specific to the proposed action (e.g., specifics of a drilling program). A programmatic EIS was developed for Lease Sale 193 that covers the area in the US waters of the Chukchi Sea where TGS plans to collect seismic data (MMS 2007; BOEMRE 2011). It is expected that BOEM will use the Lease Sale 193 Programmatic EIS NEPA analysis in its review of TGS's proposed activities.

2.1.3 Marine Mammal Protection Act

The intent of MMPA is to protect all marine mammals, including many species that the federal government considers threatened or endangered, and identifies mitigation measures necessary to protect the species and/or their critical habitat. The MMPA established federal authority to conserve marine mammals (preempting all state laws related to taking of marine mammals) and imposed a moratorium on the taking and importation of marine mammals and marine mammal products. The MMPA requires that incidental "take" levels of marine mammals be reduced to insignificant levels of injury and mortality approaching zero. Authorization can be provided for incidental or intentional takes under the MMPA, as long as the take levels are determined to have a negligible impact on the species or stock and will not have an immitigable adverse impact on the availability of the species or stock for subsistence use. TGS requires an IHA from NMFS and an LOA from USFWS for its proposed activity in international waters pursuant to the MMPA Section 102 and Title 50, Code of Federal Regulations, Part 216 (50 CFR 216), Definitions. The MMPA provides two mechanisms for authorization of takes:

- Section 101(a)(5)(A) of the MMPA authorizes an agency to allow the incidental, unintentional take of small numbers of marine mammals within a specified geographic region for specified activities for up to five years under an Incidental Take Regulation (ITR). If an ITR is in place, the authorized agency can then allow specific activities that result in takes under a LOA.
- Section 101(a)(5)(D) of the MMPA authorizes an agency to allow the incidental, unintentional take of small numbers of marine mammals within a specified geographic region for specified activities for up to one year under an IHA.

The effective difference between a LOA and an IHA is the information provided by the applicant and the amount of time necessary for agency review. The LOA is supported by an ITR; therefore, an LOA application does not require inclusion of calculated take estimates. An IHA application not only requires this information, but also must undergo an intensive review.

The USFWS developed an ITR for the polar bear and Pacific walrus for oil and gas industry activities in the Chukchi Sea under Section 101(a)(5)(A) of the MMPA (i.e., the five-year rule). The USFWS issued the final ITR for the Chukchi Sea in June 2008. This rule is in effect until June 11, 2013. In January 2012, the Alaska Oil and Gas Association submitted a petition to the USFWS for new ITRs for Oil and Gas Activities in the Chukchi Sea and Adjacent Lands in 2013–2018. The new ITRs were published in the Federal Register on January 9, 2013 (78 FR 1941 2013).

To date, the NMFS has authorized takes under IHAs and has not used the ITR/LOA approach for oil- and gas-related activities on the Chukchi Sea.

2.1.4 Endangered Species Act

The ESA established federal responsibility to conserve animal and plant populations that are in jeopardy, and provides a process by which these populations can be listed as threatened or endangered in order to protect the species or its critical habitat. An endangered species is defined as an animal or plant species that is in danger of extinction throughout all or a significant part of its range; a threatened species is an animal or plant species that is likely to become endangered within the foreseeable future throughout all or a significant portion of its range. The ESA also requires a designation of critical habitat for the listed species. During the past few years, several species in the Alaska Arctic have been listed as either threatened or endangered, or are under pending listing decisions from USFWS or NMFS (e.g., Pacific walrus).

ESA Section 7 prohibits any federal action that is likely to jeopardize a listed species or adversely modify designated critical habitat. For ESA species that are also marine mammals, Section 7 Consultation is performed as part of the MMPA permitting process. The ESA allows up to 135 days for the consultation to occur, which may affect the timing of permit issuance.

2.1.5 Executive Order 12898, Environmental Justice

EO 12898 was issued on February 11, 1994, and required or obligated federal actions to address EJ in minority populations and low-income populations. In addition, it directs federal agencies, including BOEM, Bureau of Safety and Environmental Enforcement, NMFS, and USFWS, to the extent practicable and permitted by law, to identify and address, as appropriate, disproportionately high and adverse human health or environmental effects of regulatory programs, policies, and activities on minority populations or low-income populations (EO 12898 §1-101). Each federal agency shall conduct its programs, policies, and activities that substantially affect human health or the environment in a manner that ensures that such programs, policies, and activities do not have the effect of excluding persons from participation in or subjecting persons to discrimination under such programs, policies, and activities (EO 12898 §2-2). In addition, each federal agency shall work to ensure that public documents, notices, and hearings related to human health or the environment are concise, understandable, and readily accessible to the public (EO 12898 §5-5).

2.2 Other US Regulatory Programs

2.2.1 Clean Air Act

The Clean Air Act (CAA), amended 1990, governs oil and natural gas drilling exploration activity but does not apply to seismic exploration activity with the exception of Title II. Title II of the CAA governs emission standards for mobile sources, including non-road engines and vessels. In 2003, the US Environmental Protection Agency (EPA) promulgated emission standards for non-road engines on US-flagged vessels (EPA 2012).

2.2.2 Clean Water Act

The Federal Water Pollution Control Act, commonly referred to as the Clean Water Act (CWA), has several programs that are applicable to proposed activities in offshore waters, including the OCS. Most of the CWA programs are administered by the EPA or individual states.

The Chukchi Sea General Permit applies to drilling exploration activity but does not apply to seismic exploration activity such as proposed by TGS. However, the Vessel General Permit (VGP) will apply to TGS seismic surveys.

In February 2009, EPA finalized the VGP for Alaska waters. The VGP is generally applicable for all vessels greater than 79 ft (24.08 m) in length or vessels that discharge ballast water on inland US waters and waters within 3 nautical miles (nm) (6 km) of the shoreline. Applicants of General Permits are required to submit a Notice of Intent to the EPA before receiving coverage under the General Permit. The current VGP is in effect until December 18, 2013. After December 18, the VGP will be renewed, and an additional Small Vessel General Permit (sVGP) will go into effect. The sVGP will apply to non-recreational vessels less than 79 ft (24.08 m) in length. However, this will not affect TGS because the scoped survey activities are anticipated to be complete by the end of October 2013.

2.3 Permits

Because the proposed activities will be conducted in federal and international waters (i.e., outside State of Alaska jurisdiction), only federally issued permits are required. Permits and authorizations must be obtained before beginning work on the proposed project. The applicable federal permits and associated documents are provided in Table 2-3-1.

Table 2.3-1. Federal Permits and Authorizations Required for Proposed Survey Activity

Agency	Permit	Application and Supporting Documents
Bureau of Ocean Energy Management	G&G Exploration Permit	G&G Permit Application (Forms BOEM 0328 and BOEM 0327)
		Plan of Operations
		Environmental Evaluation Document
National Marine Fisheries Service	IHA	IHA application
		Marine Mammal Monitoring and Mitigation Plan
		Plan of Cooperation
US Fish and Wildlife Service	LOA	LOA
		Bear and Walrus Avoidance and Bear–Human Encounter/Interaction Plan
		Marine Mammal Monitoring and Mitigation Plan
		Plan of Cooperation

BOEM = Bureau of Ocean Energy Management
G&G = Geological and Geophysical
IHA = Incidental Harassment Authorization (for whales and seals)
LOA = Letter of Authorization (for polar bears and Pacific walruses)

2.3.1 Geological and Geophysical Exploration Permit

A G&G Exploration permit is required from BOEM, pursuant to 30 CFR 551.4, for TGS to conduct geological or geophysical exploration for mineral resources. The G&G Exploration permit allows seismic surveys to be conducted in accordance with appropriate statutes, regulations, and stipulations for a specified length of time and in a specified area.

To support their permit applications and required NEPA analysis, TGS has prepared this EED, which provides analysis similar to what is required by NEPA and will include the EED with application submittal to the federal agencies.

2.3.2 Incidental Harassment Authorization

NMFS issues IHAs pursuant to Section 101 (a)(5)(D) of the MMPA and the requirements of 50 CFR 216, Subpart I —*General Regulations Governing Small Takes of Marine Mammals Incidental to Specified Activities*. A take is defined under the MMPA as to “harass, hunt, capture, kill or collect or attempt to harass, hunt, capture, kill or collect.” TGS will submit an IHA to allow non-lethal “take” by harassment of small numbers of whales and seals incidental to 2D seismic exploration activities proposed during the 2013 open-water period in Alaska and international waters of the Chukchi Sea.

NMFS has asserted TGS requires an IHA for its proposed activity in international waters pursuant to the MMPA Section 102 and 50 CFR 216 Definitions (Nachman 2012).

An IHA application typically takes several months to prepare because of the need to calculate take estimates from the proposed activities and species densities. Once filed, the IHA application review process takes between 180 and 272 days to complete and includes a Peer Review Panel and public discussion at the annual Open Water Meeting (typically held in Anchorage, Alaska, in March). The draft permit is published in the Federal Register and is open to public comments before issuance of the final permit.

2.3.3 Letter of Authorization

The USFWS issues the LOA for the incidental take of polar bears and Pacific walruses and intentional take of polar bears by harassment. The LOA is issued in accordance with incidental, unintentional take requirements under 50 CFR 18, Subpart J – *Nonlethal Taking of Marine Mammals Incidental to Oil and Gas Exploration, Development, and Production Activities in the Beaufort Sea and Adjacent Northern Coast of Alaska*. Because LOAs are issued under ITRs, the time necessary to obtain an LOA upon submittal of the application is much less than required by an IHA. In addition, it is not necessary to include calculations of take estimates in an LOA application.

2.4 International Environmental Treaties and Agreements

The US adheres to numerous international environmental treaties and agreements. These agreements are designed to limit pollution by limiting or prohibiting certain discharges, as well as implementing specific ship design criteria and cargo stowage criteria. In addition, the US is a participant to international treaties and commissions to protect certain threatened marine mammal species such as polar bears and whales by limiting hunting and/or subsistence activities. The following sections summarize the applicable treaties and agreements in relation to TGS seismic activities.

2.4.1 International Convention for the Prevention of Pollution from Ships (MARPOL)

MARPOL 73/78 is the principal international legislation governing pollution of the marine environment by ships from operational or accidental causes. MARPOL 73/78 is the combination of two treaties adopted in 1973 and 1978 and has been updated by amendments during the past 30 years. The MARPOL 73/78 consists of six technical annexes:

- Annex I: Regulations for the Prevention of Pollution by Oil
- Annex II: Regulations for the Control of Pollution by Noxious Liquid Substances in Bulk
- Annex III: Prevention of Pollution by Harmful Substances Carried by Sea in Packaged Form
- Annex IV: Prevention of Pollution by Sewage from Ships
- Annex V: Prevention of Pollution by Garbage from Ships
- Annex VI: Prevention of Air Pollution from Ships

2.4.2 International Convention for the Control and Management of Ships' Ballast Water and Sediments

The IMO adopted the International Convention for the Control and Management of Ships' Ballast Water and Sediments in February 2004. This convention includes technical standards and requirements for the control and management of ships' ballast water and sediments. The purpose of the convention is to minimize and ultimately eliminate the transfer of harmful aquatic organisms and pathogens through the control and management of ships' ballast water and sediments. The convention required ports and terminals to have ballast management standards to remove ballast water and sediments safely. For vessels, the convention requires ships to have a Ballast Water Record Book to record when ballast water is taken on board, circulated or treated, discharged into the sea or at a reception facility, and accidental or exceptional discharges.

2.4.3 International Convention on the Control of Harmful Anti-fouling Systems on Ships

In October 2001, the IMO adopted the International Convention on the Control of Harmful Anti-fouling Systems on Ships. This convention prohibited the use of harmful organotins in anti-fouling paints used on ships and established a mechanism to prevent the potential future use of other harmful substances in anti-fouling systems.

2.4.4 International Convention on Oil Pollution Preparedness, Response, and Cooperation

In November 1990, the IMO adopted additional measures to prevent oil pollution from ships. The Oil Pollution Preparedness, Response, and Cooperation (OPRC) protocol requires ships to carry aboard an oil pollution emergency plan. The OPRC also requires vessels to report incidents of pollution to coastal authorities, carry onboard equipment to combat potential oil spills, and conduct periodic training exercises for dealing with oil pollution. The OPRC furthers the actions required in Annex I of MARPOL 73/78.

2.4.5 Protocol on Preparedness, Response, and Cooperation to Pollution Incidents by Hazardous and Noxious Substances

The IMO adopted the Protocol on Preparedness, Response, and Cooperation to Pollution Incidents by Hazardous and Noxious Substances in March 2000. The protocol follows the principles of the OPRC to pollution incidents by hazardous and noxious substances (HNS). The IMO, for purposes of the HNS protocol, defined any substance other than oil that, if introduced into the marine environment, is likely to create hazards to human health, to harm living resources and marine life, to damage amenities, or to interfere with other legitimate uses of the sea. Vessels are required to carry a shipboard pollution emergency plan to deal with HNS incidents. The HNS protocol ensures that ships carrying HNS are covered by preparedness and response regimes similar to those for oil pollution.

2.4.6 World-wide Navigational Warning System Expanded to Arctic

In March 2011, the IMO and World Meteorological Organization (WMO) announced that the World-wide Navigational Warning System had been expanded into Arctic waters. This expansion will allow vessels transiting the Arctic to receive information about five new navigational areas (NAVAREAS) and meteorological areas (METAREAS) as delineated by the IMO and WMO. These five NAVAREAS and

METAREAS are specific to the Arctic region and are considered essential to enhancing safety of navigation and protection of the marine environment.

2.4.7 Agreement of Conservation of Polar Bears (1973)

The US is one of five countries (Canada, Denmark, Norway, Russia, and the US) party to the 1973 treaty for the conservation of polar bears. The Agreement is implemented in the US by the MMPA. The Agreement prohibits the taking (hunting, killing, capturing) of polar bears, except in limited circumstances. The Agreement calls for appropriate action to protect the ecosystem of which polar bears are a part, with special attention to habitat components such as denning, feeding, and migration areas, and management under sound conservation practices based on best available scientific data. The Agreement also imposes trade restrictions and promotes cooperative international research.

2.4.8 Agreement between the Government of the United States and the Government of the Russian Federation on the Conservation and Management of the Alaska–Chukotka Polar Bear Population (2005)

The US and Russia are parties to the 2005 treaty that specifically concerns the Chukchi Sea polar bear population stock. Implemented under a 2007 amendment to the MMPA, the Agreement limits consumptive use to Native people, provides for establishing annual take levels, calls for joint scientific research efforts, and adopts habitat and other goals from the 1973 Agreement.

2.4.9 International Whaling Commission and Alaska Eskimo Whaling Commission

The International Whaling Commission (IWC) was established in 1946 as the global body in charge of the conservation of whales and the management of whaling under the International Convention for the Regulation of Whaling. In 1982 the IWC adopted a moratorium on commercial whaling. The AEWC was formed to represent Alaska's whaling communities at the IWC and to protect subsistence bowhead whaling.

2.5 Marine Mammal Co-management Groups in Alaska

A 1994 amendment to the MMPA included provisions that allowed cooperative agreements to be developed between agencies and Alaska Native organizations. There are five Alaska Native marine mammal co-management groups:

- AEWC
- Ice Seal Committee
- Alaska Nanuuq Commission
- Eskimo Walrus Commission
- Alaska Beluga Whale Committee

These co-management groups regularly hold meetings with federal agencies (USFWS and NMFS) to discuss expectations of co-management. Thus, USFWS and NMFS require that each operator applying for the incidental take of marine mammals submit a POC. The POC summarizes the actions TGS has taken to describe important subsistence activities near the proposed survey program, methods they have taken to inform subsistence communities of the proposed survey activities, and measures they will take to minimize adverse effects on marine mammals where proposed activities may affect the availability of a species or stock of marine mammals for Arctic subsistence uses or near a traditional subsistence hunting area.

At a minimum, the POC must include the following:

- A statement that the applicant has provided the affected communities with a Draft POC
- A schedule for meeting with the affected subsistence communities to discuss proposed activities and resolve potential conflicts related to proposed operations
- A description of the measures the applicant has taken, or will take, to ensure that the proposed activities will not interfere with subsistence hunting
- A plan to continue to meet with the affected subsistence communities, both before and during operations, to resolve conflicts and notify communities of operational changes.

The Conflict Avoidance Agreement is a third-party agreement between the AEWC and industry participants and contains procedures for communication between subsistence and industry participants, conflict avoidance guidelines and other mitigation measures that are to be followed by oil and gas operators, measures to be taken in the event of an emergency, and dispute resolution procedures.

The AEWC holds several meetings throughout the year to discuss present and future Conflict Avoidance Agreements, and generally sends out final Conflict Avoidance Agreements for signature in March.

3.0 Overview of Ecosystems of Northeastern Chukchi Sea

TGS proposes to conduct a 2D seismic exploratory survey during the 2013 open-water season in the northern and northeastern Chukchi Sea (Figure 1.2-1). Two vessels will be used to conduct the survey. One vessel will tow the acoustic receiver cable and airgun source array, and the other vessel will carry PSOs to monitor and document marine mammal presence/activities behavior. The source array consists of four sub-arrays discharging 3,280 in^3 (53,750 cm^3) of compressed air. The survey area is vast, encompassing at least two distinct ecosystems according to the CSESP.

The CSESP is an integrated ecosystem-based environmental studies program developed by three energy companies. The program incorporates science marine research from disciplines including:

- Acoustic Monitoring
- Benthic Communities
- Chemical Oceanography
- Fisheries
- Marine Mammal Ecology
- Physical Oceanography
- Seabird Ecology
- Planktonic Communities.

The CSESP studies were started in 2008. Initial results by discipline are presented in final reports by year on the CSESP web site located at: http://www.chukchiscience.com/StudytheScience/Benthic/tabid/217/Default.aspx. Results of studies through 2011 are expected to be published in a series of scientific papers and available in a special issue of *Continental Shelf Research*.

The CSESP indicates that the TGS proposed seismic survey covers two distinct oceanographic water masses as described by Weingartner, et al. (2005, 2011). These are the Alaska Coastal Water mass near the relatively shallow coastline and the Bering Shelf Water mass farther offshore. Descriptions of the water masses and their characteristics are shown in Table 3.0-1.

Table 3.0-1. Characteristics of Chukchi Sea Water Masses

Water Mass	Water Characteristics
Alaska Coastal Water	Warm, low salinity (less than 32.2 ppt), Bering Sea origin flowing in nearshore shallows northward and eastward along the Alaska coast
Bering Shelf Water (offshore)	Winter Water (WW) – Cold, high salinity, created by extrusion of fresh water as ocean water freezes Bering Sea Water – relatively warm, moderately saline, flows northward during open-water season Meltwater – Cold, low salinity, near surface created as ocean water thaws during open-water season

ppt = parts per thousand
WW = winter water

These water mass differences and spatial extents characterize the unique species assemblages across the northeastern Chukchi Sea (Weingartner, et al., 2011). The water masses and their physical and chemical characteristics show differences in productivity and organism abundance (Weingartner, et al. 2011; Walsh, al. 1989; Priest, et al. 2011). The zooplankton community exhibits considerable spatial, seasonal, and inter-annual variability (Questel, et al. 2012). The benthic community also shows spatial variability based on associated environmental gradients (Blanchard, et al. 2011). The sediment type (e.g., sand, fine mud) deposited relates to the stronger or weaker currents in an area and influences the benthic community assemblage.

Demersal fish and seabird communities were variable inter-annually and appear to closely follow the areal extent of water masses in this region (Gallaway and Norcross 2011; Gall, et al. 2012; Priest, et al. 2011). For fish communities, salinity, depth, and percentage of sand in the substrate influences the assemblage structure (Priest, et al. 2011). Therefore, variability occurs in the distribution of benthic- and pelagic-feeding marine mammals in the northeastern Chukchi Sea (Aerts, et al. 2011).

On the basis of the CSESP studies, there is considerable variability in the Chukchi Sea biological resources with respect to location. The Chukchi Sea water masses and circulation patterns appear to influence the distribution and species of organisms found throughout the study area. Because the proposed seismic survey crosses large expanses with variable water depths and water masses, the ability to measure the effects of the seismic survey would be difficult. TGS will integrate mitigation measures as defined by agency LOA and IHA to minimize effects of the seismic survey.

4.0 Physical Environment

This section describes the physical environment in the TGS 2013 2D project area. The survey is in the Chukchi Sea between 70-77°N latitude and 154–165°W longitude. With the exception of the acoustic environment, the TGS project will have a negligible effect on the physical environment. The project is scheduled to occur between July 15 and October 31, 2013, but the physical environment, particularly the presence of sea ice, will have a large effect on the operations timeline and success.

4.1 Meteorology and Air Quality

The Chukchi Sea is located in the Arctic Climatic Zone and is characterized by freezing temperatures for most of the year and sustained winds and low precipitations. The area is subject to intense winds because of the absence of natural wind barriers. Cloudy skies, fog, and light rain are the most common weather conditions during the summer.

4.1.1 Air Temperature

The project area is characterized by subfreezing temperatures for most of the year. The Chukchi Sea is covered by ice from early December until mid-May. Winter mean air temperatures range from 0 to -22 degrees Fahrenheit (°F) (-17.7 to -30 degrees Celsius [°C]). Summer mean air temperatures range from 35 to 42 °F (1.6 to 5.5 °C) with highs in the mid-70s (MMS 2007). Table 4.1.1-1 shows the mean air temperature, mean maximum air temperature, and mean minimum air temperature for Barrow.

Table 4.1.1-1. Barrow Mean, Maximum, and Minimum Temperatures (°F) (1971–2000)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec	Annual
Mean Temp	-13.7	-15.9	-13.7	-0.5	20.1	35.0	40.4	38.7	31.2	14.6	-0.9	-10.6	10.4
Mean Maximum Temp	-7.7	-9.8	-7.4	6.3	24.9	39.5	46.5	43.6	34.8	19.3	4.6	-4.7	15.8
Mean Minimum Temp	-19.6	-22.0	-20.0	-7.3	15.3	30.4	34.3	33.8	27.5	9.8	-6.4	-16.4	5.0

Source: Alaska Climate Research Center 2012
°F = degrees Fahrenheit

4.1.2 Wind

The project area is characterized by moderate winds for the majority of the year. Wind speeds greater than 22 miles per hour (mph) (10 meters per second [m/s]) are rare and tend to occur from October to March. During July and August, the Chukchi Sea exhibits a complex wind direction regime, with alternating north and south winds. The average wind speeds range from 16 to 20 mph (7 to 9 m/s) and gales (39-46 mph [17.4–20.6 m/s]) occur about 2 percent of the time. In September, north winds become more frequent, signaling the return of winter.

The surface winds along the coast, between Point Lay and Barrow, range from 9 to 18 mph (4 to 8 m/s) and commonly blow from the east and northeast (MMS 2007). Gales are infrequent and unlikely in March through August (US Department of Commerce 2012). Table 4.1.2-1 shows the mean wind speed and Table 4.1.2-2 shows the prevailing wind direction for Barrow and Wainwright. Table 4.1.2-3 shows average wind direction in coastal areas off Barrow and Cape Lisburne.

Table 4.1.2-1. Barrow and Wainwright Mean Wind Speed (mph) (1996–2002)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec	Annual
Mean wind speed–Barrow	12.5	13.1	12.7	12.9	12.0	11.4	12.7	13.3	12.2	13.4	14.1	13.0	12.8
Mean wind Speed–Wainwright	10.2	11.4	12.2	12.6	11.3	11.0	11.8	12.6	11.0	12.2	11.4	10.0	11.5

Source: Alaska Climate Research Center 2012
mph = miles per hour

Table 4.1.2-2. Barrow and Wainwright Prevailing Wind Direction (1996–2002)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec	Annual
Prevailing Wind Direction–Barrow	ENE	E	E	E	E	E	E	E	E	E	E	ENE	E
Prevailing wind direction–Wainwright	E	E	E	E	E	E	W	E	E	E	E	E	E

Source: Alaska Climate Research Center 2012
E = east
ENE = east northeast
W = west

Table 4.1.2-3. Average Wind Directions in the Coastal Areas off Barrow and Wainwright

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec	Annual
Coastal area off Barrow	W	N	NE	E	E	N	E	E	E	NE	E	E	E
Coastal area off Wainwright	SE	N	W	W	N	SE	SE	N	NW	N	NE	N	NW

Source: US Department of Commerce 2012
E = east
N =north
NE = northeast
NW = northwest
SE = southeast

Waves in the Chukchi Sea are commonly less than 6.6 ft (2 m) in height. Development of waves in the Chukchi Sea depends on wind speed and direction, on presence of ice, and on the sea depth. Strong winds are relatively rare at the beginning of the summer, and sea areas clear of ice are small, which prevents wave development. Waves of maximum magnitude develop in September and October. Greater wave heights associated with lower air temperatures can increase the potential for sea spray icing. In November, the Chukchi Sea is almost completely ice-covered and waves are small.

Table 4.1.2-4 shows the percentage of time wind speeds are evaluated as being greater than 33 knots and wave heights observed to be greater than 9 ft (2.7 m) in the coastal area off Barrow.

Table 4.1.2-4. Wind Speed and Wave Height Percentage Frequency in the Coastal Areas off Barrow

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec	Annual
Wind speed > 33 knots	0.8	0.0	0.0	2.9	0.4	0.5	0.5	0.5	1.2	1.8	3.5	1.7	1.0
Wave height > 9 feet (2.7 m)	0.0	0.0	0.8	2.6	0.0	0.0	0.6	0.3	1.9	0.8	7.1	0.0	1.0

Source: US Department of Commerce 2012
> = greater than
< = less than

The general air circulation is dominated by a regime of high pressure located over the Beaufort Sea. Low-pressure systems with southeasterly winds occasionally move northeasterly through the Bering and Chukchi seas into the Arctic Basin, bringing warm air and moisture into the region. During the summer months, rain and fog conditions are frequent and can decrease visibility to less than 0.6 mi (1 km). From June through August, periods of low visibility range from 25 percent to 30 percent in the open sea, decreasing to 10 percent along the mainland coast. Table 4.1.2-5 shows the number of days with fog and reduced visibility in the coastal areas off Barrow.

Table 4.1.2-5. Numbers of Days with Fog and Reduced Visibility in the Coastal Areas off Barrow

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec	Annual
Number of days with fog	14	14	13	14	20	22	23	24	20	17	15	14	210
Visibility < 2 nautical miles	16.7	12.6	7.6	12.2	9.4	18.5	29.1	21.7	19.5	17.1	9.7	10.0	21.4

Source: US Department of Commerce 2012
< = less than

The region is characterized by small amounts of precipitation, with annual accumulations ranging from 5 to 15 in (12.7 to 38.1 cm). While the amounts are small, some form of measurable precipitation falls on 200 to 300 days every year. July, August, and September receive the heaviest amounts of precipitation averaging 2 to 4 inches (5 to 10.1 centimeters) monthly. Snow can fall each month of the year, but is more frequent in the October to May period (US Department of Commerce 2012). Table 4.1.2-6 shows the precipitations in the Barrow area.

Table 4.1.2-6. Barrow Precipitations

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec	Annual
Mean precipitation	0.12	0.12	0.09	0.12	0.12	0.32	0.87	1.04	0.69	0.39	0.16	0.12	4.16
Days with precipitations >0.01 inch (0.25 mm)	5	4	4	4	5	6	9	12	13	12	6	5	85
Days with precipitations >0.1 inch	0	0	0	0	0	1	3	4	2	1	0	0	11
Mean snowfall	2	1.9	1.7	2.1	1.7	0.8	0.2	0.9	5	7.4	3.2	2.2	29.1

Source: Alaska Climate Research Center 2012
> = greater than

4.1.3 Storms

Storms are meteorological conditions characterized by wind speeds greater than 33.5 mph (15 m/s). Six to 10 stormy days are recorded in the Chukchi Sea every month. Those storms range in duration from 6 to 24 hours, 70 to 90 percent of the time, but stormy weather can last up to 14 days.

4.1.4 Air Quality

The EPA established National Ambient Air Quality Standards (NAAQS) for six "criteria pollutants" to provide protection from adverse effects on human public health and public welfare. The six criteria pollutants are: carbon monoxide, nitrogen oxides (NO_x), particulate matter, sulfur dioxide, ozone, and lead.

The onshore area adjacent to the Chukchi Sea is the Northern Alaska Intrastate Air Quality Control Region 9. The EPA has designated this region as Class II and in attainment or unclassifiable for all criteria air pollutants.

The existing air quality in the project area is considered to be good because of the lack of pollutant emission sources. Concentrations of regulated air pollutants are much lower in the area than the maximum allowed by the NAAQS. Emissions in the area come primarily from electrical power-generating facilities in small villages such as Barrow, Wainwright, Point Lay, and Point Hope. Small amounts of pollutants are also emitted from vehicles and construction equipment. Industrial sources exist within the oil fields near Prudhoe Bay located to the east of the project area (MMS 2007).

4.2 Physical Oceanography

The proposed TGS project is located in the Chukchi Sea Large Marine Ecosystem (LME). LMEs are areas of oceans characterized by distinct bathymetry, hydrography, productivity, and trophic interactions. The Chukchi Sea LME is one of the 17 Arctic LMEs and is situated off Russia's east Siberian coast and the northwestern coast of Alaska. The Chukchi Sea LME is a shallow marginal sea with a surface of 299,863 square miles (mi^2) (776,643 square kilometers [km^2]) and an extensive continental shelf (Belkin and Heileman 2012). The Chukchi Sea has an estimated surface of 229,730.8 mi^2 (595,000 km^2) and a water volume of 10,076.3 mi^3 (42,000 km^3) (Tsyban, et al. 2005). The project area is characterized by shallow water in the southern part (approximately 169 ft [50 m]) and deeper water that can reach more than 656 ft (200 m) in the northern and northeastern part.

Ocean currents move Pacific Ocean water through the Chukchi Sea, traveling from the Bering Strait to the Arctic Ocean. Three water masses move through the Bering Strait: the nutrient-rich Anadyr Current passes through the western channel of the Bering Strait and the Bering Shelf Water and the Alaska Coastal Water travel through the eastern channel of the Bering Strait. Bering Sea Water of the Chukchi Sea is formed by the mixing of the Anadyr Current and the Bering Shelf Water. An additional water mass outside of the Bering Strait, the Siberian Coastal Current, is a seasonal current that moves from north to south along the Chukotka Peninsula of Russia (MMS 2007).

The International Bathymetric Chart of the Arctic Ocean (IBCAO) provides the most comprehensive and current bathymetric data set covering the Arctic Ocean. The goal of the IBCAO initiative is to develop a digital data base that contains all available bathymetric data north of 64°N, for use by mapmakers, researchers, institutions, and others whose work requires a detailed and accurate knowledge of the depth and the shape of the Arctic seabed. The latest IBCAO compilation, Version 3.0, was introduced in 2012 and has a new grid with 0.3-mi (500-m) spacing. The area covered by multibeam surveys has increased from approximately 6 percent in Version 2.0 to approximately 11 percent in Version 3.0 (IBCAO 2012). The Chukchi Sea bathymetry is shown on Figure 1.2-1.

4.3 Sea Ice

Sea ice develops in three zones: the fast-ice zone attached to the shore, stamukhi ice which is grounded, and ridged ice and pack ice which includes first-year and multiyear ice and moves under the influence of wind and currents. The extent to which those three types of ice are present in the project area varies and is affected by bathymetry, location of offshore shoals, and meteorological conditions.

Sea ice reaches its maximum extent in March and its minimum in September. The formation and breakup patterns of sea ice present large inter-annual variability. The ice generally begins forming in late September or early October and covers the project area by early December. In some years, ice can extend south, reaching St. Paul Island in the Bering Sea.

Chukchi Sea melt-onset begins in early May in the southern portion of the project area. Warm water influx from the south rapidly erodes pack ice, usually reaching Point Barrow in late June and July. This process can be accelerated by winds and currents, and land-fast ice can clear as early as mid-May at Point Barrow. The summer ice conditions are highly variable from year to year, influencing the duration of the open-water season. There is a significant south-to-north gradation in open-water duration, from a historical average of 20 weeks or more around Cape Lisburne to less than 4 weeks (or no breakup at all) north of latitude 72°N. September is the month with the maximum open water, but ice can be present in the northern portion of the project area. The Chukchi Sea and Bering Sea annual minimum and maximum sea ice extent is shown on Figure 4.3-1. The Chukchi Sea summer months' median monthly sea-ice concentrations (July through October) from 1972 through 2007 are shown on Figure 4.3-2.

4.4 Water Quality

This section will discuss the physical makeup of the water mass of the Chukchi Sea. The most important properties of water in the Chukchi Sea include salinity, temperature, hydrocarbon concentrations, dissolved oxygen, density, organic carbon, nutrients, chlorophyll, light transmissivity, trace metal concentrations, and total suspended solids. Their levels vary throughout the year depending on seasonal activity like the formation of surface ice, phytoplankton blooms, cold-water upwelling, naturally occurring hydrocarbon seeps, and turbidity changes because of onshore runoff.

Terrestrial runoff, along with stream and riverine inputs, enter the northeast Chukchi Sea marine ecosystem and have the ability to directly alter water quality characteristics such as temperature, salinity, and turbidity (NMFS 2011). These pathways are also responsible for introducing naturally occurring metals into the Chukchi Sea. Metals from the Bering Sea can also be transported to Chukchi Sea sediments as the Bering Sea waters flow over a shallow Chukchi Sea shelf (NMFS 2011). A 2010 study conducted by Weingartner and Danielson in the Chukchi Sea from July through October of 2008, and the same dates for 2009, reported that salinity levels from measurements taken at the surface (up to 32.8 ft [10 m] depth) ranged from 28.5 to 31.5 practical salinity unit, and temperature ranged from 30.2 °F to 41 °F (-1.0 to 5.0 °C) (Weingartner and Danielson 2010). Nutrients are essential to the production of phytoplankton. Low nutrient concentrations will persist in surface waters in the spring as they are used up during large phytoplankton blooms. According to Hopcroft (2008), maximum chlorophyll concentrations typically occur below the surface at 65.6–98.4 ft (20–30 m) where an increase in nutrient concentration was also observed.

Water quality is not expected to be degraded as a result of TGS's proposed 2D marine seismic survey. Effects would be almost impossible to quantify and they would be negligible at best.

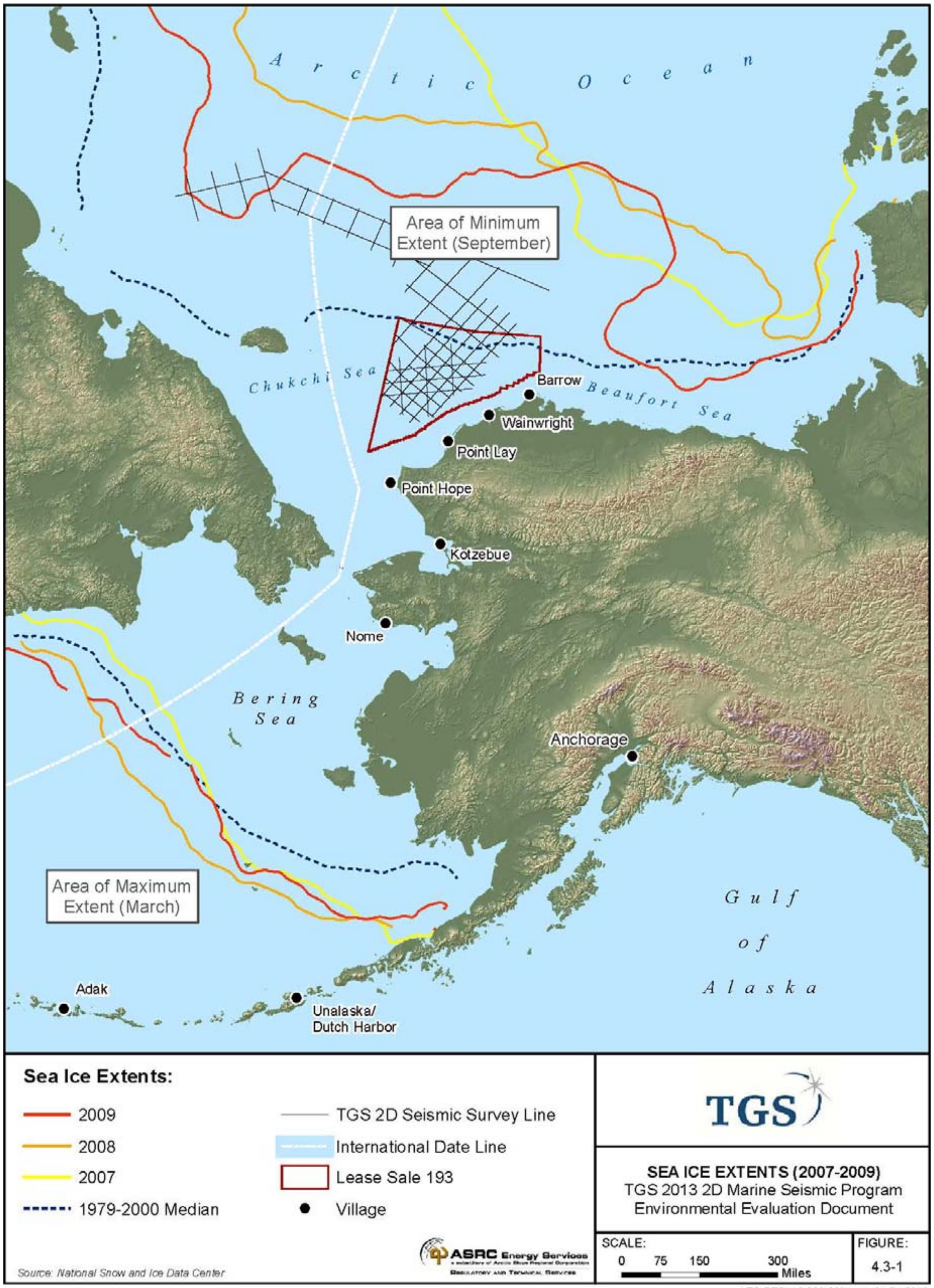

Figure 4.3-1. Sea Ice Extents (2007–2009)

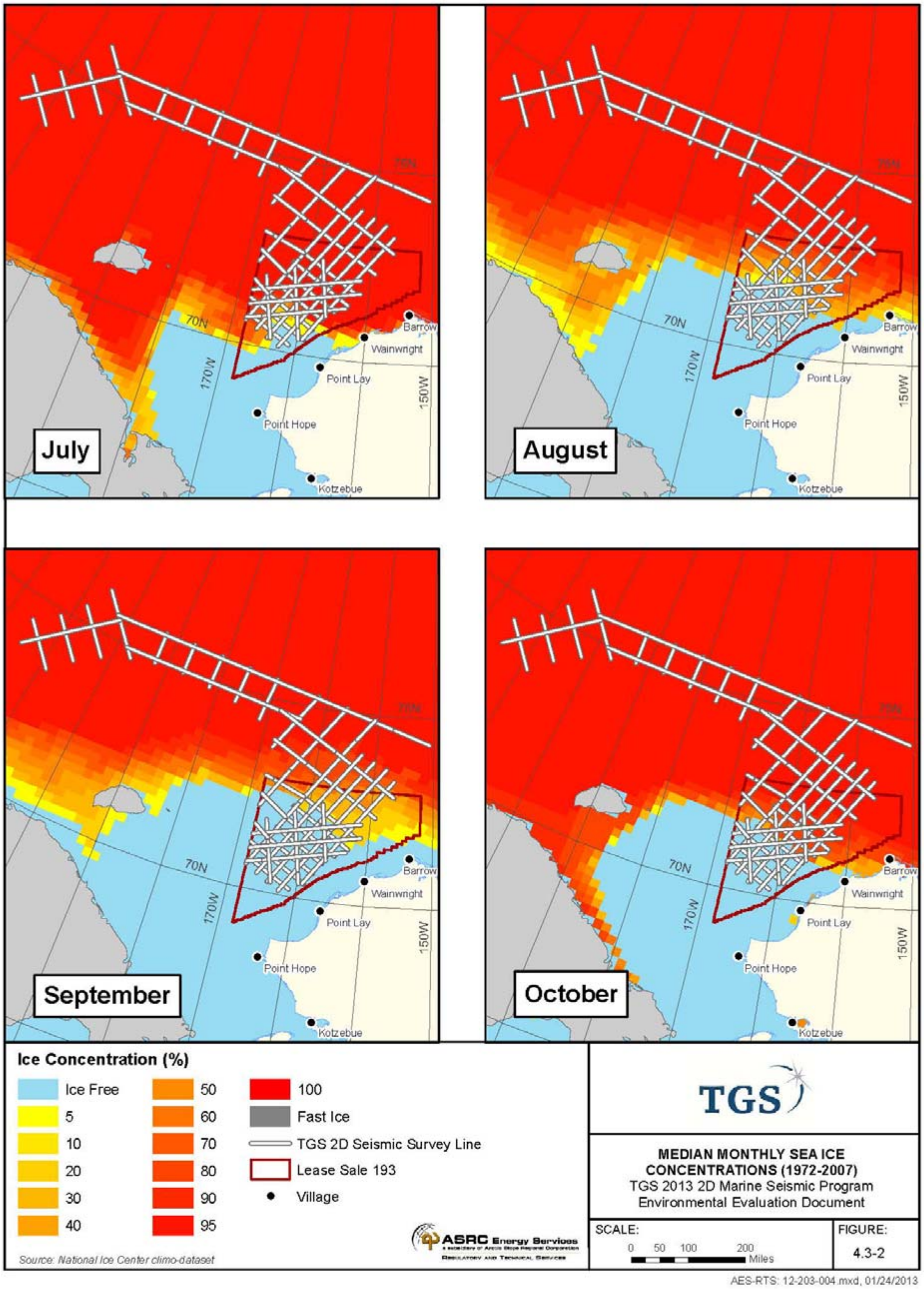

Figure 4.3-2. Median Monthly Sea Ice Concentrations (1972–2007)

4.5 Acoustic Environment

Numerous natural and anthropogenic sounds make up the acoustic environment and variable ambient sound levels that occur at any given place or time (Dol, et al. 2009; NRC 2003). Ambient sound levels in the Chukchi Sea can vary dramatically between and within seasons and are associated with the following conditions:

- Sea ice, temperature, wind, and snow depth
- Precipitation
- Subsea earthquake activity
- Vessel and industrial transit
- Sonar and seismic-survey activities
- Biological sounds.

Ambient sound levels are variable, depending on the contributions of local propagation characteristics (e.g., wind, temperature and salinity profiles, water depth, and substrate characteristics). In deep water, turbulent pressure fluctuations from surface waves and the motion of water at the air-water interfaces produce low-frequency ambient sound in the 1 to 10 Hertz (Hz) range. Sound levels at these infrasonic frequencies are only slightly affected by wind speed. Anthropogenic sound (ship transiting, etc.) dominates wind-related sounds between 20–300 Hz. Above 300 Hz, the ambient sound level depends on weather conditions, with wind- and wave-related effects mostly dominating sounds. Biological sounds arise from a variety of sources (e.g., marine mammals, fish, and shellfish) and range from approximately 12 Hz to more than 100 kilohertz (kHz) (Hannay, et al. 2009; Hannay 2012). The relative strength of biological sounds varies greatly depending on the situation. Biological sound sources can be nearly absent to dominant over narrow or even broad frequency ranges (Richardson, et al. 1995).

Research has provided typical background sound levels within the ocean, as shown in Figure 4.5-1 (Wenz 1962). The sound levels are given in underwater dB frequency bands written as dB re: 1 $\mu Pa^2/Hz$. Sea state or wind speed is the dominant factor in calculating ambient sound levels above 500 Hz.

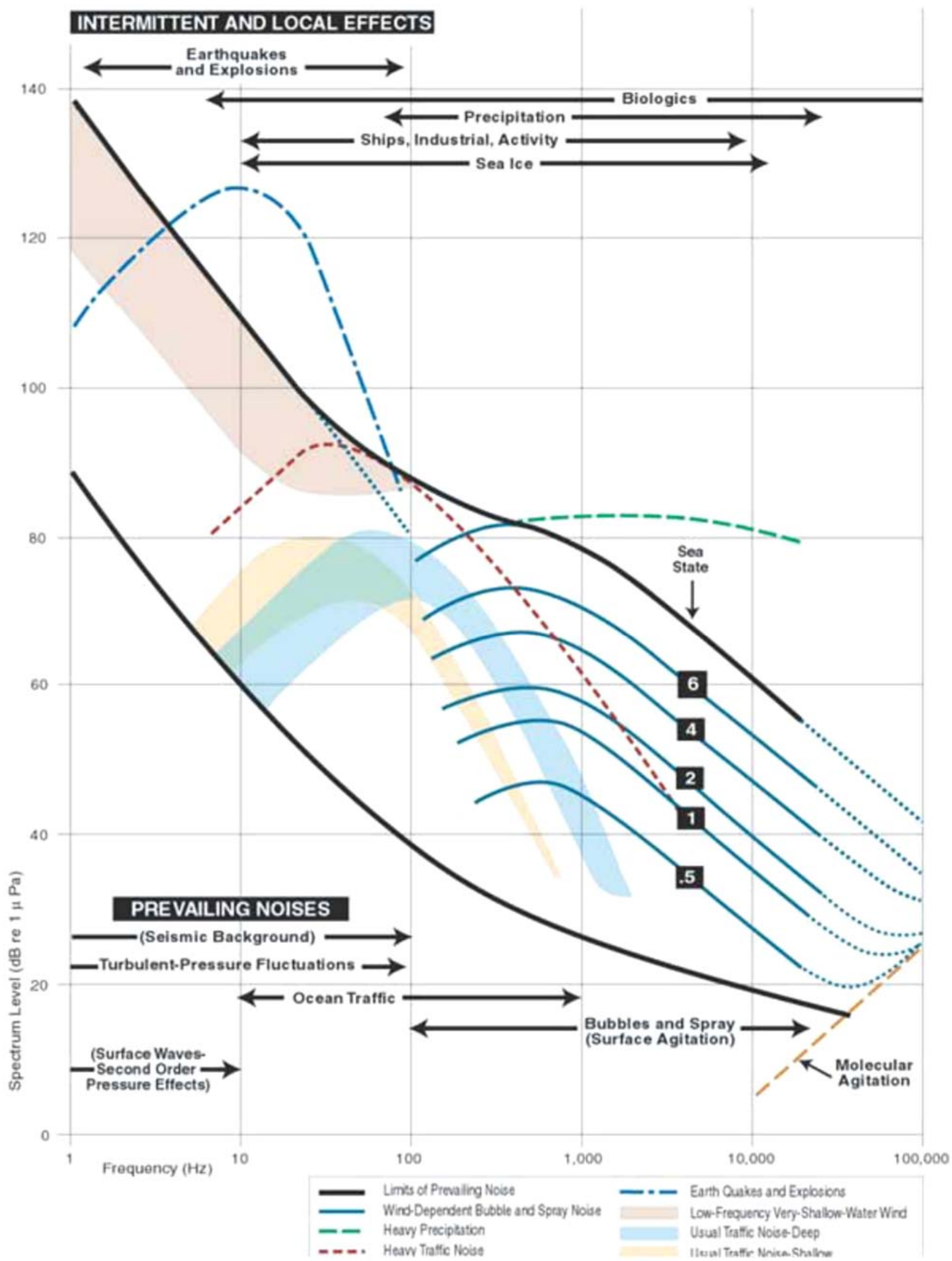

Figure 4.5-1. Background Sound Levels within the Ocean

Source: (Wenz 1962); reprinted with permission from the National Research Council (NRC). 2003. *Ocean Noise and Marine Mammals*. Washington, DC: National Academy Press.

4.5.1 Natural Ocean Sound Sources

Non-biological and biological sound sources compose the sound sources that contribute to the ambient natural sounds of the Arctic subregion. Natural, non-biological, sound sources include movements of sea ice, wind and wave action, surface precipitation, and subsea earthquakes. Biological sources of sound production are fish, marine mammals, and sea birds. Natural sounds that contribute to the overall ambient sound level have been documented for the Chukchi Sea (Brueggeman, et al. 1991; Blackwell, et al. 2010; Roth, et al. 2012; Guerra, et al. 2013).

Ambient sound level information for the Arctic Ocean was scarce before 2006 (Buck and Greene 1964). Since then, studies have been conducted in the Chukchi Sea using a large array of bottom-mounted, autonomous acoustic recorders to provide information about ambient sound levels and the contribution of natural and anthropogenic sources (Brueggeman, et al. 1991; Martin, et al. 2009; Delarue, et al. 2012; Funk, et al. 2007, 2009; Small, et al. 2011; Roth, et al. 2012; Guerra, et al. 2013).

4.5.1.1 Non-biological Sound Sources

Wind, Waves, Sea Ice, Precipitation, and Subsea Earthquake

Wind and wave actions are important sources of ambient sound during the open water season with sound levels increasing as winds and waves increase (Richardson, et al. 1995; Roth, et al. 2012). Ice deformation caused by wind and waves usually produces low-frequency sounds. Ice deformation has been shown to produce frequencies of 4–200 Hz (Greene 1981). Additionally, sea ice contributes to the ambient sound levels according to the presence, thickness, and movement of sea ice; as ice melts and breaks apart, it produces additional background sound. Sounds of ice cracking may increase sound levels by as much as 30 dB, and can range from 100 Hz–1 kHz (Milne and Ganton 1964). A background din that ranges between 40–70 dB source pressure level (re: 1µPa) in deep water and up to 90 dB in shallow coastal areas has been attributable to the combination of wind and wave actions on the surface (Stocker 2002). Sound levels have been known to rise 4 to 12 dB (Diachok and Winokur 1974) because of interactions of open-ocean waves with the marginal ice zone.

Sound propagation properties in the form of sea ice contribute significantly to the ambient sound levels (NRC 2003). The types of ice cover—including shore-fast pack ice, moving ice pack, or ice floes—can influence the sound level or intensity (NRC 2001). Temperature changes can also cause cracking of sea ice through mechanical means. The dominant source of ambient sound in continuous fast-ice cover is the ice cracking induced by thermal stresses (Milne and Ganton 1964; Richardson, et al. 1995). These data have shown that as areas of sea-ice coverage increase, sounds produced by waves and surf are reduced or eliminated.

Precipitation in the forms of rain and snow would be other forms of natural sound sources. Studies have shown that ambient sound levels have increased by up to 35 dB because of these forms of precipitation (Nystuen and Farmer 1987). Ocean sounds caused by precipitation are quite variable and temporary, as average precipitation nearest to the lease ranges from 10 in (25 cm) in Point Hope to 5 in (13 cm) in Barrow (MMS 2007). Snow cover for the Point Hope to Barrow coastal area ranges from 36–20 in (91–51 cm).

Subsea Earthquake

Sound levels from earthquake or volcanic events can produce a continual source of sound in some areas. Sound levels can increase as much as 30–40 dB above background sound and can last from a few seconds to several minutes (Schreiner, et al. 1995). There have been six earthquakes in the Chukchi Sea in the last seven months ranging from 2.7 to 3.0 magnitude and these have not affected any operations (Earthquake Track 2012).

4.5.1.2 Biological Sound Sources

The effects of sound on fish and marine mammals have been studied extensively in the last 20 years (Richardson, et al. 1995; Würsig and Richardson 2002; Popper, et al. 2003; Hastings and Popper 2005; Hildebrand 2005; Thomsen, et al. 2006; Southall, et al. 2007).

Marine Fishes

Fish have been known to grunt, grind, sing, or scrape to produce sounds for establishing territory, bonding, and hunting purposes. Fishes indicate a low threshold (higher sensitivity) to sounds within the 100 Hz–2 kHz range from most audiogram studies (Stocker 2002). Sound associations and the effects of sound on fishes are limited.

Marine Mammals

Marine mammals have been studied extensively and the songs of whales and dolphin clicks are most familiar. Of the sources of biological sound in the Chukchi Sea, the bearded seal, ring seal, and bowhead whale are the most prominent. Their contribution to the background sound in the Chukchi Sea is shown in Table 4.5.1.2-1.

Table 4.5.1.2-1. Source Level and Frequency of Sounds Produced in Selected Marine Mammals

Species	Sound Level[1]	Frequency	Reference
Bearded seal	178 dB	250-5,000 Hz	(Delarue, et al. 2012)
Ringed seal calls	95-130 dB	5 kHz	(Richardson, et al. 1995)
Bowhead whales	128-189 dB	20-3,500 Hz	(Richardson, et al. 1995)

[1] dB re: 1 μPa at 1m = relative to 1 microPascal at 1 meter

Richardson, et al., (1995) also referenced that bowhead whale calls are in the frequency modulation (FM) sound range of 50–400 Hz. Other marine mammals that contribute to the ambient sound and are found in the area include gray whales, walruses, beluga whales, spotted seals, fin whales, and humpback whales.

4.5.2 Anthropogenic Sound Sources

Human activities are increasing in the Arctic marine environment with respect to potential oil and gas exploration and commercial and recreational shipping. Sources of sounds in the Arctic produced by anthropogenic activities may be grouped into four general categories: 1) vessel transiting; 2) geophysical exploration; 3) vessel sonar; and 4) aircraft traffic. A summary of source levels by activity is shown in Table 4.5.2-1.

Table 4.5.2-1. A Comparison of Some Common Sound Levels by Source

Source	Activity	dB
Ambient environment	Ambient sound	65–133
Seismic and acoustics	Airgun arrays	235–259
	Single airguns	216–232
	Vibroseis	187–210
	Water guns	217–245
	Sparker	221
	Boomer	212
	Depth sounder	180
	Sub-bottom profiler	200–230
	Side scan sonar	220–230
	Military	200–230
Vessel activity	Supertankers	185–190
	Tankers	169–180
	Supply ship	181
	Freighter	172
	Tug pulling barge	171
	Fishing boats	151–158
	Zodiac (outboard)	156
Icebreaking	Ice management	171–191
	Ice breaking	193

Sources: (MMS 2007; Richardson, et al. 1995; Burgess and C.R. Greene 1999)
dB = decibels (a logarithmic scaled value)
re:1µPa @ 1 m = relative to 1 microPascal at 1 meter

Vessel Transiting

Commercial shipping is one of the major contributors to the overall sound budget in the world's oceans and contributes to the low frequencies from 5 Hz to a few hundred Hz (NRC 2003). Oceangoing vessels, especially larger ships such as supertankers, produce sound levels with a peak spectral density of 195 dB re: μPa^2 per Hz @ 1 m (Hildebrand 2005). The associated sound source levels for supertankers are in the range of 180–190 dB (re: 1 µPa @ 1 m).

Vessels that are commonly found in the Chukchi Sea area include icebreakers, research vessels, tugs and barges, and small skiffs. With oil and gas exploration increasing, sound levels are increasing because of predominantly seismic source vessel, support vessel, and drillship activities. Icebreaking or ice-management vessels used for activities that include research and oil and gas activities produce louder, but also more variable, sounds than those associated with other vessels of similar power and size (Richardson, et al. 1995). Activities associated with icebreaking have measured source levels at 193 dB (re: 1 µPa at 1 m). Drillship operations generate source levels of up to 185 dB (re: 1 µPa per Hz at 1 m) (Richardson, et al. 1995).

In the Chukchi Sea, vessel transiting and associated sounds presently are limited primarily to late spring, summer, and early autumn, when open waters are unimpeded by broken ice or ice sheets. Because of the shortness of the open-water season, vessel transiting—particularly large vessel transiting—is minimal in Arctic marine waters. Shipping activities during this timeframe have produced sound source levels within the range of frequencies from 20 Hz to 300 Hz. It is noted that smaller boats used primarily for fishing or whaling generate a frequency of approximately 300 Hz (Richardson, et al. 1995).

Seismic Survey Activity

Seismic survey activities generate underwater sound at pulsed, high-intensity sound levels (sound pulses at high peak levels) in the marine environment. Pulsed sounds differ from continuous sounds in that the difference between sound levels at the source and received level is greater than 3dB (Southall, et al. 2007). These sounds are generated from airgun sources that are short in duration, limiting total energy released. The airgun discharges occur every 10–15 seconds with a burst of compressed air that is directed toward the seafloor. An associated acoustic receiver cable (hydrophone array) measures the energy reflected from the subsurface, providing information about the sub-ocean geological structure.

Sound levels of various seismic single to arrays of airguns range from 216 to 259 dB re: 1µPa @ 1 m rms as indicated in Table 4.5.2-1. The rms value for a given airgun pulse is typically ~10 dB lower than the peak level, and 16 dB lower than the peak-to-peak value (Greene 1998).

While most of the energy from the airgun array is focused downward, and the short duration of each pulse limits the total energy expended into the water column, the sound can propagate horizontally for several kilometers (Greene and Richardson 1988; Hall, et al. 1994). Depending on the size of the seismic source array, in waters 82–164 ft (25 to 50 m) deep, sound produced by airguns can be detected 31–46.6 mi (50–75 km) away, and these detection ranges can exceed 62 mi (100 km) in deeper water (Richardson, et al. 1995).

The airgun array sound source pressure specifications for forward endfire and broadside from JASCO's AASM are presented in Table 4.5.2-2. These results are similar to those in other seismic exploration activities, producing a relatively high sound energy ranging from 216 to 259 dB (Burgess and Greene 1999; Richardson, et al. 1995; MMS 2007). Although the peak source levels of these energy sources are typically between 250–255 dB, horizontal transmission is more in the order of 200 dB (Engås, et al. 1993, 1996).

Table 4.5.2-2. Sound Level Pressure Specifications from JASCO's 2010 AASM Model for the 3,280-inch3 Airgun Array Towing at 8-meter Depth (Surface Ghost Effects are Excluded.).

	Forward Endfire	Broadside
Zero-peak pressure (dB re 1 µPa/1m)	248.2	246.8
90% rms level (dB re 1 µPa/1m)	233.5	232.2
90% rms duration (ms)	395.0	417.2
SEL (broadband) (dB re 1 µPa2/1m)	229.9	228.9
SEL (0–1 kHz)(dB re 1 µPa2/1m)	229.9	228.9
SEL (1–2 kHz) (dB re 1 µPa2/1m)	185.9	180.3

Source: (Zykov, et al. 2010)

dB = decibel(s)
dB re: 1 µPa2//1m =
in^3 = cubic inches
kHz = kilohertz
m = meter(s)
ms = milliseconds
rms = root mean square
SEL = Sound Exposure Level

Echosounding Equipment

The vessel M/V *Aquila Explorer* or similar vessel will be operating standard echosounder/fathometer units for the measurement of water depth during operations, as needed for safe vessel operations. Echosounding equipment produces a single, high-frequency (18–200 kHz) acoustic sound source level with a few watts to a few kilowatts of power that typically operates in the 180–200 dB re: 1 µPa @ 1 m range (Richardson, et al. 1995; Fugro 1989).

These are standard acoustical systems associated with surface vessels commonly used in the Chukchi Sea to determine water depth and identify potential navigation hazards. No other sonar equipment systems are planned to be used. The acoustical power range of these devices is 150–215 dB. These units produce a source sound level of around 180 dB as indicated in Table 4.5.2-1. There are no plans to use aircraft as a part of the seismic survey, except in emergency situations where individuals could be transported to and from vessels via helicopter.

Potential Acoustic Effects from the Proposed Activities

Potential effects from the proposed seismic survey include sound generated by the seismic airguns, the two project vessels transiting, and use of active echosounding sonar equipment. Most effects are expected to be localized to the project area and temporary, occurring only during seismic data acquisition.

Seismic exploration involves sound energy levels that are typically considered to be of sufficient intensity to cause an effect on marine mammals according to the NMFS and the USFWS. Sound energy levels that are greater than 160 dB re:3-1 1 µPa rms have the potential to result in “takes” of marine mammals as defined by both federal government agencies. Mitigation measures that will be put into place are addressed in detail in specific sections dealing with marine mammals. In the event of encountering marine mammals, acoustic safety radii have been developed for altering course and speed to maintain safety radii and to perform ramp-up, power-down, and shutdown procedures. In addition, although the mitigation measures have been designed to mitigate effects on marine mammals, they are also expected to mitigate effects on other marine life, such as fish.

The sound source levels emitted during operation may affect behavior of marine mammals near the sound source as discussed in the marine mammal section of this report. However, there are mitigation plans to ensure that potential effects of echosounding equipment are adequately addressed and disturbance is minimized in the vicinity of seismic and scout vessels.

Because of the varying depth contours that the seismic survey will encounter, tests were conducted at three different depth intervals to generate exclusion/monitoring zones based on the sound source levels from the AASM. The estimated sound energy radii (in meters) for a given sound source level and depth interval are presented in Table 4.5.3-1.

Table 4.5.3-1. Proposed Marine Mammal Exclusion/Monitoring Zones for Three Water Depth Intervals Using the 3,280 in^3 Seismic Source Array. A 10% Safety Factor is Applied to the Model Results.

	Exclusion Zone (meters [m])		
Source Level1 (dB re 1 μPa)	**Depth 17–40 m**	**Depth 40–100 m**	**Depth >100 m**
190	810	710	430
180	2,400	2,600	2,400
160	9,600	12,000	18,000

Source: Zykov, et al. 2010
Notes: Modeled estimated distances to the 120 dB re 1 μPa at the three water depth ranges are as follows: Depth 17-40 m = 170 km; depth 40-100 m = 155 km; depth >100 m = 170 km. However, TGS is not required to monitor the 120 dB re 1 μPa sound isopleth because seismic sounds are pulsed sounds, and the National Marine Fisheries Service does not require monitoring of this isopleth for pulsed sounds, only for continuous sounds (e.g., drilling sounds).

[1] Predicted from JASCO's array source model (AASM)
dB re 1 μPa = decibels referenced relative to 1 microPascal at 1 meter
m = meter(s)

5.0 Biological Environment

Baseline conditions and analyses of the potential effects of the TGS 2D seismic program on the Chukchi Sea biological environment are described under each resource.

- Lower Trophic Organisms
- Seabirds
- Fish
- Marine Mammals.

The analysis of potential effects focused primarily on marine mammals, as effects are expected to be sound-related and thus limited to marine mammals. Potential effects to fish, seabirds, and lower-trophic organisms are analyzed to a lesser extent. Impacts to terrestrial mammals are not anticipated, so they are not addressed in the EED.

5.1 Lower Trophic Organisms

5.1.1 Baseline Conditions

Lower trophic organisms provide much of the diet for fish, birds, and marine mammals in the Chukchi Sea. Nutrients, phytoplankton, and zooplankton are transported from the Bering Sea to the Chukchi Sea by northward-flowing currents (Woodgate and Aagard 2005). In addition, the presence of sea ice facilitates a prolonged algal bloom in the spring, which results in a high biomass of lower trophic organisms in the Chukchi Sea (Grebmeier and Ashjian 2012). A number of recent studies conducted in the area have indicated that the abundance and distribution of lower trophic organisms experience high inter-annual variability (Dunton, et al. 2012; Grebmeier and Ashjian 2012).

Two known kelp beds have been found near the northwest coast of Alaska: one was found 16 mi (26 km) southwest of Wainwright, and the other was 12 mi (19 km) northeast of Peard Bay (Mohr, et al. 1957; Phillips and Reiss 1985a,b). No other known kelp beds have been documented in the proposed seismic survey area.

Scientific group names for Chukchi Sea lower trophic communities are shown in Table 5.1.1-1. These organisms are divided into three distinct groups based on where they live:

- Benthic – Live on or within the seafloor. Common organisms include crabs, clams, shrimp, and polychaete worms.
- Pelagic – Live within the open water column. Common organisms include phytoplankton and zooplankton.
- Epontic – Live within or directly underneath sea ice. Common organisms include algae and diatoms.

Table 5.1.1-1. Benthic, Pelagic, and Epontic Organisms found in the Chukchi Sea.

Benthic	Pelagic	Epontic
Polychaeta	Copepoda	Diatoms
Ophiuroidea	Copepoda nauplii	Algae
Sipuncula	Larvaceans	Euphasiids
Amphipoda	Chaetognaths	Amphipoda
Bivalvia	Hydrozoans	Nematoda
Crustacea	Meroplankton	Larval Polychaeta
Anthozoa	Scyphizoans	
Echinoidea	Pteropods	

5.1.1.1 Benthic Organisms

Benthic organisms that live on the seafloor are known as epifauna, while organisms that live within the seafloor are called infauna. These lower trophic organisms convert nutrients into energy, making it usable for higher trophic organisms, such as marine mammals and fish. No known unique or biologically sensitive benthic communities exist in the Chukchi Sea (MMS 2007), but marine mammals that feed on benthic organisms have been observed (Blanchard, et al. 2011). See Section 5.4, Marine Mammals, for more information about the distribution and feeding behaviors of marine mammals in the project area.

5.1.1.2 Pelagic Organisms

Pelagic organisms live within the open water column and are either phytoplankton (plant-like) or zooplankton (animal-like). Plankton are unable to swim against water currents, so their distribution is driven by movement of Bering Sea and other Arctic water masses.

Phytoplankton are small algae (typically less than 20 micrometers [µm]) that are main contributors to primary production. Their production is measured in chlorophyll a (Chl.a), and typically varies temporally and spatially in the Chukchi Sea (MMS 2007; Dunton, et al. 2012).

Zooplankton are large (greater than 20 µm), and are composed of larval fish or invertebrates that provide a direct food source for higher trophic levels (e.g., fish and marine mammals).

5.1.1.3 Epontic Organisms

Epontic organisms are plants or animals that live within the brine channels or on the underside of sea ice. In the Chukchi Sea, these organisms have greater biomass near the center of ice floes, rather than the floe edge (Ambrose, et al. 2005)

Production from epontic organisms is driven mainly by under-ice light level, which is influenced by ice thickness and snow cover. Similar to the pelagic algal bloom in the spring, an epontic algal bloom occurs in the Chukchi Sea. It is small compared to the pelagic bloom, but the combination of both blooms creates conditions for high nutrient production, supporting higher trophic level feeders (BOEM 2011).

5.1.2 Potential Effects on Lower Trophic Organisms

The studies regarding the potential effects of seismic activity on lower trophic organisms are limited. Experimental research of snow crab (*Chionoecetes opilio*) eggs directly exposed to seismic energy indicated that seismic exposure resulted in a higher proportion of dead eggs and delayed embryonic development (Christian, et al. 2003; BOEMRE 2010). However, it should be noted that these were under controlled laboratory settings and more information is needed about in situ effects of seismic energy on developmental stages of fish and invertebrates.

Vessel traffic and sound are anticipated to have negligible effects on lower trophic organisms (BOEMRE 2010). Seismic streamers may potentially entrain pelagic organisms, leading to potential introduction of invasive species, but seismic activities are considered low-risk compared to other types of vessel activity (Kinloch, et al. 2003). Because of routine cleaning of streamers, in combination with US Coast Guard (USCG) regulations and inspections, TGS does not anticipate any likelihood of introducing invasive species to the proposed survey region.

5.2 Seabirds (or Marine and Coastal Birds) and Threatened and Endangered Species (Birds)

5.2.1 Baseline Conditions

The Chukchi Sea provides vital avian habitat for a number of waterbirds such as alcids, gulls, jaegers, loons, terns, and waterfowl. Because of the influx of warm water from the Bering Sea, plankton and benthic organisms are abundant in the eastern Chukchi Sea (Gall and Day 2011). Strong currents bring nutrient-rich water into the area, providing marine birds with ample food supplies (Gall and Day 2011). These food sources are an important component to migrating seabirds. During the spring months, birds migrate northward where they use leads between pack ice and landfast ice (Gall and Day 2011).

Birds that use the Chukchi Sea for feeding use coastal areas and barrier islands for nesting and brood-rearing. Other important nesting areas in the Chukchi Sea region are cliffs along the coastline. The USFWS identified 34 seabird nesting colonies between Point Hope and Barrow.

From 2008 to 2010, Gall and Day, as part of the CSESP, collected distribution and abundance of seabirds in the northeast Chukchi Sea (Gall and Day 2011). The study area consisted of a total of three study areas, which were the ConocoPhillips' Klondike prospect, Shell's Burger prospect, and Statoil's Amundsen prospect (Gall and Day 2011). The Klondike and Burger prospects were studied in all three years and the Amundsen prospect was added to the study in 2010 (Gall and Day 2011). The Klondike prospect area was determined to be a pelagically dominated system and marine birds found in this area generally feed on pelagic fish (Gall and Day 2011). The Burger prospect area was shown to be a benthically dominated system and marine birds in this area predominantly feed on benthic organisms (Gall and Day 2011). The Statoil study area is considered a mix of both pelagically and benthically dominated systems (Gall and Day 2011).

Between 2008 and 2010, Gall and Day identified a total of 36 species of seabirds, two species of passerines, and one species of owl (see Table 5.2.1-1) (Gall and Day 2011). The distribution of birds observed was sporadic, but higher densities were found in areas with bathymetric relief where oceanic productivity was elevated (Gall and Day 2011).

Birds observed in the CSESP study were predominantly plankton-feeding marine birds such as crested auklets, least auklets, and short-tailed shearwaters. A total of 22,391 crested auklets and 15,075 short-tailed shearwaters were identified, which consisted of 84 percent of all birds observed (Gall and Day 2011).

Alcids (auklets and murres) were the most abundant bird group in the 2008 and 2010 surveys, and the second most abundant in 2009 (Gall and Day 2011). Tubenoses (petrels and shearwaters) were the second most abundant bird group in 2008 and 2010, and the most abundant in 2009 (Gall and Day 2011). Larids (gulls and terns) were the third most abundant group species in all three years (Gall and Day 2011).

Waterfowl were present in all three study areas in all three seasons and years, with long-tailed ducks (*Clangula hyemalis*) being the most abundant (Gall and Day 2011). Phalaropes were seen from late August to early October in 2008, late July to early September in 2009, and in late August to early September in 2010 (Gall and Day 2011). Loons were reported from late August to early October in all three years, but were absent all three years in late July and early August (Gall and Day 2011).

Table 5.2.1-1. Species of Birds Identified by Gall and Day in 2011

Species	Number Observed	Group
American Pipit	3	Passerine
Ancient Murrelet	103	Alcid
Arctic Tern	57	Larid
Black Guillemot	19	Alcid
Black-legged Kittiwake	1,443	Larid
Common Eider	8	Waterfowl
Common Murre	62	Alcid
Crested Auklet	22,391	Alcid
Dovekie	7	Alcid
Glaucous Gull	408	Larid
Herring Gull	38	Larid
Horned Puffin	20	Alcid
Ivory Gull	2	Larid
King Eider	8	Waterfowl
Kittlitz's Murrelet[a]	12	Alcid
Least Auklet	2,151	Alcid
Long-billed Dowitcher	1	Shorebird
Long-tailed Duck	250	Waterfowl
Long-tailed Jaeger	6	Larid
Northern Fulmar	752	Tubenose
Pacific Loon	311	Loon
Parakeet Auklet	125	Alcid
Parasitic Jaeger	8	Larid
Pectoral Sandpiper	15	Shorebird

Table 5.2.1-1. Species of Birds Identified by Gall and Day in 2011

Species	Number Observed	Group
Pigeon Guillemot	5	Alcid
Pomarine Jaeger	117	Larid
Red Phalarope	170	Shorebird
Red-necked Phalarope	737	Shorebird
Red-throated Loon	2	Loon
Ross's Gull	203	Larid
Sabine's Gull	142	Larid
Short-eared Owl	1	Owl
Short-tailed Albatross[b]	0	Tubenose
Short-tailed Shearwater	15,075	Tubenose
Snow Bunting	2	Passerine
Spectacled Eider[c]	1	Waterfowl
Steller's Eider[c]	0	Waterfowl
Thick-billed Murre	62	Alcid
Tufted Puffin	14	Alcid
White-winged Scoter	3	Waterfowl
Yellow-billed Loon[a]	40	Loon

[a] Candidate Species
[b] Endangered Species
[c] Threatened Species

5.2.2 Seabirds

During the summer months, many seabirds use the offshore areas of the Chukchi Sea. Some seabirds use coastal areas for nesting colonies and are known to forage more than 75 mi (120 km) offshore. The majority of seabirds that use the Chukchi Sea migrate away from the region by late October; however, a few species winter in polynyas near the coast.

Because of the reclusiveness of birds' nesting colonies, their remote location, and large amounts of time spent at sea, the biological status of many seabirds is unknown. Numerous species of cliff-nesting seabirds are long-lived with low reproductive rates, and are therefore slow to rebound from population-level disturbances.

Northern fulmars, short-tailed shearwaters, crested auklets, least auklets, and parakeet auklets all use the pelagic waters of the Chukchi Sea, but nest in the Bering Strait.

Two species of seabirds are listed under the Endangered Species Act. The short-tailed albatross is listed as endangered and the Kittlitz's murrelet is listed as a candidate species in Table 5.2.1-1.

5.2.3 Jaegers

The pomarine, parasitic, and long-tailed jaegers are all found in the Chukchi Sea area from July until late September. Jaegers are found to be common in the central and southern Chukchi Sea until late September, and uncommon in the northern extent of the Chukchi Sea. It is estimated that roughly 100,000 jaegers use the Chukchi Sea from late July to late August. Historic data suggest that pomarine jaegers were the most abundant seabird species found in the western Chukchi Sea.

The population of prey species heavily influences the number of successful breeding jaegers on the North Slope. It is therefore reasonable to assume that the density of jaegers found in the pelagic waters of the Chukchi Sea depends upon the number of successful breeding jaegers found on the adjacent tundra. Between 2008 and 2010, the CSESP study identified a total of 133 jaegers, with the majority of sightings taking place in late summer and early fall.

5.2.4 Waterfowl

Waterfowl species found within the Chukchi Sea region include ducks, geese, and swans. King eiders, common eiders, and long-tailed ducks migrate across the Beaufort and Chukchi seas en route between wintering, breeding, and molting areas in northern Alaska and Canada. Many species use the Chukchi Sea coast and use nearshore and offshore marine habitats.

5.2.4.1 Eiders

Eiders are large seaducks that breed in northern latitudes. There are four species of eiders found in the Chukchi Sea. The two common species found are the king and common eiders. However, during the CSESP study, only two king eiders and three common eiders were identified.

The other two species of eiders, the spectacled and Steller's eiders, are listed under the Endangered Species Act. During the CSESP bird survey, one spectacled eider and no Steller's eiders were identified (see Table 5.2.1-1).

5.2.4.2 Loons

Three species of loons are found in the Chukchi Sea region. They include the red-throated, Pacific, and yellow-billed loons. Loons primarily prey on fish and begin to migrate north to their breeding grounds between early May and mid-June. Loons migrate north by traveling along the coast and also use inland routes. During their fall migration, loons follow the coast south to the Lisburne Peninsula and then move out to sea. The fall migration occurs in late August and early September. The yellow-billed loon is listed as a candidate species under the Endangered Species Act.

5.2.5 Other Birds of Importance

In addition to the species addressed above, CSESP surveys found large numbers of short-tailed shearwaters, least auklets, black-legged kittiwakes, and crested auklets, which are discussed briefly below.

5.2.5.1 Short-Tailed Shearwater

Short-tailed shearwaters are Australian burrowing breeders. They spend most of their non-breeding time traversing over the open ocean, arriving in Alaska waters about May and remaining until about September (Divoky 1987). The heaviest concentrations are over the OCS in the southern Bering Sea, and along the western Gulf of Alaska. Some birds are found as far north as the Chukchi and Beaufort seas. Non-breeders may remain in Alaska waters throughout the northern winter (Denlinger 2006). The total worldwide population of short-tailed shearwaters is estimated to be about 20 million individuals (Seattle Audubon Society 2012).

Short-tailed shearwaters were the second most abundant species identified during CSESP surveys, with a total of 15,075 individuals counted. A total of 491 individuals were counted in the Statoil study area (Gall and Day 2011).

5.2.5.2 Least Auklet

Least auklets breed and nest in rock crevices on remote islands with rocky beaches, sea-facing talus slopes, cliffs, boulder fields, or lava flows. Nests are usually concentrated on unvegetated talus slopes. They generally nest in association with crested auklets. Least auklets breed on the Aleutian Islands, Shumagin and Semidi islands, and on isolated islands in the Bering Sea (Denlinger 2006). They are uncommon in the western Chukchi Sea until late August when they are found in large numbers: up to 40,000 inhabit the area until late September (Divoky 1987). The estimated total North American population ranges from 5.5 million to 9 million individuals at 37 nesting colony sites (USFWS 2011a).

CSESP surveys found 2,151 least auklets in the CSESP study areas from 2008 through 2010.

5.2.5.3 Black-Legged Kittiwakes

Black-legged kittiwakes build their nests on narrow cliff ledges, usually on offshore islands or inaccessible areas of coastal mainland. They nest from Cape Lisburne southward to the Gulf of Alaska, and into Southeast Alaska. At the Cape Lisburne nesting colony, they forage as far as 75 mi (120 km) offshore (Roseneau and Herter 1984). More than 371 colony sites have been identified, with an estimated population of approximately 1.3 million individuals (USFWS 2011a). An estimated 400,000 black-legged kittiwakes use the pelagic waters of the Chukchi Sea (Divoky 1987).

A total of 1,443 black-legged kittiwakes were identified in the CSESP bird surveys.

5.2.5.4 Crested Auklets

Crested auklets are colonial nesters, usually building their nests in rock crevices on talus slopes, cliffs, boulder fields, or lava flows. They are a very social species, nesting with least auklets. These mixed colonies can vary in size from a few hundred birds to more than 100,000 pairs (Jones 1993). Worldwide, 43 colony sites are known. These colonies are concentrated in the northern Bering Sea and western Aleutian Islands. The total North American population is estimated at about 2.9 million birds (Denlinger 2006). Divoky (1987) reported regular widespread use of the central Chukchi Sea by crested auklets from late August until early October.

The CSESP surveys identified 23,391 crested auklets in all three study areas from 2008 to 2010.

5.2.6 Threatened and Endangered Species

There are five species of birds that occur within the Chukchi Sea region that are listed under the Endangered Species Act. The short-tailed albatross is listed as endangered under the ESA. The spectacled and Steller's eiders are listed as threatened under the ESA and the yellow-billed loon and Kittlitz's murrelet are both listed as candidate species under the ESA. Each species is discussed in detail below.

5.2.6.1 Short-Tailed Albatross

The short-tailed albatross is federally listed as endangered throughout its range (USFWS 2008a). This species is considered to be critically endangered because of a low number of individuals and low reproductive rate. There are only two known nesting colonies, and 85 percent of the world's breeding population nests at a single colony on the island of Torishima in the Philippine Sea. In 2008, the USFWS estimated about 2,400 short-tailed albatross existed worldwide, including approximately 450 to 500 breeding pairs (USFWS 2008a). The range of the short-tailed albatross covers most of the North Pacific Ocean. They have been occasionally observed in the Chukchi Sea; however, their historic range is generally considered south of the Bering Straits (USFWS 2008a).

5.2.6.2 Spectacled Eider

On May 10, 1993, the USFWS listed the spectacled eider as threatened because of a population decline of 94 to 98 percent on its breeding range in Alaska (USFWS 1993). On March 8, 2001, the USFWS designated approximately 38,926 mi^2 (100,988 km^2) as critical habitat for the spectacled eider. The areas designated include areas on the Yukon–Kuskokwim Delta (Y–K Delta) and in Norton Sound, Ledyard Bay, and the Bering Sea. Designation of critical habitat prohibits adverse modification of this habitat by any activity funded, authorized, or carried out by any federal agency (USFWS 2001).

Male spectacled eiders leave their North Slope breeding grounds for molting areas the third week of June. Females with failed broods follow near the third week of July, and females with successful broods follow in late August to early September (Peterson, et al. 1999). Peterson, et al., (1999) identified two different molting areas used by spectacled eiders in Alaska east of Norton Sound and Ledyard Bay. Arrival and departure dates to these molting areas are shown in Table 5.2.6.2-1.

Table 5.2.6.2-1. Dates of Arrival and Departure for Molting Areas of Tagged Spectacled Eiders, 1993–1995

Molting Area	Paired Males	Failed Females	Females with Broods
Arrival at Molting Area			
Ledyard Bay	June 25 to July 26	None	September 7–11
Norton Sound	None	July 20 to August 10	September 4–16
Departure from Molting Area			
Ledyard Bay	August 26 to October 19	None	October 6–25
Norton Sound	None	September 17 to October 10	October 2–29

Source: (Peterson, et al. 1999)

Females in Norton Sound were found to molt 6 mi (10 km) closer to shore than the females in Ledyard Bay. The males molting at Ledyard Bay were found to be almost twice as far off-shore as those of Norton Sound. Both sexes of eiders tended to remain offshore during migration through the Chukchi Sea; males averaged 21.5 mi (34.7 km) offshore, while females averaged 33.5 mi (56.9 km) offshore.

Both sexes of spectacled eider wintered at the same location in open-water areas south of the Bering Straits. These open-water areas can vary, but early winter distance offshore averaged 32 mi (52.0 km) and mid-winter distance averaged 67 mi (108.2 km) (Peterson, et al. 1999). Arrival at wintering areas varied between sexes and breeding success. Males arrived between September 28 and November 2, unsuccessful females arrived between October 12 to 22, and successful females arrived between November 1 to 11.

The CSESP observed a single spectacled eider in the Klondike study area in the early fall survey in 2009 (Gall and Day 2011).

5.2.6.3 Steller's Eider

Most of the world's Steller's eiders nest in the Russian Arctic. The Alaska breeding population is much smaller and nests primarily on the Arctic Coastal Plain, while a few pairs (approximately 10) still nest on the Y–K Delta (Safine 2011). The USFWS listed the Alaska-breeding population as threatened under the ESA in 1997 because of a substantial decrease in the species' nesting range, and reduction in the number nesting in Alaska (USFWS 1997). In 2001, the USFWS designated Steller's eider critical habitat for breeding habitat and four marine units in southwest Alaska. There is no Steller's eider critical habitat designated in the marine waters of the Chukchi Sea.

Steller's eiders are sparsely distributed across the Arctic Coastal Plain of northern Alaska, with the greatest density of breeding pairs near Barrow. Ground-based breeding pair surveys have been conducted around the Barrow area since 1991. The surveys have been designed to provide near 100 percent coverage of the approximately 83-mi^2 (134-km^2) study area.

The number of Steller's eiders located varies from year to year. In 2008, a total of 195 were counted, 9 were found in 2009, and 33 in 2010. The variation in brood initiation and success of Steller's eiders may be related to the abundance of brown lemmings. Large lemming populations provide predators—primarily foxes, snowy owls and pomarine jaegers—with alternative food sources. This results in less predation on nesting Steller's eiders, which correlates to greater breeding success for Steller's eiders (Safine 2011).

During the spring migration, Steller's eiders use lagoons and nearshore waters of the northeastern Chukchi Sea en route to nesting areas near Barrow. Once they leave their nesting areas, they migrate to coastal areas from Cape Lisburne to the Dease Inlet. Steller's eiders from the Russian and Alaska populations molt in lagoons on the north side of the Alaska Peninsula, in Kuskokwim Bay, and the Commander Islands in the Bering Sea (MMS 2007).

There were no Steller's eiders identified during the CSESP bird surveys conducted from 2008 to 2010.

5.2.6.4 Kittlitz's Murrelet

Kittlitz's murrelets have undergone a dramatic population reduction in recent years and are currently designated as a candidate species throughout their range (USFWS 2011b). Current worldwide population estimates are 30,900 to 56,800, with 11,110 in Russia and the balance in Alaska (Balogh 2010). Divoky (1987) found Kittlitz's murrelets in the pelagic Chukchi Sea from approximately 13 to 132 mi (21 to 213 km) offshore. He found them to be rare until late August, when they became regular but uncommon (Divoky 1987).

All of the North American and most of the world population of Kittlitz's murrelets breed, molt, and winter in Alaska. They inhabit coastal waters discontinuously from Point Barrow (Divoky 1987) south to northern portions of Southeast Alaska (Denlinger 2006). Their solitary nests have been found as far north as the DeLong Mountains and Lisburne Hills. Molting likely occurs during late August and they have been observed in Barrow in September and October. In the fall, the Kittlitz's murrelets using the Chukchi and Bering seas move south with the advancement of pack ice, with a substantial number of individuals migrating into Prince Williams Sound. Others migrate to Kenai Fjords, Kachemak Bay, Kodiak Island, Sitka Sound, and the northern Gulf of Alaska (USFWS 2011b).

The CSESP identified a total of 12 Kittlitz's murrelets. Seven were observed in 2009, all in the Burger study area. In 2010, five were reported, three in the Klondike study area, one in the Burger study area, and one in the Statoil study area (Gall and Day 2011).

5.2.6.5 Yellow-billed Loon

The CSESP bird surveys identified 40 yellow-billed loons in 2008 and 2009. In 2008, 6 yellow-billed loons were identified, and a total of 34 yellow-billed loons were identified in 2009. No yellow-billed loons were observed during the 2010 surveys (Gall and Day 2011).

In 2009, the USFWS determined listing the yellow-billed loon as a threatened or endangered species is warranted but precluded by other higher-priority listing actions. The listing of a species as "warranted, but precluded" means the proposal to list is delayed while the USFWS works on listing proposals for other, higher-priority species (USFWS 2009a). Yellow-billed loons are vulnerable because of a low starting population, low reproductive rate, and very specific breeding habitat requirements.

The yellow-billed loon is a circumpolar breeder, nesting in freshwater lakes across northern Alaska, Canada, and Russia on lakes that are deep enough to support overwintering fish (Earnst, et al. 2005). Earnst, et al. (2005) noted that 91 percent of all yellow-billed loons observed were located within the National Petroleum Reserve – Alaska (NPR-A). Yellow-billed loon foraging habitats include lakes, rivers, and the nearshore marine environment during the breeding season (Earnst, et al. 2005).

Yellow-billed loons are generally thought to migrate along coastal routes next to Alaska, Canada, and Russia, but evidence suggests overland routes are also used. Open-water leads and polynyas are known to be important for staging and spring migration (Shell Gulf of Mexico Inc. 2011). They begin to arrive along the Chukchi Sea coast in early May and leave at the end of August to mid-September (Johnson and Herter 1989). They winter in ice-free waters from southern Alaska to British Columbia. Telemetry studies indicate that most yellow-billed loons breeding on the North Slope winter off North Korea, Japan, and China (USGS 2011).

The 2009 yellow-billed loon index was the highest index in the 18 years of the survey. It was 47 percent above the long-term mean from 1986–2006 (Larned, et al. 2010). The population growth rate indicates a significant positive trend over both the long-term (since 1986) and most recent 10-year reference periods (1999–2009). Distribution of yellow-billed loons was highest between Teshekpuk Lake and the Topogoruk River (Larned, et al. 2010). Earnst, et al. (2005) estimated that fewer than 1,000 nesting pairs inhabit northern Alaska in most years.

5.2.7 Potential Effects on Seabirds and Threatened and Endangered Species

The species of birds expected in the project area when the vessels are operating are limited because of the distance from shore and the water depths. These species include northern fulmar, short-tailed shearwater, long-tailed duck, phalaropes, jaegers, glaucous gulls, black-legged kittiwake, thick-billed murre, Ross's gull, black guillemot, Arctic tern, least auklet, and crested auklet. Other species may be present in smaller numbers or found in shallower waters between the prospects and the coast. A survey of seabird populations and species composition in the project area by Gall and Day (2010) contains a complete list of species observed over 2008 to 2010 open-water seasons (Table 5.2.1-1).

5.2.7.1 Survey Sounds

The sound generated from the operation of a seismic airgun array travels predominantly vertically and to a lesser extent horizontally in the water column. Sound generated from a typical seismic airgun array in water depths comparable to those of the project area (25–50 m [82–164 ft]) travel about 31–47 mi (50–75 km) (Richardson, et al. 1995). Estimated distances specifically at which the TGS seismic array sound are expected to be heard based on three water depths and various sound levels is shown in Table 4.5.3-1.

Published research about the effects of seismic airgun sound on coastal and marine birds is limited. However, studies by Evans, et al. (1993), evaluating marine bird behavior in the North Sea, found no observable difference in bird behavior in the presence of operating seismic vessels. Similar studies in the Canadian Arctic by Webb and Kempf (1998) and Stemp (1985) found no statistical difference comparing bird distribution with or without ongoing seismic surveys.

Lacroix, et al. (2003), investigated effects of a marine seismic survey on molting long-tailed ducks in the Beaufort Sea and found that the survey program did not cause them to move from their feeding areas and had no effect on their movements or diving behavior. These studies indicate that sound sources (seismic airguns) result in no long-term effects on birds. Any effects would consist of temporary and minor behavior responses, such as the flushing of birds from the vicinity of the vessel. Any such effects would likely last only minutes to a few hours (MMS 2009).

5.2.7.2 Vessel Transit

Vessel transit to the survey area will occur more than 55 mi (88 km) offshore where bird densities are relatively low compared to coastal areas.

Studies of bird response to vessel transit are limited. Lacroix, et al. (2003) conducted an investigation of the effects of a marine seismic survey on ducks in the Beaufort Sea that involved the transit of five vessels with lengths of 23–41 m (75–135 ft). They found the survey activities had no significant effect on the birds' behavior. Agness, et al. (2008) studied the effects of various types of vessels with lengths of 6–305 m (20–1,000 ft) on Kittlitz's murrelets and observed only temporary effects on the birds' behavior in the area. Neither the murrelet group size nor foraging habitat was affected by vessel activity.

The USFWS restricts vessel operation within the Ledyard Bay Critical Habitat Unit (LBCHU) from July 1 through November 15 to minimize disturbances to molting eiders. Vessels are only allowed within the LBCHU during this timeframe in response to human safety or to respond to an oil spill (USFWS 2007). Only minor disturbances to marine and coastal birds from vessel transit are anticipated.

Transit of project vessels could result in very minor and temporary disturbance to birds found in offshore waters, leaving no demonstrable effect on the bird populations. The probability of such short-term disturbance effects on birds in coastal areas associated with activity from TGS's proposed surveys is extremely low (MMS 2007).

5.2.7.3 Vessel Strikes

Seismic surveys from oil and gas activities operating within the Lease Sale 193 area in recent years have not reported strikes with any bird species. Vessels transiting through open water can pose a collision risk to some species of birds; however, collisions between birds and seismic or support vessels are not expected to occur because of the relatively low density of birds in the project area.

TGS's proposed survey activity will begin in Alaska waters between July 15 and August 5 when daylight is plentiful. By the time there are periods of darkness the survey will be far off shore where bird densities are very low. According to the USFWS *Biological Opinion 2012 Shell Environmental Baseline Studies – Coastal Chukchi Sea and Onshore*, vessels that encounter flocks of birds along their path will maintain a steady speed and divert around these flocks to avoid unnecessary disturbance. Therefore, it is reasonable to assume that the USFWS may require the same from TGS during their seismic operations.

Studies indicate some bird species that fly at low altitudes or are attracted to lighting have the highest potential of colliding with vessels and that attraction or disorientation from lighting on project vessels may be exacerbated by fog or rain (Brown 1993). Little information is currently available on the cause and effect of light-induced bird strikes. The most relevant studies in the Arctic Ocean are those assessing the behavior of birds at the Endicott and Northstar facilities (Day, et al. 2005), which are located on artificial islands in nearshore waters of the Alaska

Beaufort Sea. Studies conducted at the Northstar Island facilities for monitoring bird strikes indicate the probability of bird strikes with vessels in the project area will be extremely low at that time of year.

No avian collisions with the vessels are expected to occur during the planned survey operations, as the project area is located at least 55 mi (88 km) offshore where bird densities are low (Divoky 1987; Gall and Day 2010). When TGS plans to operate in areas of higher bird densities within US waters, daylight will be at nearly 24 hours. Therefore, light-oriented birds are not expected to be affected. Although TGS is not a Chukchi Sea lease holder, it is reasonable to assume that the USFWS and/or BOEM may require them to follow the same terms and conditions that lease holders are required to follow while operating in the Chukchi Sea. To further reduce effects to light-oriented birds, any vessel lighting may be directed inward and downward, rather that upward and outward (MMS 2008).

5.2.7.4 Aircraft Traffic

TGS does not intend to use aircraft in support of their seismic operations. Any aircraft used by TGS during their seismic operations would be for emergency situations such as search and rescue or for human safety. In the event that TGS were to use aircraft for such reasons, they would likely be required to follow the same stipulations as the lease holders, including maintaining a minimum elevation of 1,500 ft (457.2 m) ASL over the following Chukchi Sea lease blocks: 6624, 6625, 6674, 6675, 6723-6725, 6773-6775, 6822, 6823, 6872, between April 15 and June 10; and over the LBCHU between July 1 and November 15, unless weather conditions or human safety does not permit operation at this altitude. This is to prevent disturbance to migrating birds (MMS 2008).

5.3 Fish Resources

5.3.1 Baseline Conditions

There are 81 fish species listed as occurring in the Chukchi Sea (FishBase 2012). Subsistence fishing takes place throughout the region by the local inhabitants onshore and offshore, but no commercial fishery is allowed because of the lack of information about fishery populations in the area. Acoustic discharge primarily affects fish hearing, which can be an important sense in an aqueous medium where sound waves travel farther than light waves. Fish have two primary mechanical adaptations to allow them to hear: a direct pathway to the inner ear, and in some instances, a connection from the swim bladder to the inner ear. The direct pathway to the inner ear (‘hearing generalists’) operates in a similar manner as human hearing. Vibration affects an ear bone and associated hair cells, whose movement triggers electrical signaling, interpreted as sound. This method of hearing can be broad range and generalist.

The secondary hearing system (‘hearing specialists’) uses the swim bladder, whose primary function is involved in regulating orientation and depth of the fish. This oil-filled organ is less dense than the rest of the fish and will vibrate in accordance with surrounding physical vibrations. Through a variety of methods, vibrations in the swim bladder can be transmitted to the inner ear. This can provide increased sensitivity to sound detection, and can cause the same acoustic discharge to have a larger effect on some species with this ability.

Finally, in addition to hearing, vibration detection takes place via the lateral line system, which is responsible for detection of movement within a few body lengths of the fish. There has not been extensive study done on the effects of acoustic discharge on the lateral line system, and effects on acoustic discharge have not focused on this system.

5.3.2 Essential Fish Habitat and Arctic Fishery Management Plan

Fishery resources in the US are broad, including a large variety of species, and have a variety of regulations that focus on protecting commercially exploited populations and species. The primary regulatory tool in the study area is the Essential Fish Habitat (EFH) under the Arctic Fishery Management Plan (AFMP), which is regulated by the NMFS.

The Magnuson-Stevens Fishery Conservation and Management Act mandated agencies to protect, conserve, and enhance essential fish habitat. EFH is defined as those waters and substrate necessary to federally managed fish for spawning, breeding, feeding, or growth into maturity. Fish is defined broadly to include finfish, shellfish, and other living marine resources where harvest takes place. Regional Fishery Management Councils and Fishery Management Plans have been developed to manage fish and invertebrate species in federal waters, including requiring description of adverse impacts on EFH, and promoting the conservation and enhancement of EFH.

The Arctic Fishery Management Plan was approved by the Secretary of Commerce and the North Pacific Fishery Management Council in 2009 (North Pacific Fishery Management Council 2009). This covers the Chukchi and Beaufort seas and initially bans commercial fishing until more information is known about the stocks. EFH was defined for Arctic cod, saffron cod, and snow crab.

EFH for Arctic cod includes the pelagic and epipelagic water from depths of 0–1,640 ft (0–500 m) throughout Arctic waters and also often includes ice floes over deeper waters. EFH for saffron cod includes pelagic and epipelagic waters along the coastline, within nearshore bays, and under ice along the shelf (0–164 ft [0–50 m] deep) throughout Arctic waters with substrates of gravel and sand. EFH for snow crab includes habitats from 0–328 ft (0–100 m) depth in waters south of Cape Lisburne with substrates of mud.

In addition, the ADF&G designates EFH for freshwater species in Alaska (ADF&G 2012a). In the project area, Chinook salmon, chum salmon, and pink salmon have EFH designated in the project area as defined by the ADF&G Anadromous Waters Catalog.

5.3.3 Potential Effects on Fish Resources

The potential effect to fish resources will be from the acoustic discharge by the seismic airguns. The proposed array consists of 28 individual units with volumes ranging from 40–300 in^3 (655.5–4,916 cm^3). These airguns would fire periodically over many hours, depending on segment line length.

5.3.3.1 Frequency

Fish hearing is generally restricted to low frequencies (Blaxter 1981; Popper and Fay 1999; Mann, et al. 1997). Hearing generalists are sensitive to underwater sounds with frequencies less than 1,000 Hz. Hearing specialists are sensitive to frequencies less than 4,000 Hz, with the herring shad family being sensitive to frequencies less than 100,000 Hz.

Frequencies received are dependent on sound level, with 160 dB re 1 μPa and above containing the 0–1,000 Hz range, and 160–120 dB re 1 μPa containing the >1,000 Hz range (Zyov, et al. 2010). It is not unusual for the 120 dB re 1 μPa threshold level to extend to more than 43.5 mi (70 km) from the source (Zykov, et al. 2010). This is reflected in Table 5.3.3.1-1 below.

Table 5.3.3.1-1. Frequency Sensitivity of Fish from Modeled Seismic Discharge

Hearing Group	Sensitive Frequency	Sensitive Decibels	Sensitive Range
Hearing generalists	<1,000 Hz	> 160	< 6.2 mi (< 10 km)
Hearing specialists	<4,000 Hz	160–120 dB re 1 µPa	> 43.5 mi (> 70 km)
Herring shad family	<100,000 Hz	160–120 dB re 1 µPa	> 43.5 mi (> 70 km)

Source: Zykov, et al. 2010
> = greater than
< = less than
dB re 1 µPa = decibel referenced to 1 microPascal at 1 meter
Hz = Hertz
Km = kilometers

5.3.3.2 Sound Pressure Levels

The following discussion provides an overview of the effects from sound pressure levels on the physical and behavioral effects, local movement, and fisheries. There has been more extensive research on the effects of sound pressure levels (SPLs) (dB re 1 μPa) on fisheries.

The modeled received SPLs for similar projects are predicted to be those indicated in Table 5.3.3.2-1 (Zykov, et al 2010):

Table 5.3.3.2-1. Modeled Received Sound Pressure Levels for Seismic Discharge

	Depth 55.8–131 ft (17–40 m)	Depth 131–328 ft (40–100 m)	Depth 328 ft (>100 m)
190 dB re 1 µPa	2,657.5 ft (810 m)	2,329 ft (710 m)	1,410.7 ft (430 m)
180 dB re 1 µPa	7,874 ft (2,400 m)	8,530 ft (2,600 m)	7,874 ft (2,400 m)

Source: Zykov, et al. 2010
> = greater than
dB re 1 µPa = decibel referenced to 1 microPascal at 1 meter

Physical Effects

Received SPLs between 165–209 dB re 1 μPa over a period of 101 minutes produced extensive damage in the inner ear in pink snapper (*Pagrus auratus*) (McCauley, et al. 2000a, 2000b, 2003). More extensive damage, and no repair of previous damage, was found on fish examined 58 days post exposure. During the study, fish also exhibited startle and alarm responses, which decreased over time and fish returned to pre-exposure state within 30 minutes of the experiment ending.

The survival of fertilized eggs for capelin (*Mallotus villosus*) and monkfish (*Lophius americanus*) was studied by exposure to 10 to 30 discharges of 199 to 205 dB re 1 μPa (Payne, et al. 2009). No difference was found in survivability. Other studies of survivability on fertilized eggs have demonstrated that while some mortality occurs, natural mortality is a more important effect on recruitment (Kostyvchenko 1973; Booman, et al. 1996; Saetre and Ona 1996).

The effect on freshwater fish hearing was investigated with five discharges of received level 176–180 dB re 1 μPa (Popper, et al. 2005). Broad whitefish showed no temporary threshold shift (TTS), while northern pike and lake chub both showed a TTS of 10 to 15 dB. No physical damage was observed on the ears.

Blood chemistry was analyzed in European sea bass (*Dicentrarchus labrax*) exposed to 256 dB re 1 µPa over a two-hour period (Santulli, et al. 1999). Blood analyzed for stress hormones (cortisol, glucose, and lactate) was significantly higher than blood in control fish. Stress hormones returned to normal levels within 72 hours. In addition, startle responses were seen when discharges were closer than 1.56 mi (2.5 km) from the cage. When the gun was within 590.6 ft (180 m) of the bass, the sea bass were densely packed and exhibiting active stress behavior. Behavior returned to normal two hours after the airgun stopped discharging.

Behavioral Effects

The behaviors of rockfishes (*Sebastes* sp.) were examined when exposed to received SPLs of 137–206 dB re 1 µPa (Pearson, et al. 1992). They displayed alarm and startle responses at a minimum at 200 dB re 1 µPa and 177 dB re 1 µPa, respectively. Fish returned to pre-exposure state within 60 minutes of the experiment ending. Pearson concluded that overt responses occurred at 180 dB re 1 µPa and subtle responses occurred at 161 dB re 1 µPa.

The behavior of lesser sand eel (*Ammodytes marinus*) was examined when exposed to a source SPL of 256 dB re 1 µPa in a cage at 180.4 ft (55 m) water depth (Hassel, et al. 2003, 2004). Distance to the airgun ranged from 180.4 ft to 4.66 mi (55 m to 7.5 km). During discharge, fish exhibited startle responses and had increases in tail beat frequency. The frequency of the startle response increased as the airgun moved closer.

Local Movement

Changes in local movements are expected because of seismic activity, as exemplified by the use of acoustic discharge for salmon exclusion from the Bering Sea pollock fishery (Balsiger 2011; Noatch and Suski 2012).

The local movements of silver hake (*Merluccius bilinearis*) were observed in reaction to received SPLs at 178 dB re 1 µPa (Chapman and Hawkins 1969). Fish were observed to move from holding at a depth of 82–180 ft (25–55 m) to holding to depths >180 ft (>55 m). After an hour, fish habituated to the discharge and returned to 82–180 ft (25–55 m). When airgun discharge ceased, and was restarted in another trial, fish again demonstrated the same descent to below 180 ft (55 m) water depth.

The local movements of demersal fishes, blue whiting, and small pelagic fishes was measured by trawls and acoustic surveys when exposed to received SPLs 200-210 dB re 1 µPa every 10 seconds for a week (Dalen and Knutsen 1986). Acoustic monitoring showed a significant decrease in abundance of demersal fish, but trawls did not support the finding.

The local movements of fish distribution was measured by echosounder and trawling with a 16-airgun array and had a source SPL of 256 dB re 1 µPa, with a shot interval of 25 seconds over 4.6–12 hours (La Bella, et al. 1996). Horizontal distribution did not change, but populations shifted deeper. The trawling catch rates did not differ significantly.

The local movement of fish distribution was measured by telemetry and video on saithe, pollock, cod, and mackerel on a reef in response to received SPLs of 195–218 dB re 1 µPa (Wardle, et al. 2001). Fish exhibited startle responses at all discharges, but only moved away from the source when the source was visible.

The local movement of fish distribution was observed with a source SPL of 222.6 dB re 1 µPa for 12 days of surveys over 1 month (Slotta, et al. 2004). The various species of pelagic fish showed no change in horizontal distribution, but demonstrated 66 to 164 ft (20 to 50 m) deeper vertical distribution. Densities of fish also decreased around the seismic source, and increased away from the seismic source.

The effects on freshwater fish local movement was investigated with received discharges of 176–180 dB re 1 µPa (Jorgenson and Gyselman 2009). No changes in fish movement could be detected.

In addition, studies conducted with questionable (Hastings and Popper 2005) methodology on salmonids have indicated that 230 dB re 1 µPa (Turnpenny and Nedwell 1994) damages salmonid swim bladders (Falk and Lawrence 1973). Another study (Thomsen 2002) indicates that received SPLs of 142–186 B re 1 µPa did not affect nearby fishery longline data, and only generated minor behavioral effects.

Fisheries Effects

Effects to fisheries have been documented in other Arctic fisheries (Hovem 2011) though there is no commercial fishery in the project area. In some fisheries, an increase in catch rates may be seen with a change in gear, because of fish disorientation (Løkkeborg, et al. 2012).

When rockfishes from a hook and line fishery were exposed to received SPLs from 186-191 dB re 1 µPa, a significant decline in total catch was observed (Pearson, et al. 1992).

In the Barents Sea distribution and catch rates of cod and haddock were investigated with a source SPL of 248 dB re 1 µPa (Engas, et al. 1993, 1996). Density decreases in fish were observed between 45–64 percent, with the lowest catch rates <6.2 mi (<10 km) from the sound source. Catch rates from trawlers and longliners also had significant decreases.

The effects on cod catches was investigated with a source SPL 239 dB re 1 µPa, and was used for 43 hours over 11 days with discharges on a 5-second interval (Løkkeborg 1991; Løkkeborg and Soldal 1993; Dalen and Knutsen 1986). Catch rates of cod decreased between 55–80 percent and persisted at least 24 hours, over a 6.2-mi (1- km) study area.

The effects on bass fisheries on shallow, nearshore environments (16.4–98.4 ft [5–30 m] water depth) was investigated with a source level of 250 dB re 1 µPa, with received levels between 163–191 dB re 1 µPa (Turnpenny and Nedwell 1994; Turnpenny, et al. 1994). No evidence of migration or reduced catch could be found during acoustic discharge when compared to control days. Shallow nearshore environments may dissipate the sound sufficiently to greatly reduce individual fish exposure.

Two other studies for sea bass (Skalski, et al. 1992) and rockfish (Pickett, et al. 1994) found similar results. During acoustic discharge, the rockfish were significantly more difficult to catch and moved to deeper waters. The authors hypothesized that catch rates would quickly return to normal upon cessation of acoustic discharge because of the reaction being behavioral. A study on sea bass over a period of four to five months found that bass did not leave the area over the long term, and that no significant catch rates in the long term could be identified.

5.4 Marine Mammals and Threatened and Endangered Species (Mammals)

The MMPA, as amended through 1997, established federal authority to protect and conserve all marine mammals within US marine waters. Under the MMPA, it is unlawful to take, attempt to take, or unintentionally take, marine mammals. The MMPA defines the term “take” as harassing, hunting, capturing, killing, or collecting; or attempting to harass, capture, kill, or collect marine mammals.

Harassment is statutorily defined as “any act of pursuit, torment, or annoyance.” An exemption stated in Section 119 of the MMPA allows subsistence hunts by Alaska Natives.

The ESA of 1973 established a process by which animal or plant populations that are in jeopardy of extinction throughout all or a significant portion of their range could be listed as threatened or endangered to protect the species and its critical habitat. A threatened species is an animal or plant species that is likely to become endangered within the foreseeable future throughout all or a significant portion of its range. Table 5.4-1 shows current ESA status, estimated abundance, preferred habitat, and occurrence in the project area of the 14 marine mammal species that may occur in the project area. ESA-listed species are presented first followed in descending order of species relative abundance in the Chukchi Sea. Three cetacean species (bowhead, fin, and humpback whales) are listed as endangered under the ESA. The most expected species to occur in the project area are the bowhead, beluga, and gray whale. Six pinniped species are known to occur within or near the project area and may be encountered during the proposed activities, as well as the polar bear.

Table 5.4-1. Fourteen Marine Mammal Species That are Known to Occur or May Occur in the Project Area

Species (Stock)	US Federal Status[1]	Estimated Stock Abundance[2]	Relative Abundance in Chukchi Sea	Preferred Habitat in Chukchi Sea	Seasonal Occurrence in Chukchi Sea	Occurrence in Project Area Boundaries
Cetaceans						
Bowhead Whale (*Western Arctic stock*)	EN	11,836	Common seasonally	Pack ice and coastal	Primarily spring and fall migrations	July–October
Humpback Whale (*Western North Pacific stock*)	EN	20,800	Seasonally uncommon	Widely distributed, coastal, and offshore ice-free waters; shelf	Summer and fall in ice-free waters	July–September
Fin Whale (*Northeast Pacific stock*)	EN	Currently, no reliable abundance estimate is available for this stock. In 2006, it was estimated that 1,652 individuals were in the area.	Rare	Slope, mostly pelagic ice-free waters	Extralimital	July–September
Gray Whale (*Eastern North Pacific stock*)	DL	19,126	Common seasonally	Coastal, lagoons in ice-free waters	Summer and fall feeding	July–October
Beluga Whale (*Eastern Chukchi Sea/Beaufort Sea*)	NL	3,71039,258	Common seasonally	Offshore, coastal, ice edges, pack ice	Spring and fall migrations	October
Killer Whale (*Eastern North Pacific Alaska resident stock*)	NL	2,084	Rare	Widely distributed, including among pack ice	Spring, summer, and fall	July–October
Harbor Porpoise (*Bering Sea Stock*)	NL	48,215	Seasonally uncommon	Coastal, inland ice-free, and, occasionally, shallow offshore waters	Summer and fall in ice-free waters	July–October
Minke Whale (*Eastern North Pacific stock*)	NL	810	Seasonally uncommon	Widely distributed, coastal, shelf, and offshore in ice-free or light-ice waters	Extralimital	July - October

Species (Stock)	US Federal Status[1]	Estimated Stock Abundance[2]	Relative Abundance in Chukchi Sea	Preferred Habitat in Chukchi Sea	Seasonal Occurrence in Chukchi Sea	Occurrence in Project Area Boundaries
Pinnipeds						
Ringed Seal (*Alaska*)	Threat-ened	Up to 3.6 million. Currently, no reliable abundance estimate is available for the Beaufort Sea; however, combined with surveys from the Chukchi Sea, approximately 250,000 are estimated.	Common year-round in areas of ice	Landfast ice, pack ice, and open water	Regular	July - October
Bearded Seal (*Alaska*)	Threat-ened	Currently, no reliable abundance estimate is available for this stock. An early estimate of the Bering–Chukchi seas was 155,000.	Common year-round	Shelf waters, pack ice, open water	Regular	May - October
Spotted Seal (*Alaska*)	NL	Several thousand and several tens of thousands. An estimate with correction using 1992 data = 59,214 seals, but is preliminary at best.	Common year-round	Shelf waters, pack ice, coastal haul-outs, and open water	Rare	July - October
Ribbon Seal (*Alaska*)	NL	Currently, no reliable abundance estimate is available for this stock. Early estimates of the Bering Sea were 49,000.	Rare	Offshore, pack ice, and open water	Rare	July - October
Pacific Walrus	Candidate Species	Currently unknown, but approximated at 200,000.	Common at or near ice edge	Ice edge	Regular	June–October
Other						
Polar Bear	Threat-ened	2,000	Common at or near ice edge and terrestrial denning areas along the coast	Sea ice	Spring, fall, and winter; when sea ice is present	October–April

1 ESA = Endangered Species Act. Stocks listed as depleted under the MMPA (Marine Mammal Protection Act) are described as any stock that falls below its optimum sustainable population must be classified as "depleted," 16 U.S.C. § 1362(1)(A). The numeric threshold for optimum sustainable population (OSP) has been interpreted by NMFS and USFWS as being above 0.6 K (i.e., greater than 60 percent of carrying capacity [K]). In other words, a stock that dropped in numbers to below 60 percent of K would qualify as "depleted" under the MMPA. The term "strategic stock" is defined as a marine mammal stock: (A) for which the level of direct human-caused mortality exceeds the Potential Biological Removal level; (B) which, based on the best available scientific information, is declining and is likely to be listed as a Threatened species under the Endangered Species Act of 1973 within the foreseeable future; or (C) which is listed as a Threatened species or Endangered species under the Endangered Species Act of 1973, or is designated as depleted under [the MMPA]. DL = Delisted, EN = Endangered, NL = Not listed under ESA, not listed as depleted under MMPA, and not classified as a strategic stock.

Many studies documenting the distribution, relative abundance, and acoustic detections of marine mammals in the Chukchi Sea region have occurred. The methods of these studies are summarized in Section 1.4, Chukchi Sea Marine Mammal Baseline Studies. Marine mammals are specialized to receive and produce sounds to locate prey, communicate, and navigate. Because of their specialized biology and sensitivity to sound in the environment, the potential effects of a 2D seismic program on marine mammals will be discussed in this section. Additionally, species-specific results from the baseline studies will be discussed in their respective sub-sections.

Information presented in this section was obtained from the following sources:

- Regulatory agency documents (e.g., environmental impact statements, environmental assessments and stock assessments)
- Data collected as part of the COMIDA program and CSESP
- Industry monitoring data published in 90-day reports
- Institutionally and privately funded research.

5.4.1 Cetaceans (Whales)

Eight species of cetaceans may occur within the TGS project area: bowhead, humpback, fin, gray, beluga, killer, and minke whales and the harbor porpoise. This section describes the ecology and life history of each species and details the known occurrence within the project area. Table 5.4.1-1 summarizes the sightings of cetaceans observed during the surveys mentioned above and described in Section 1.4. These studies have indicated that beluga whales and gray whales are the cetacean species most likely to be seen in the project area, followed by bowhead whales.

Table 5.4.1-1. Number of Individual Cetaceans Observed in the Chukchi Sea Region during Selected Surveys, Reported by Survey and Year(s)

Cetacean Species	Study Name and Year(s): Area Surveyed			
	Brueggeman, et al. 1990-1992: Chukchi Sea Planning Area1, 2	Clarke, et al. 2008-2010 (COMIDA): Between 68-72°N, 157-169°W2	Funk, et al. 2006-2010 (Joint Industry Monitoring): Lease Sale 193 Area and Nearshore† Waters1, 2	Aerts, et al. 2008-2010 (CSESP): Lease Sale 193 Area1
Bowhead whale	15	112	149	59
Humpback whale	0	1	11	7
Fin whale	0	1	6	0
Gray whale	301	835	498	118
Beluga whale	1,336	1,567	44	0
Killer whale	12	0	12	9
Minke whale	1	0	59	3
Harbor porpoise	0	0	119	15
Unidentified cetacean	18	140	93	16

[1] vessel-based survey
[2] aerial survey
† 20 mi (32 km) offshore

5.4.1.1 Bowhead Whale

Bowhead whales (*Balaena mysticetus*) are large baleen whales that filter feed primarily on copepods and euphausiids (Lowry 1993). Evidence exists of bowhead whales feeding during both the fall migration and spring migrations through the Arctic Ocean (Lowry, et al. 2004; Mocklin 2009). They have also been observed feeding near Point Barrow and other nearshore regions of the northeast Chukchi Sea (Clarke, et al. 2011b). Bowhead whales have no known predators, except for subsistence users and occasionally killer whales (NMFS 2008). More recently, they have been observed with a high percentage of apparent killer whale scars (Sims, et al. 2013).

Bowhead whales live long, grow slowly, mature relatively late, and reproduce infrequently (Zeh, et al. 1993; Koski, et al. 1993). Females become sexually mature starting around age 15 years (Koski, et al. 1993). Females reach sexual maturity when they are around 42.6–44.3 ft (13.0–13.5 m) in length and males mature later, around 17 to 27 years of age (IWC 2004) and are generally smaller than females (Koski, et al. 1993). Annually, bowhead whale mating may start as early as January or February, but mainly occurs during their spring migration (Nerini 1984; Koski, et al. 1993). Females give birth to a single calf every three to four years after a gestation period of 13–14 months (Nerini 1984). Calving starts in March and has been seen to occur until early August (Koski, et al. 1993). They have been documented to live past 100 years of age (George, et al. 2004).

Of the four recognized stocks of bowhead whales worldwide, the largest is the Western Arctic stock (also known as the Bering–Chukchi–Beaufort Sea stock) (IWC 2010; Allen and Angliss 2012). This stock inhabits the Bering, Chukchi, and Beaufort seas (Figure 5.4.1.1-1) (Rugh, et al. 2003; Allen and Angliss, 2012). The stock is currently listed as federally Endangered under the ESA (35 FR 18319 1970) and is classified as a strategic stock by NMFS (Allen and Angliss 2012). No critical habitat is designated for this species.

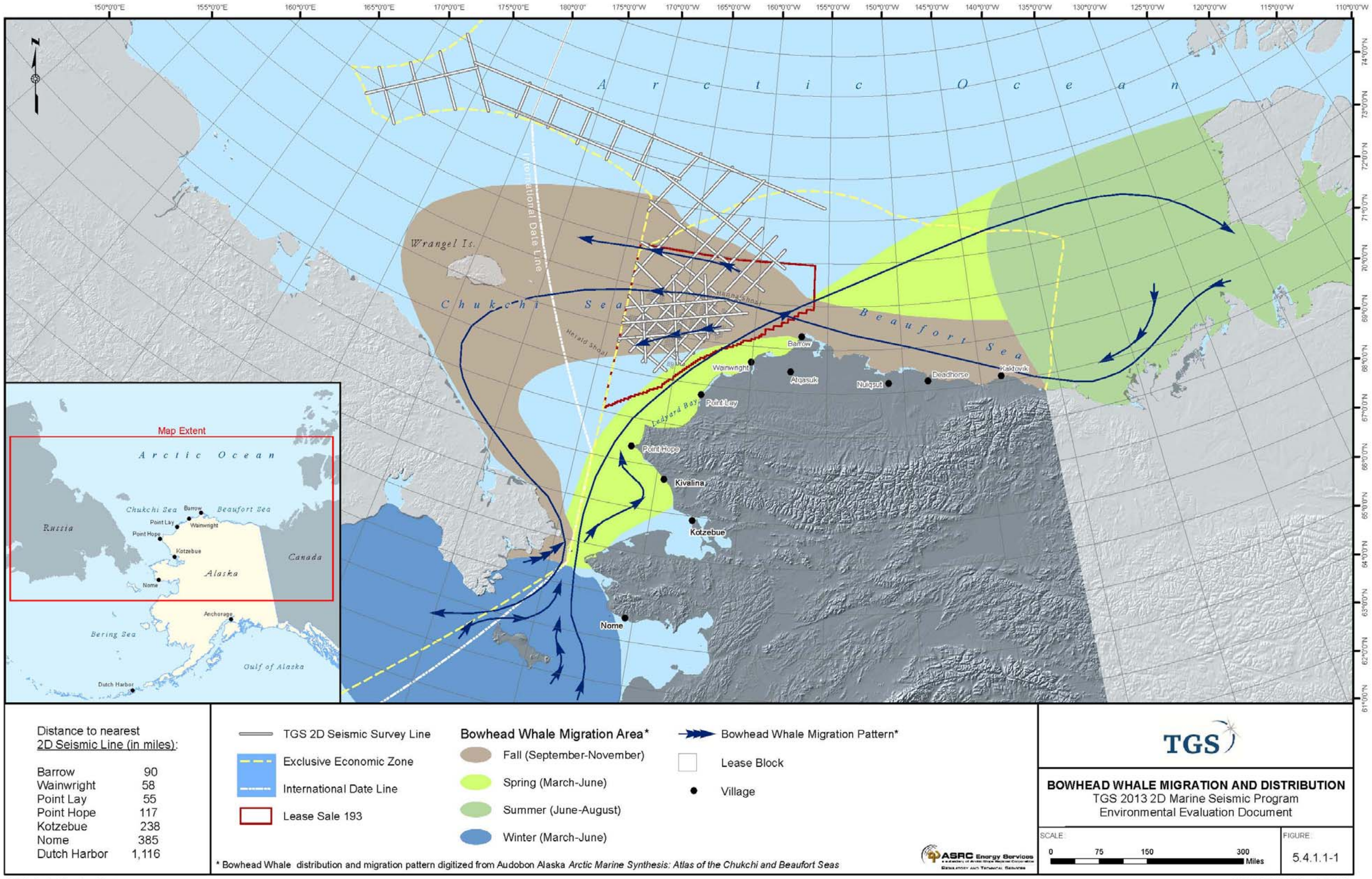

Figure 5.4.1.1-1. Bowhead Whale Migration and Distribution

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The Western Arctic stock winters in the Bering Sea (Figure 5.4.1.1-1). From March through June, the stock migrates north and east across the Chukchi Sea following open ice leads to summer and feed in the Canadian Beaufort Sea (Braham, et al. 1980, 1984; Allen and Angliss 2012; Rugh, et al. 2003; Moore and Reeves 1993; Quakenbush, et al. 2010a). In the fall, these bowhead whales migrate back west past Barrow and through the northern Chukchi Sea, some into Russian waters, before turning southeast towards the Bering Sea (Moore, et al. 1995; Mate, et al. 2000; Quakenbush, et al. 2010a). A small number of satellite-tagged bowheads reached approximately 75°N during the westward fall migration (Quakenbush, et al. 2010a).

On the basis of aerial and vessel survey data and satellite-tagging studies, a small number of individuals from this stock have been documented in or near waters of the project area in August–October during the species' westward migration (Brueggeman, et al. 2009, 2010; Quakenbush, et al. 2010a; Aerts, et al. 2011; Clarke, et al. 2011a, 2011b, 2012). Bowhead whales potentially occurring in the project area would be expected to prefer waters less than 656 ft (200 m) deep based on results of other studies (summarized in LGL 2012). No confirmed bowheads were seen or heard during extensive summer/fall vessel-based marine mammal monitoring programs associated with the 2011 University of Alaska Geophysical Institute seismic project in an area overlapping the proposed TGS operations as reported in the associated 90-day reports to NMFS (Cameron, et al. 2012). However, bowheads were seen or heard between September 18 and October 12, 2011, during the Statoil marine mammal monitoring program out to approximately 124.2 mi (200 km) northwest of Wainwright (Hartin, et al. 2011).

The Western Arctic stock of bowhead whales has been steadily increasing in numbers as documented over the last four decades. George, et al. (2004) reported that the stock has increased at a rate of 3.4 percent from 1978–2001. During this period, abundance doubled from approximately 5,000 to 10,000 whales (LGL 2012). The count of 121 calves during the 2001 census was the highest yet recorded. This peak was likely caused by a combination of variable recruitment and the large population size (George, et al. 2004; Zeh, et al. 2004; LGL 2012). The calf count provides corroborating evidence for a healthy and increasing population (LGL 2012). The Western Arctic stock was recently estimated at 11,836 whales and has been growing at an annual rate of about 3.2 percent (Schweder, et al. 2009; LGL 2012).

The bowhead whale is an important subsistence species for Alaska Native communities. Eskimos have been taking bowhead whales for at least 2,000 years (Stoker and Krupnik 1993; NMFS 2008). Subsistence takes have been regulated by a quota system under the authority of the IWC since 1977 (NMFS 2008). There are two Alaska villages currently participating in subsistence hunts that are located in or near the project area: Wainwright and Barrow. These villages are along the coast of the Chukchi Sea (NMFS 2008).

5.4.1.2 Gray Whale

Gray whales (*Eschrichtius robustus*) are large baleen whales that filter feed primarily on benthic amphipods. The lifespan of gray whales is unknown, but they are known to live more than 40 and up to 75 years (Reeves, et al. 2002; Jones and Swartz 2002). They reach sexual maturity at approximately eight years old and females generally give birth to one calf after a gestation period of 12 to 13 months. Calves, born dark gray in winter, become independent in seven to nine months, before the southward migration (Reeves, et al. 2002). Gray whales travel alone or in small groups, but aggregations may occur in breeding or feeding grounds (Reeves, et al. 2002).

The Eastern North Pacific stock or California gray whale population, like all large whale populations, was once hunted to near extinction. However, it has since recovered significantly from commercial whaling. The stock was removed from the US Endangered Species List in 1994 and is not considered by NMFS to be a strategic stock (Allen and Angliss 2012). The population is currently estimated at 19,126 whales (LGL 2012; Allen and Angliss 2012).

The Eastern North Pacific gray whale ranges from the Bering, Chukchi, and Beaufort seas (in summer) to the Gulf of California (in winter) (Figure 5.4.1.2-1) (Rice and Wolman 1971; Nerini 1984; Rice 1998; Moore, et al. 2003). However, gray whales also forage in waters off Southeast Alaska, British Columbia, Washington, Oregon, and California (Rice and Wolman 1971; Berzin 1984; Nerini 1984; Darling 1984; Clarke, et al. 1989; Quan 2000; Calambokidis, et al. 2002; Moore, et al. 2007; Allen and Angliss 2012). Most of the Eastern North Pacific population makes a round-trip annual migration of over 4,971 mi (8,000 km) from Alaska feeding waters to breeding and calving waters in Baja California, Mexico (Rice and Wolman 1971; Rice, et al. 1981; Allen and Angliss 2012). From late May to early October, the majority of the population feeds in the northern and western Bering and Chukchi seas.

Typically, gray whales inhabit shallow water, remaining closer to shore than any other large cetacean throughout the year. Gray whales are considered common summer residents in the nearshore waters of the eastern Chukchi Sea. They are occasionally seen east of Point Barrow in late spring and summer, as far east as Smith Bay (Green, et al. 2007). Sightings of small groups or individuals have been reported in the project area during August–October (Brueggeman, et al. 2009, 2010; Clarke, et al. 2011a, 2011b). At least eight gray whales were seen between August 6 and September 27, 2011, during marine mammal monitoring associated with the Statoil project in an area overlapping the TGS Alaska project area (LGL 2011). No gray whales were reported during vessel-based monitoring for the UAGI seismic project during September 8 to October 9, 2011, in an area overlapping the Alaska TGS project area (Cameron, et al. 2012).

On the basis of available data, gray whale numbers in the Chukchi Sea are expected to be much higher during summer than fall, with most individuals concentrated in nearshore areas well east of the TGS project area. Furthermore, gray whales rarely range north of 72°N in the Chukchi Sea (Figure 5.4.1.2-1). Thus, relatively low numbers of gray whales are expected to be encountered in the project area, with few if any expected to occur near proposed fall operations north of 72°N.

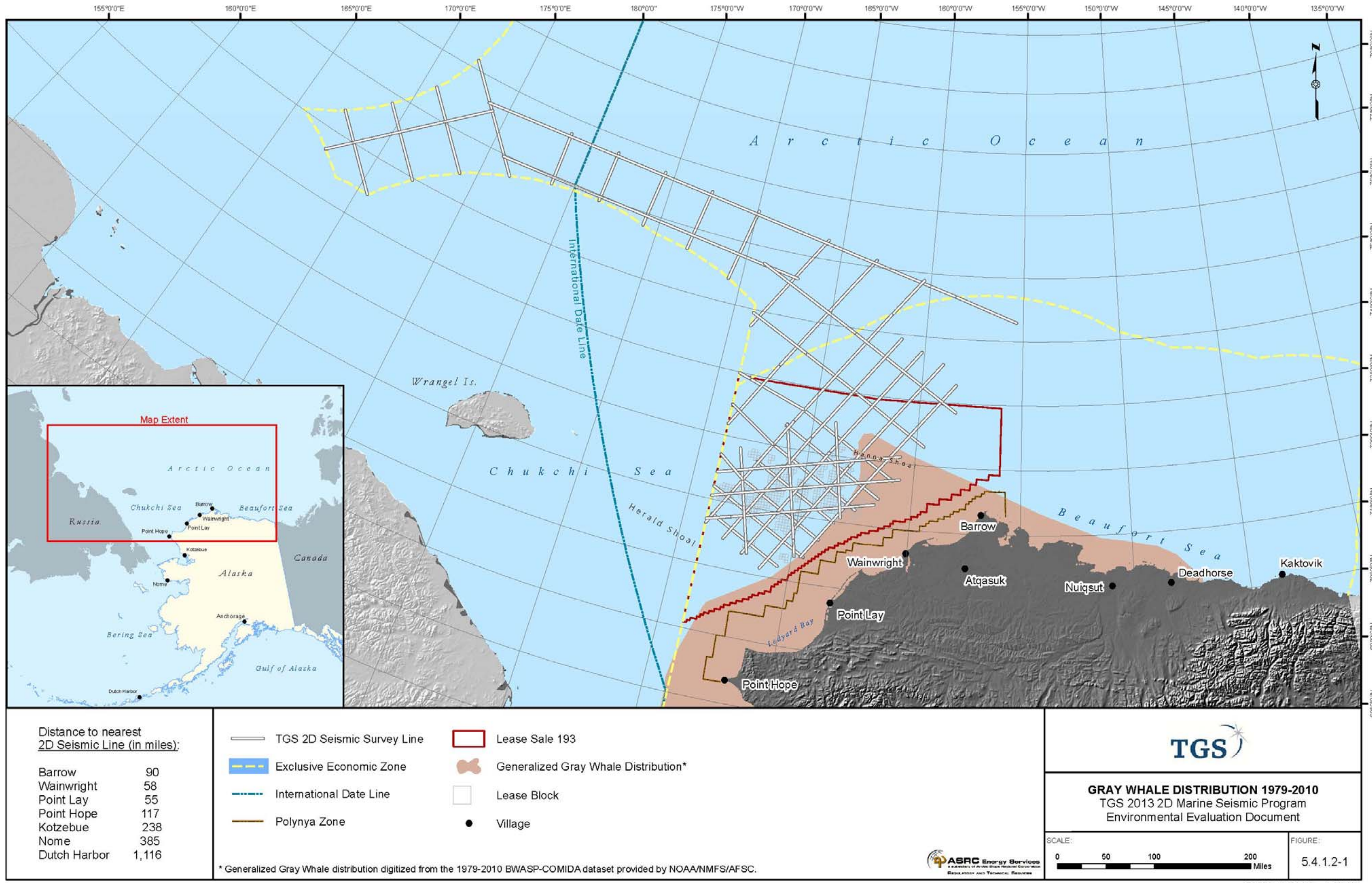

Figure 5.4.1.2-1. Gray Whale Distribution 1979-2010

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5.4.1.3 Beluga Whale

Beluga whales (*Delphinapterus leucas*), also known as white whales, are small odontocetes (toothed whales), that feed opportunistically on a variety of fishes, crustaceans, squids, mollusks and other invertebrates (Reeves, et al. 2002; NMFS 2012a). They live over 25 years, and possibly over 50 years, and are extremely social animals that migrate, hunt, and interact in groups of 10 to several hundred (Reeves, et al. 2002). Belugas have a circumpolar distribution and exhibit extreme levels of site fidelity. They summer in ice-free waters and occur in polynyas near the ice edge during winter. Female belugas reach sexual maturity at around four to seven years of age, and males around seven to nine years (NMFS 2012a). Belugas mate in springtime and after a 14- to 15-month gestation period, give birth to a single, dark gray calf every two to three years, which may nurse for one to two years (Reeves, et al. 2002).

Of the five beluga stocks occurring in Alaska (O'Corry-Crowe, et al. 1997; Allen and Angliss 2012) only the Eastern Chukchi Sea stock and possibly the Beaufort Sea stock may be encountered in the project area (Figure 5.4.1.3-1). Any occurrences of the beluga whale in the project area are most likely individuals from the Eastern Chukchi Sea stock. The latter stock is not considered by NMFS to be a strategic stock, and the current population trend of the Beaufort Sea stock is not in decline (Allen and Angliss 2012). Small numbers of beluga whales may occur in the project area in October (Clarke, et al. 2011). However, none were seen or heard during extensive summer-fall marine mammal monitoring programs associated with the 2011 UAGI and 2010 Statoil seismic projects in areas overlapping the proposed TGS Alaska operations as reported in the associated 90-day reports to NMFS (Hartin, et al. 2011; Blees, et al. 2012).

Both stocks overlap in the Beaufort Sea, and both winter in the Bering Sea (Suydam, et al. 2001; Allen and Angliss 2012). Much of the Eastern Chukchi stock breeds in Kasegaluk Lagoon in June and July. The current abundance estimate of 3,710 is considered the “most reliable” for the eastern Chukchi Sea beluga whale stock based on 1989–1991 aerial surveys (Frost, et al. 1993; Allen and Angliss 2012). Additional surveys were conducted in 1998 (DeMaster, et al. 1998) and again in July 2002 (Lowry and Frost 2002). However, both were partial surveys and therefore, a more complete abundance estimate for this stock is not available (Allen and Angliss 2012). The Beaufort Sea stock moves out of the Chukchi Sea into the Beaufort Sea during spring (April to May) (Braham, et al. 1984). They return in fall for their annual migration back to Bering Sea wintering areas. Migration generally occurs in deeper water along the ice front (Hazard 1988; Clarke, et al. 1993; Richardson, et al. 1995; Miller, et al. 1998).

Aerial surveys conducted in 2006 and 2007 in the Chukchi Sea reported peak sightings of belugas about 23 mi (37 km) from shore in July (Thomas, et al. 2009). Monthly sighting rates were lowest in September. Based on combined data, sightings rates of belugas and numbers of individuals were highest 16–22 mi (26–35 km) from shore in the Chukchi Sea. However the largest groups were seen within 3 mi (5 km) of shore. In summary, results reported by Thomas, et al. (2009) indicate that the highest numbers of belugas in this region occur close to the Alaska coast in the Chukchi Sea during summer.

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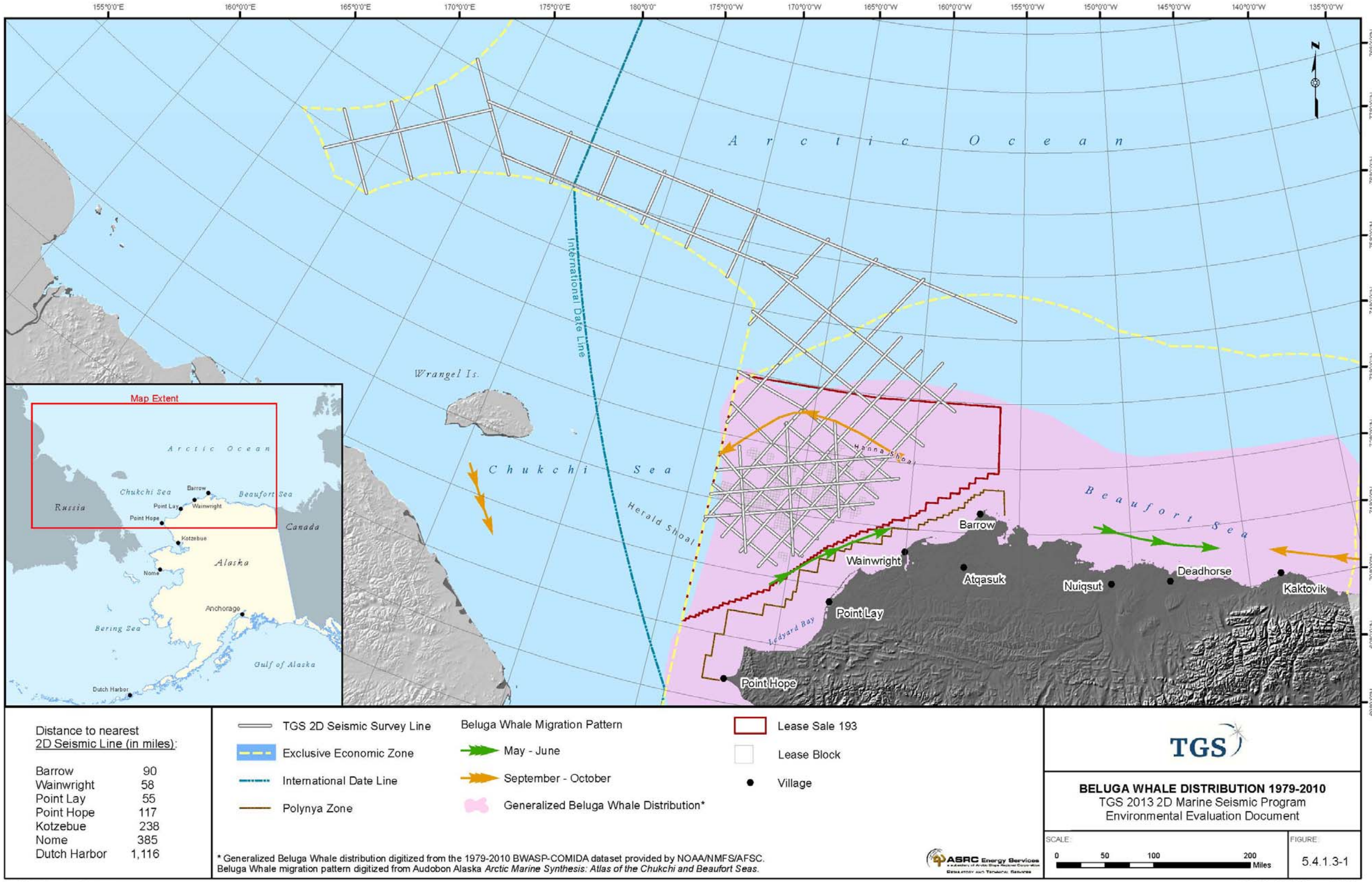

Figure 5.4.1.3-1. Beluga Whale Distribution 1979-2010

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Beluga whales are also known to congregate in Kasegaluk Lagoon along the Chukchi Alaska coast during summer. However, a small number of individuals have been shown to range from this lagoon into the Arctic Ocean north of the Beaufort Sea based on satellite-tagging studies (Suydam, et al. 2005). Of 23 beluga whales satellite-tagged in late June and early July of 1998–2002, five individuals moved into pack ice of the Arctic Ocean to 79-80°N (Suydam, et al. 2005). These whales as well as other tagged individuals traveled to areas up to 685 mi (1,102 km) from shore between Barrow and the Mackenzie River Delta in areas characterized by up to 90 percent ice coverage.

Small numbers of belugas could be encountered in the project area during proposed seismic operations. However, the number of belugas in the project area is expected to be relatively low, as most individuals appear to be much closer to shore and/or are closely associated with sea ice habitat. While some belugas may continue to concentrate at inshore breeding lagoons during summer, the majority of the migration will have passed this area by July on their way to the Beaufort Sea. However, a small number could also be encountered in waters north of 72°N in summer or fall based on satellite-tagging studies. If proposed seismic surveys extend into the fall, southward migrating belugas might also be encountered. However, proposed TGS operations would occur at least 55 mi (88 km) from the Alaska coast, with most operations much farther offshore where beluga density is expected to be relatively low. By approximately mid-September, TGS operations are expected to be occurring in international waters, over 200 nm from the Alaska coast. In addition, the seismic program will avoid ice conditions preferred by this species.

5.4.1.4 Fin Whale

Fin whales (*Balaenoptera physalus*), also known as finback whales, are large baleen whales that lungefeed only in summer months on krill and small schooling fish (Reeves, et al. 2002). Fin whales live at least 80 years and have a cosmopolitan distribution – occurring in all major oceans in temperate to polar latitudes (Reeves, et al. 2002). Although they most often travel alone or in small groups, large feeding aggregations are known to occur (Reeves, et al. 2002). Little is known of fin whale mating and breeding behavior, but females generally give birth to a single calf every two to three years after a gestation period of approximately 12 months.

Based on limited information, the IWC considers fin whales in the North Pacific to all belong to the same stock (Mizroch 1991). However, there is additional evidence that supports establishment of subpopulations in the North Pacific (Allen and Angliss 2012). For management purposes, three stocks of fin whales are currently recognized in US waters: Alaska (Northeast Pacific), California/Washington/Oregon, and Hawaii. Fin whales in the Bering Sea belong to the Northeast Pacific stock. Fin whales occur seasonally off the coast of North America and in the Bering Sea during summer (Allen and Angliss 2012). The fin whale is listed as endangered under the ESA, and therefore designated as depleted under the MMPA. As a result, the Northeast Pacific stock is classified as a strategic stock.

The fin whale population for the entire North Pacific region was estimated at 1,652 in 2006 (Zerbini, et al. 2006). However, reliable estimates of current and historical abundance for the entire Northeast Pacific fin whale stock are currently not available (Allen and Angliss 2012). Recent studies provide some information on the distribution and occurrence of fin whales. However, they do not provide estimates of population size. Fin whale abundance estimates were nearly five times higher in the central-eastern Bering Sea than the southeastern Bering Sea

(Moore, et al. 2002). Most sightings in the central-eastern Bering Sea occurred in a zone of particularly high productivity along the shelf break (Moore, et al. 2000; Allen and Angliss 2012).

Fin whale calls were detected in the southeast Bering Sea using an instrument moored there from April 2006 through April 2007. Results showed fin whale call detections peaked from September through November 2006 and also in February and March 2007 (Stafford, et al. 2010; Allen and Angliss 2012). Fin whales could be encountered in very low numbers in the project area, and are unlikely to occur above 72°N where TGS expects to be operating during September-October.

5.4.1.5 Humpback Whale

Humpback whales (*Megaptera novaeangliae*) are large baleen whales which filterfeed only in summer months primarily on small schooling fish and krill. Humpback whales generally occur alone or in small groups, but aggregations often occur during cooperative foraging events or during breeding season when males compete for a single female. They migrate between summer foraging grounds in the mid and high latitudes to tropical or subtropical winter breeding grounds (Reeves, et al. 2002). Females give birth to a single calf every two years, after a gestation period of about 11 months, with weaning occurring six to 10 months after birth.

The stock origin of the few individual humpbacks whales recorded in the Chukchi Sea is not known. These individuals may belong to the Central North Pacific stock (Funk, et al. 2010; Allen and Angliss 2012), or the Western North Pacific stock (Hashagen, et al. 2009). The humpback whale is listed as endangered under the ESA and is designated as “depleted” under the MMPA. Humpback whales are not taken for subsistence purposes by Alaska Natives from villages near the Chukchi or Beaufort Seas. The most recent population estimate for the Central North Pacific stock was 6,000-14,000 (Allen and Angliss 2012).

Currently, the “approximate distribution” of the Western North Pacific Stock of humpback whales extends into the southwestern Chukchi Sea during the summer feeding period (Allen and Angliss 2012). They have been known to feed periodically in the southern Chukchi Sea (Nemoto 1957; Tomlin 1967; Johnson and Wolman 1984; Mel'nikov 2000; Allen and Angliss 2012). However, the species is considered extralimital in the northern Chukchi Sea, including the project area vicinity. Only one humpback whale was observed during aerial surveys conducted from 2008-2010 (Clarke, et al. 2011) in the northern Chukchi Sea. The single observation was recorded in July 2009 and was within the proposed TGS project area.

The area proposed for TGS’s 2D seismic program is not within normal humpback whale feeding or migration areas. Thus, they are considered highly unlikely to be encountered during the program.

5.4.1.6 Minke Whale

Minke whales (*Balaenoptera acutorostrata*) are large, baleen whales which filterfeed on crustaceans, plankton, and small schooling fish. Minke whales generally occur in small groups, but larger feeding aggregations may occur (Jefferson, et al. 2008). Sexual maturity is reached between three and eight years of age, and mating/calving is thought to occur in winter in low latitudes (Jefferson, et al. 2008). Females give birth to a single calf annually after a gestation period of 10-11 months (Jefferson, et al. 2008).

Minke whales are found in coastal and offshore waters, including along ice floes and pack ice. Their normal range in Alaska is limited to the Gulf of Alaska north to the Bering and Chukchi seas, where they are considered relatively common (Mizroch 1991; Allen and Angliss 2012). Minke whales are known to penetrate loose ice during the summer, and some individuals venture north of the Bering Strait (Leatherwood, et al. 1982; Allen and Angliss 2012).

The population size of minke whales in Alaska is unknown and data are insufficient to determine population trends for this stock (Allen and Angliss 2012). Minke whales are not expected to be encountered in high numbers, as the expected density of this species is 0.6 individuals per square mile in the region (km^2) (Ireland, et al. 2008). Based on aerial and vessel survey data, a small number of individuals from this stock may occur in or near waters of the project area during August through October (Brueggeman, et al. 2009, 2010; Hartin, et al. 2011).

5.4.1.7 Killer Whale

Killer whales (*Orcinus orca*) are sexually dimorphic odontocetes, and females are considerably smaller than males and have shorter dorsal fins (Reeves, et al. 2002). Their diet is often geographically specific and varies from fish eating "Residents" to marine mammal eating "Transients." A third type, known as "Offshore" killer whales are similar to Residents; however, they have distinguishing physiological features and less sexual dimorphism. Females reach sexual maturity when they are about 15-18 ft (4.6-5.4 m) in length and give birth to a single calf after a gestation period of about 15-18 months (NMFS 2012b). Calves may nurse for up to two years. Killer whales have a cosmopolitan distribution and are divided into several subspecies and stocks.

Of the eight killer whale stocks recognized in the Pacific, the trans-boundary Alaska Resident stock inhabiting southeastern Alaska to the Chukchi Sea (Allen and Angliss 2012) is the only stock that could possibly be encountered during the TGS 2D seismic program. Based on aerial and vessel survey data, a small number of individuals have been reported in the project area in August – October (Brueggeman, et al. 2009). Based on NMML surveys the Alaska Resident stock consists of a minimum estimate of 2,084 killer whales (Allen and Angliss 2012).

Killer whales inhabit all Alaska waters (Braham and Dahlheim 1982), although they are considered rare in the Chukchi Sea. This species occurs throughout the world's oceans and seas, from the equator's more tropical waters to the cooler waters in the high latitudes (Leatherwood & Dahlheim 1978). They are most common in cooler coastal waters of both hemispheres, but appear in greatest numbers within 497 mi (800 km) from continental coasts (Mitchell 1975; Leatherwood & Dahlheim 1978; Forney and Wade 2006). Sightings near Point Barrow have coincided with the bearded seal migration, which may attract killer whales to this quite northern location.

5.4.1.8 Harbor Porpoise

Harbor porpoises (*Phocoena phocoena*) are small odotocetes that forage on schooling fishes and cephalapods (Reeves, et al. 2002). They are generally observed alone or in small groups, but foraging aggregations also occur (Reeves, et al. 2002). Harbor porpoises occur in nearshore waters, often in bays, estuaries and harbors of northern temperate and subarctic waters (Reeves, et al. 2002). Females are sexual mature by age three or four years and may give birth to a single calf every year, gestating for 10 to 11 months (Reeves, et al. 2002).

Harbor porpoises are unlikely to occur in significant numbers within the seismic acquisition area as the seismic transects will occur well offshore in water depths averaging approximately 131-328 ft (40-100 m) or more. Harbor porpoise are not listed as "depleted" under the MMPA or listed under the ESA. The Bering Sea stock of harbor porpoise is not classified as a strategic stock. Population trends and status of this stock relative to OSP are currently unknown.

The harbor porpoise is a small coastal cetacean generally inhabiting shallow coastal waters (Gaskin 1984; Dahlheim, et al. 2000, 2009). The Bering Sea stock, which ranges to Point Barrow (Suydam and George 1992), occurs most frequently in waters less than 328 ft (100 m) deep (Waite and Hobbs 2010; Allen and Angliss 2012). During summer, however, a small number of harbor porpoises from the Bering Sea stock do regularly move north into the Chukchi Sea (Allen and Angliss 2012). The harbor porpoise is considered highly unlikely to occur in the TGS project area given its rarity in the Chukchi Sea and its preference for shallow coastal waters, particularly given the offshore relatively deep waters characterizing the project area.

The most recent abundance estimate for the Bering Sea stock, based on aerial surveys conducted by NMML in Bristol Bay, is about 48,000 animals (Allen and Angliss 2012). These estimates are considered conservative, but are higher than an earlier estimate of about 11,000 by Dahlheim, et al. (2000).

5.4.2 Potential Effects on Cetaceans

5.4.2.1 Project Activities Evaluated for Potential Effects

Project activities that may potentially affect cetaceans include sounds generated from seismic activity or vessels, as well as vessel discharges and an accidental diesel fuel spill. Effects from vessel discharges and an accidental diesel fuel spill are discussed in Section 1.3 and are excluded here because the potential effects are expected to be extremely low.

Potential effects from seismic activities are discussed specifically for the bowhead whale because it occurs in large numbers during migrations in the Chukchi Sea and because it is a valuable subsistence species of great cultural importance to the local Alaska Native communities. The beluga whale is also a subsistence species valuable to Alaska Native communities. However, since most belugas are found much closer to shore and/or are closely associated with sea ice habitat, the number of belugas is expected to be low in the TGS project area. Therefore, we have discussed potential effects for beluga whales in a broader context than the bowhead whale. Potential effects to all other cetacean species are discussed in broad terms. Specific examples are discussed to draw distinctions or illustrate commonalities between species.

5.4.2.2 Sound from Seismic Activity

Project activities that produce sound into the marine environment include vessel activity, seismic airguns, and fathometers. TGS will be towing a 26,575-mi (8,100-km) hydrophone cable and will not be working in areas near sea ice. Ice management will not be necessary. Potential effects include behavioral reactions or responses and masking effects. Masking indicates the reduced ability of a marine mammal to detect sounds, such as communication calls, and is caused by the interference or masking of sounds (natural or introduced) in the marine environment (Richardson, et al. 1995). Any masking effects are expected to be temporary and not have lasting effects. Hearing impairment is possible in the form of Temporary or Permanent Threshold Shifts (TTS or PTS). TTS indicates a temporary reduction in hearing ability and PTS indicates a permanent shift or hearing loss. Such impairments could be a result of sudden exposure to a loud sound, such as a seismic pulse. However, TGS plans to implement a PSO program and mitigation measures to minimize exposures to seismic activity. Exposure to seismic sound sources is expected to be temporary.

Bowhead whale – Bowhead whales (Figure 5.4.1-1) will likely show some behavioral changes during seismic source activity based on available studies. However, depending on distance and received sound levels from the sound source, overall displacement should be minimal. Baleen whales exposed to strong sound pulses from seismic sources often react by deviating from their normal migration route and/or interrupting their feeding or respiration/dive patterns and moving away (LGL 2012). However, bowhead whales in the Beaufort Sea were observed remaining in a location where they were exposed to seismic, dredging, and drilling sounds. Their social and feeding behavior appeared normal as industry-related sounds occurred (Richardson and Würsig 1997). When observed over multiple years, bowhead whales in the same area also did not appear to avoid seismic locations. MMS did not find a statistical difference in the change of direction for bowhead whales traveling during seismic activity when analyzing fall migration data from 1996 to 1998 (MMS 2005). Bowhead and gray whales have appeared unbothered when seismic pulses between 160 to 170 dB re 1 µPa (rms) were discharged from a seismic vessel within a few miles (km) of their locality, but tended to avoid the area when levels exceeded 170 dB re 1 µPa (rms) (Richardson & Würsig 1997).

It is unclear exactly what causes displacement. However, whales have tended to show shorter surface and dive times, fewer blows per surfacing, and longer blow intervals when sound levels were at or above 152 dB re 1 µPa (rms); they also have exhibited avoidance of seismic operations within a 12.4 mi (20 km) radius (Ljungblad, et al. 1988; Richardson 1999). Bowhead whales may also leave or show total avoidance of vessels if they are too close (Richardson and Würsig 1997). Bowhead whales showed total avoidance at distances of 0.8 mi, 4.5 mi, 2.2 mi, and 1.8 mi (1.3 km, 7.2 km, 3.5 km, and 2.9 km) when the sound level was 152 dB, 165 dB, 178 dB, and 165 dB re 1 µPa (rms), respectively, in the Beaufort Sea (Ljungblad, et al. 1988).

Bowhead whales belong to the low-frequency functional hearing group of baleen whales (Southall, et al. 2007). Inferring from their vocalizations, bowhead whales should be most sensitive to frequencies between 20 Hz - 5 kHz, with maximum sensitivity between 100-500 Hz (LGL 2012).

In 1996-1998, studies were conducted on the effects on fall migrating bowheads from seismic source operations located within the main migration corridor in the Beaufort Sea. Results indicated a tendency for the general bowhead whale migration corridor to be farther offshore on days with a seismic source operating vs. days without a seismic source operating (Richardson 1999). However, the distribution of bowheads overlapped in terms of distances from shore during both the presence and absence of seismic source operations. Data from aerial surveys suggested that bowheads appeared to avoid the area within about 12-19 mi (20-30 km) of the operating source. Within 12 mi (20 km) of seismic operations, sighting rates were significantly lower in the presence vs. the absence of seismic sounds. From 12-24 hours after seismic operations stopped, sighting rates were similar within 12 vs. beyond 12 mi (20 vs. beyond 20 km) away. No obvious changes in headings, general activities, or swimming speeds were recorded in the presence vs. absence of seismic operations. Overall, results indicated that during seismic operations, most bowheads occurred 12-19 mi (20-30 km) away.

The above reported avoidance distance of 12-19 mi (20-30 km) is the largest such radius documented for any baleen whale. This includes extensive studies conducted on the behavior and occurrence of bowheads near industrial activities in the Beaufort Sea in the 1980s; however, this is a smaller avoidance radius than the 30 mi (55 km) suggested by subsistence whalers (the latter is based on their impression of seismic operational effects prior to 1996) (Richardson 1999). During the 1980s, seismic activities involved 2D in deeper water. The more recent seismic activities involved three-dimensional (3D) ocean bottom cable focused in shallow water.

Analyses of bowhead whale calls recorded during the same 1996-1998 study indicated the following (per Greene, et al. 1999a): (1) during the fall migration, bowhead whales called in the study area; (2) calling continued when exposed to seismic source pulses; and (3) detection rates of calls differed significantly at some locations when a seismic source was detectable vs. undetectable. However, no significant consistent tendency was noted for changes in call-detection rates relative to the staring or stopping of the seismic source. Blackwell, et al. (2013) recently reported decreased calling rates by bowhead whales in the Beaufort Sea with increased sound levels of industrial sounds (Blackwell, et al. 2013).

As a result of the aforementioned 1996-1998 studies, a summary statement was released by the peer-review group at the 2001 Arctic Open-Water Noise Peer Review Workshop. The statement supported the study's methods and results showing bowhead avoidance of seismic sounds. The peer-review group stated: monitoring studies of 3D seismic exploration (a seismic source array consisting of 8-16 airguns totaling 560–1,500 in^3 [1,422–3,810 cm^3]) in the nearshore Beaufort Sea during 1996-1998 have demonstrated that nearly all bowhead whales will avoid an area within 12 mi (20 km) of an active seismic source, while deflection may begin at distances up to 22 mi (35 km). Sound levels received by bowhead whales at 12 mi (20 km) ranged from 117–135 re 1 μPa (rms) and 107-126 dB re 1 μPa (rms) at 19 mi (30 km). These received sound levels are considerably lower levels than have previously been shown to elicit avoidance in bowhead or other baleen whales exposed to seismic pulses."

Miller, et al. (2002) estimated that bowheads observed surfacing 1,060–2,014 ft (323–614 m) from the operating seismic vessel would have been exposed to sound levels of approximately 180 dB re 1 μPa (rms) before the seismic source array was immediately shutdown as mitigation (Miller, et al. 2002). A total of seven shutdowns occurred when bowheads were observed less than 0.62 mi (1 km) away from the seismic vessel. The authors estimated that at 6,421 ft (1,957 m) from the operating seismic source array (the average vessel-based sighting distance), bowheads would have been exposed to sound levels of approximately 170 dB re 1 μPa (rms). The estimated received sound level for the multiple sightings made from the observation aircraft 3.3–12.4 mi (5.3–19.9 km) from the seismic vessel ranged from about 150–130 dB re 1 μPa (rms), respectively.

In contrast, a study conducted in summer 2001 (Miller, et al. 2002) showed very different results for bowhead whales exposed to seismic sounds. For example, in the 2001 study, a total of 262 bowhead sightings were made from the seismic observation vessel compared to only one bowhead sighting during six seasons spanning 1996-2001. The avoidance distance in 2001 was much smaller (approximately 1.24 mi [2 km]) than the up to 12-19 mi (20-30 km) reported for migrating fall bowheads. It was concluded that fall migrating bowheads appeared to be more sensitive to seismic sound disturbance than summer feeding bowheads (Davis 1987).

Proposed seismic operations are likely to result in short-term behavioral changes by some bowheads based on results of studies summarized above and other studies. There is no evidence that such short-term behavioral changes result in injuries or long-term effects on individuals or populations of bowheads, and no such effects are expected (NMFS 2011). Weather and ice permitting, TGS plans to begin survey operations in late July-early August when bowheads are feeding primarily in Canadian waters of the Beaufort Sea. When bowheads begin migrating back to the Chukchi and Bering seas in the fall, TGS plans to be conducting seismic operations north of 72°N in international waters, where bowheads are much less likely to be found based on available data (see Figure 1.2-1 and Figure 5.4.1.1-1). Furthermore, on average, studies indicate that by 15 October, about 97 percent of bowheads have migrated through the eastern US Beaufort

Sea (Miller, et al. 2002) and are south of 72°N when the TGS operations are planned to be in international waters above this latitude.

Other cetaceans – Low numbers of humpback, fin, minke, and killer whales, as well as harbor porpoise are expected in the TGS project area. Therefore, potential effects are expected to be insignificant on these species. If any of the above species do occur in the TGS project area, it is likely that they will avoid the area during seismic activities and possibly exhibit temporary displacement. Mitigation measures, as mentioned above and in Section 8, should prevent any significant effects.

Gray and beluga whales are more likely to occur in the TGS project area than the above species. Gray whales are likely to show behavioral avoidance to seismic sounds exceeding 170 dB re 1 μPa (rms) based on available studies (Richardson, et al. 1995; Richardson and Würsig 1997). In addition, behavioral changes such as shorter blow periods and increased swim speed have been observed as a result of seismic activity at distances up to 19 mi (30 km) away (Würsig, et al. 1999). However, a multi-year shore-based study noted no change in abundance during seismic activities (Johnson, et al. 2007). Beluga whales are likely to show temporary displacement from seismic exposure, but the effect is not expected to be long-term or significant. Belugas are known to remain within the ensonified zones of stationary sound sources (i.e. dredges), and have been observed in low numbers within 6.2 to 12.4 mi (10 to 20 km) of seismic vessels (LGL 2006)

5.4.2.3 Disturbance from Vessels

Cetaceans may react to vessel activity within the project area, including transitory operations of both the source and scout vessel. As the number of project vessels is limited to two, the affect is expected to be minimal. Potential displacement may occur, as seen with humpback whales (Miles and Malme 1983; Baker, et al. 1982) and killer whales (Williams and Ashe 2007; Foote, et al. 2004). However, the mitigation and monitoring measures (Section 8) are in place to minimize these effects. Belugas are known to be tolerant of sound from some large vessels but often flee from small, erratically moving vessels (Richardson, et al. 1995). By adjusting speed and altering course (if feasible), the project vessels will avoid and minimize interactions with cetaceans.

5.4.3 Pinnipeds (Ice Seals)

This section includes information on the distribution and abundance of ice seals in the project area. Ice seals described in this section include ringed, spotted, ribbon, and bearded seals. Ice seals are closely associated with the ice pack for all or part of the year, but some species regularly occur in open water in the summer months (BOEMRE 2010). Based on marine mammal survey data, ringed and bearded seals are the most abundant, while spotted and ribbon seals have not been observed in high numbers (Table 5.4-3).

Table 5.4-3. Number of Pinniped Sighted in the Chukchi Sea Region during Selected Surveys, Reported by Survey and Year(s)

Ice Seal Species	Study Name and Year(s): Area Surveyed			
	Brueggeman, et al. 1990-1992: Chukchi Sea Planning Area1, 2	Clarke, et al. 2008-2010 (COMIDA): between 68-72°N, 157-169°W2	Funk, et al. 2006-2010 (Joint Industry Monitoring): Lease Sale 193 Area and near shore† waters1, 2	Aerts, et al. 2008-2010 (CSESP): Lease Sale 193 Area1
Ringed seal	776	2	1,302	149
Spotted seal	54	not observed	355	98
Ribbon seal	1	not observed[#]	9	6
Bearded seal	358	174	722	265
Unidentified pinniped [$]	803	819	2,031	313

[1] vessel-based survey
[2] aerial survey
† 32 km (20 mi) offshore
[$] Unidentified pinnipeds are likely ringed seals, but could also be bearded seals, ribbon seals, spotted seals, or Pacific walruses
[#] Ribbon seals are not common in the area surveyed

5.4.3.1 Ringed Seal

The ringed seal (*Phoca hispida*) is the smallest (5 ft [1.5 m]) and most common seal in the Arctic. Their distribution is circumpolar, ranging from 35°N to the North Pole. They are closely associated with ice floes and pack ice, and are solitary animals that separate themselves when hauled out on ice. Ringed seals breed in the spring (March – April), and give birth to a single pup after a nine-month gestation period. They largely feed on fish and invertebrates. The Alaska stock is the only recognized stock of ringed seals in US waters and has an estimated population of 249,000 individuals (NMFS 2012c).

Ringed seals are the most abundant seal species in the proposed survey area, followed by bearded seals then spotted seals. Ringed seals are year-round residents in the Arctic (Figure 5.4.3.1-1) and occur in TGS project area boundaries from July–October. Ringed seals are generally found on the ice front, but they have also been observed in open water in the project area during August–October (Brueggeman, et al. 2009, 2010; Hartin, et al. 2011; Cameron, et al. 2012). CSESP studies indicate that ringed seal presence was higher in years when sea ice had moved into the survey areas (Aerts, et al. 2011).

COMIDA surveys conducted from 2008-2010 reported only two ringed seal observations in the Lease Sale 193 area (Table 5.4-3) (Clarke, et al. 2011). However, ringed seals were reported as the most common species identified by observers during the 2006–2010 Joint Industry Monitoring study (Funk, et al. 2011). Most ringed seals were observed in water compared to on ice, as they use the water for basking (Aerts, et al. 2011). Ringed seals were not observed hauled out on land during CSESP studies.

In 2010, NMFS proposed the Arctic ringed seal (in addition to the Okhotsk and Lagoda stocks) be listed as threatened under the ESA because of threats of global climate change. This proposal for designation was under review for nearly two years (75 CFR 77476 2010) before NMFS listed the final ruling for the threatened status of ringed seals in December 2012 (77 FR 76706 2012).

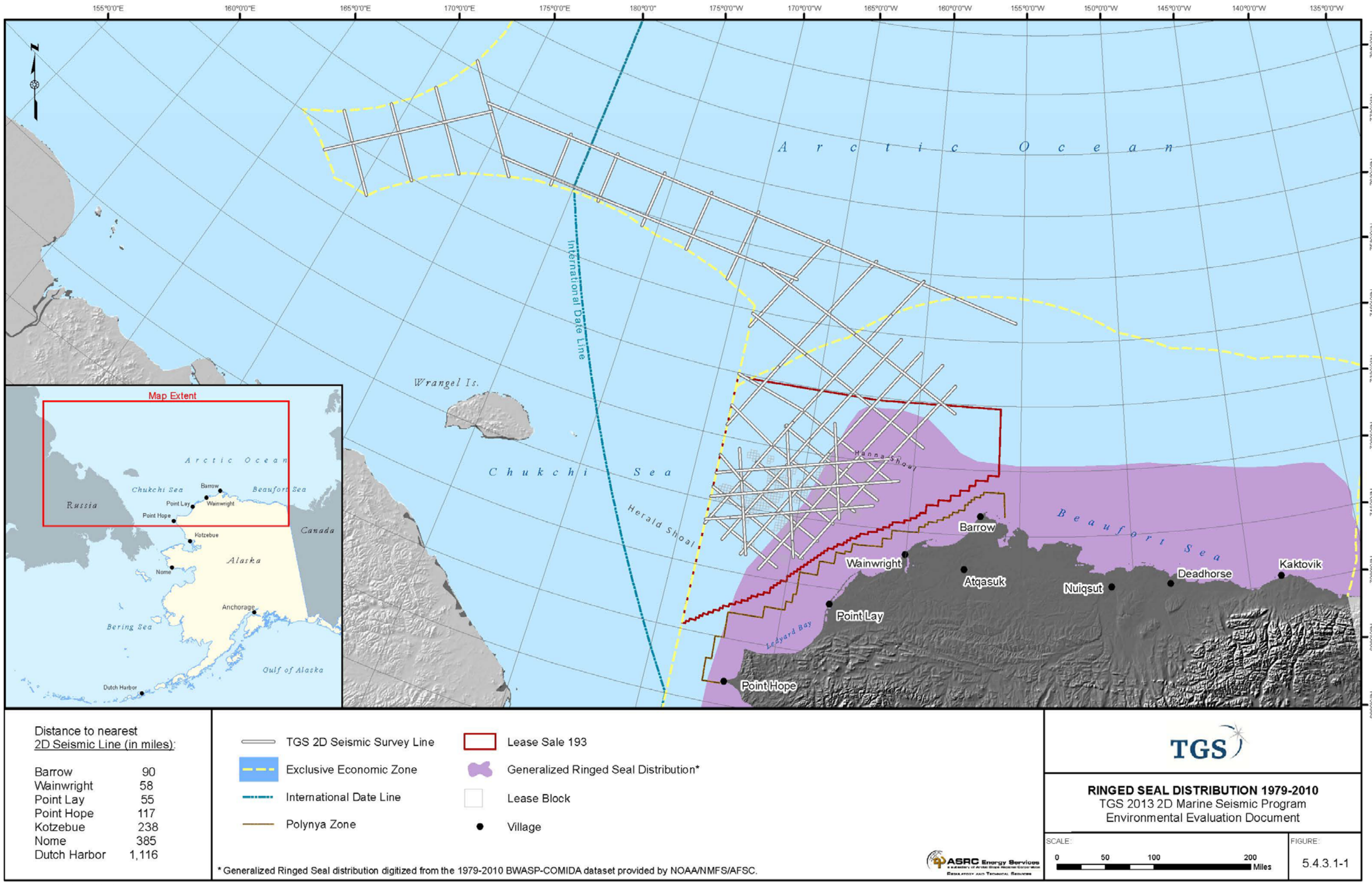

Figure 5.4.3.1-1. Ringed Seal Distribution 1979–2010

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5.4.3.2 Bearded Seal

The bearded seal (*Erignathus barbatus*) is the largest of the Arctic seals at about 7_8 ft (2.0–2.5 m) long. It has a circumpolar distribution and prefers areas along the ice margin (Figure 5.4.3.2-1). Bearded seals are also associated with floating sea ice. Similar to ringed seals, they are solitary animals. Vocalization is common for this species, and males can be heard up to 12 mi (19 km) away (NMFS 2012d). Bearded seals are primarily benthic feeders, so they tend to be found in waters less than 660 ft (200 m) deep.

Bearded seals are the second most common seal species in the proposed survey area (Table 5.4-3). Bearded seals are generally concentrated near the ice front, but small numbers have been observed in open water in the project area during August–October (Aerts, et al. 2011; Brueggeman, et al. 2009, 2011; Hartin, et al. 2011).

Some traditional knowledge suggests that bearded seals haul out on land more often than scientific literature suggests (Quakenbush, et al. 2010b). In the Chukchi Sea, residents observed bearded seals hauled out on barrier islands, especially between Cape Lisburne and Wainwright.

The Alaska stock (also referred to as the Beringia Distinct Population Segment) of bearded seals is the only one in US waters. While current population estimates for this stock are unknown, earlier estimates were approximately 155,000 individuals (Allen and Angliss 2012). In 2010, NMFS proposed that both Pacific populations (Okhotsk and Beringia/Alaska stocks) of bearded seals be designated as threatened under the ESA (75 FR 77496 2010). The final ruling for the threatened status of bearded seals was issued in December 2012 (77 FR 76740 2012).

5.4.3.3 Spotted Seal

The spotted seal (*Phoca largha*) is only slightly larger (5 ft [1.5 m]) than ringed and ribbon seals. Adult diets consist primarily of fish, while juveniles feed on invertebrates. Spotted seals haul out on ice floes to breed from January–March (NMFS 2012e). In the open water season when the ice margin recedes, spotted seals occupy shallow waters of the Chukchi Sea continental shelf, as well as terrestrial haulouts (Figure 5.4.3.3-1) (BOEMRE 2010).

In the Chukchi Sea, spotted seals are less common than ringed and bearded seals, but are more common than ribbon seals. From August–October, small numbers of spotted seals have been observed in or near the proposed project area (Brueggeman, et al. 2009, 2010), but most spotted seals will inhabit nearshore waters during this time.

No spotted seals were identified during aerial COMIDA surveys conducted from 2008 to 2010 (Table 5.4-3) (Clarke, et al. 2011). However, approximately 750 small unidentified pinnipeds were observed, a few of which could have been spotted seals (Clarke, et al. 2011a). About 60 percent of those sightings were made in August. In 2010, nine individual spotted seals were identified during CSESP vessel-based surveys from the Burger prospect to Wainwright (Aerts, et al. 2011).

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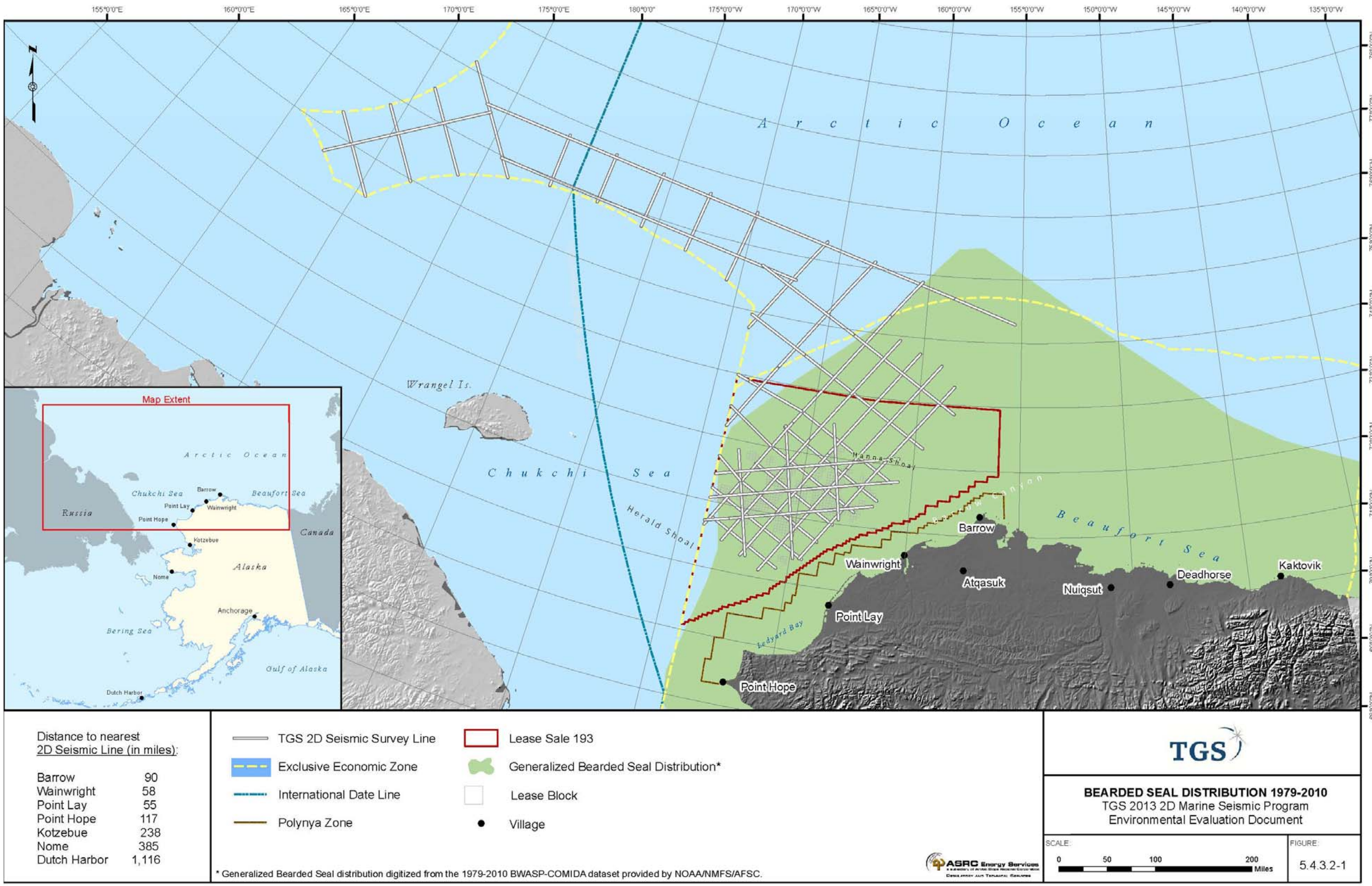

Figure 5.4.3.2-1. Bearded Seal Distribution 1979–2010

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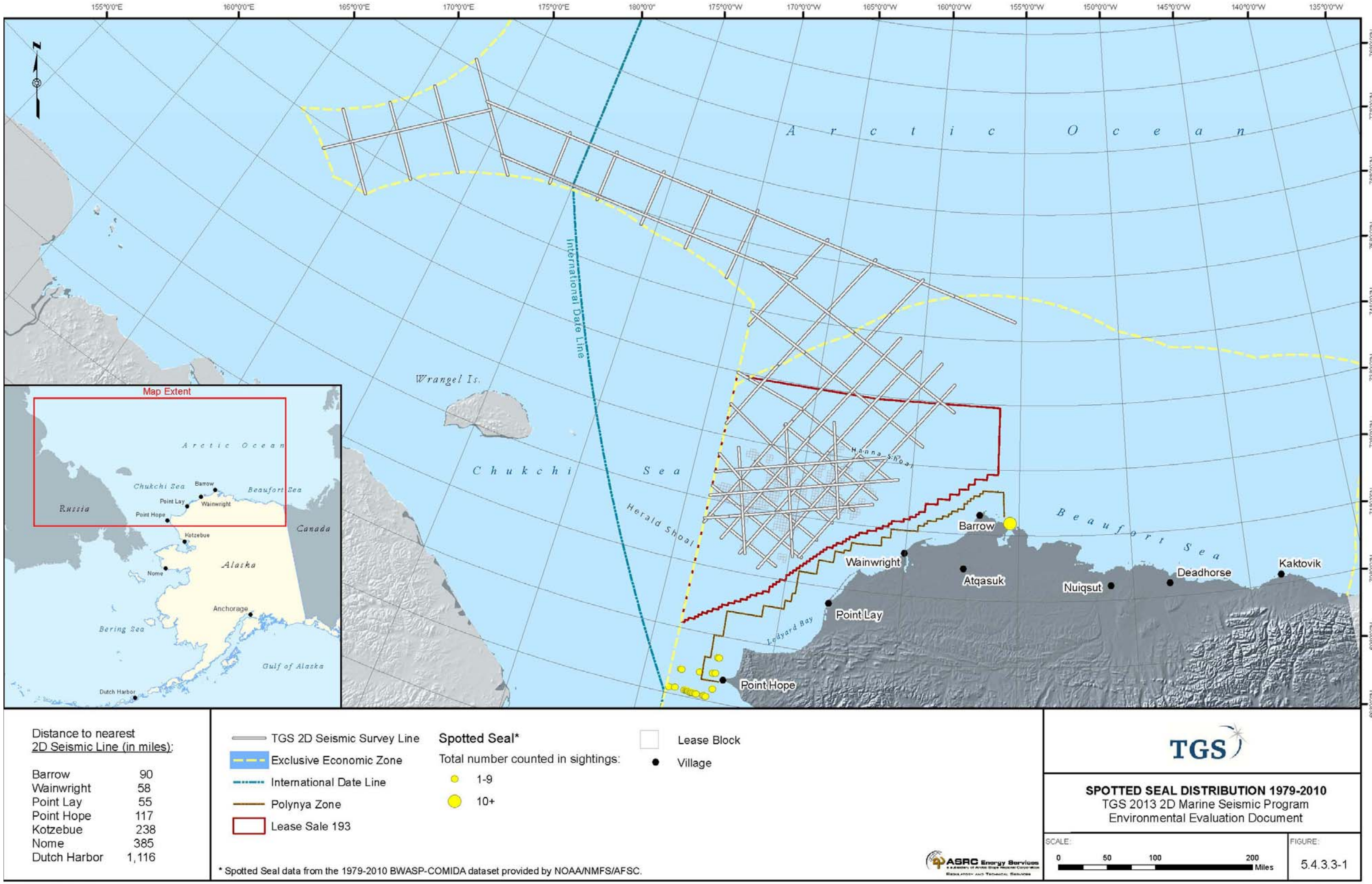

Figure 5.4.3-3-1. Spotted Seal Distribution 1979–2010

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The Alaska stock (also known as the Bering Sea Distinct Population Segment) of spotted seals is the only stock in US waters, and its population is estimated at 59,000 individuals (NMFS 2012e). In 2009, NMFS issued a 12-month finding indicating that this stock was not warranted for listing under the ESA (74 FR 53683 2009).

5.4.3.4 Ribbon Seal

The ribbon seal (*Histriophoca fasciata*) is about the same size as the ringed seal (5 ft [1.5 m]). Although its distribution ranges from the eastern Siberian to the western Beaufort seas (NMFS 2012f), they have not been observed in large numbers during recent Chukchi sea studies (Aerts, et al. 2011; Brueggeman, et al. 1992b; Funk, et al. 2011; Clarke, et al. 2011a). Ribbon seals are strongly associated with sea ice from March–June, during molting and pupping. When the ice recedes, ribbon seals follow it north until it gets too thick, and will then spend the rest of the year in open water of the Bering and Chukchi seas (BOEMRE 2010).

Ribbon seals were not observed during aerial COMIDA surveys in 2008 to 2010 (Table 5.4-3) (Clarke, et al. 2011). A large number of unidentified pinnipeds were observed, but few, if any, were likely to be ribbon seals, given their low abundance in the proposed survey region.

The 2007 stock assessment report estimated the Bering Sea population of ribbon seals at 90,000–100,000 individuals (NMFS 2012f). The same year, NMFS received a petition from the Center of Biological Diversity to list the ribbon seal as threatened or endangered under the ESA and to designate critical habitat. In 2008, NMFS completed a status review of the species and concluded that listing of the species was not warranted (73 FR 79822 2008). However, the Center for Biological Diversity filed suit in 2009, and NMFS settled with the organization, agreeing to initiate a new status review and make a determination by June 10, 2013 (NOAA 2012).

5.4.4 Potential Effects on Ice Seals

Ice seal species most likely to be encountered during the seismic program are ringed and bearded seals.

NMFS uses the received sound pressure level of 190 dB re 1µPa (rms) as the exclusion radius for all ice seals. The TGS seismic program will occur in open water, where ice seals may pass through. In the Arctic, ice seals have shown little or no reaction to seismic sources. They have been observed at nearly identical rates in periods of no airgun versus one airgun firing, but there was partial avoidance of the area during full-array seismic (Harris, et al. 2001). However, the mean sighting distance between no airgun and full array operating was only a 295 ft (90 m) difference (Harris, et al. 2001). The potential effects to ice seals from seismic activity are expected to be limited to temporary avoidance reactions. To reduce potential sound exposure to ice seals, TGS will adhere to its mitigation measures and monitor acoustic exclusion radii (see Section 8, Mitigation Measures). Disturbance from vessel traffic is not expected to adversely affect ice seals, so it is not discussed.

5.4.5 Pacific Walrus

The Pacific walrus (*Odobenus rosmarus divergens*) uses floating sea ice for birthing, nursing, resting, isolation from predators, and to transport to new feeding areas (USFWS 2009b). They generally need ice at least 20 in (50 cm) thick to support their weight (USFWS 2008b). Walruses can break through ice, but prefer occupying areas with natural openings, such as polynyas. When suitable sea ice is not available near foraging areas, walruses will haul out on land along the eastern Chukchi Sea coast (Clarke, et al. 2011; NMFS 2011).

Walruses have small eyes and resulting poorly developed vision. Instead, they use their mystacial vibrissae (stiff facial bristles) for tactile perception to locate benthic prey. Their hearing is well-developed underwater, and they produce low-frequency sounds primarily to socialize and communicate (USFWS 2008b).

Female walruses begin breeding at age six to seven years and produce usually only one calf every two years. Walruses can live up to 40 years and mate in the winter (January–March). They undergo delayed implantation, resulting in a gestation period of 15 months, which is the longest of all the pinnipeds. In late spring, calves are born on ice floes and typically stay with their mother for the first two years (ADF&G 2012b).

Walruses pass through the Bering Strait into the Chukchi Sea during the northward spring migration in May and June, and are typically associated with the southern edge of the pack ice (Figure 5.4.5-1) (USFWS 2008b). By July, large groups (up to several thousand walruses) can be found along the edge of the pack ice between Icy Cape and Point Barrow. In recent years when the ice edge retreats beyond the relatively shallow waters of the continental shelf, walruses have either moved west near Chukotka, Russia, or moved to land haul-out areas along the northern Chukchi Sea coast.

The population size of the Chukchi Sea stock of Pacific walruses is currently unknown. Several studies have estimated the population at approximately 200,000 individuals. These studies have been limited by budgeting and logistical constraints and the USFWS states that these estimates are not useful for detecting population trends (USFWS 2008b).

In 2008, the USFWS received a petition requesting that the Pacific walrus be listed as a threatened or endangered species and for the designation of critical habitat. On February 10, 2011, (76 FR 7634 2011) the USFWS found that listing of the Pacific walrus as a threatened or endangered species was warranted, but was precluded by higher-priority actions. The finding currently gives them candidate species status under the ESA (76 FR 7634 2011). The Pacific walrus is still currently under review and will be considered for listing by the USFWS in 2013.

Chukchi Sea environmental studies indicate that walruses have largely been associated with the pack ice distribution. In the open-water season when ice is sparse, walruses haul out on barrier islands along Kasegaluk Lagoon to Icy Cape and Cape Lisburne. Industry-related studies of Pacific walrus sightings are shown in Table 5.4.5-1 and indicate that sightings have varied greatly, usually because of the amount of sea ice in any particular open-water season.

Table 5.4.5-1. Number of Walruses Sighted in the Chukchi Sea Region during Selected Surveys, Reported by Survey and Year(s)

Study Name and Year(s): Area Surveyed			
Brueggeman, et al. 1990–1992: Chukchi Sea Planning Area[1, 2]	**Clarke, et al. 2008-2010 (COMIDA): between 68–72°N, 157–169°W[2]**	**Funk, et al. 2006–2010 (Joint Industry Monitoring): Lease Sale 193 Area and Nearshore† Waters[1, 2]**	**Aerts, et al. 20082010 (CSESP): Lease Sale 193 Area[1]**
65,451	79,907	13,397	1,405

[1] vessel-based survey
[2] aerial survey
† 20 miles (32 kilometers) offshore

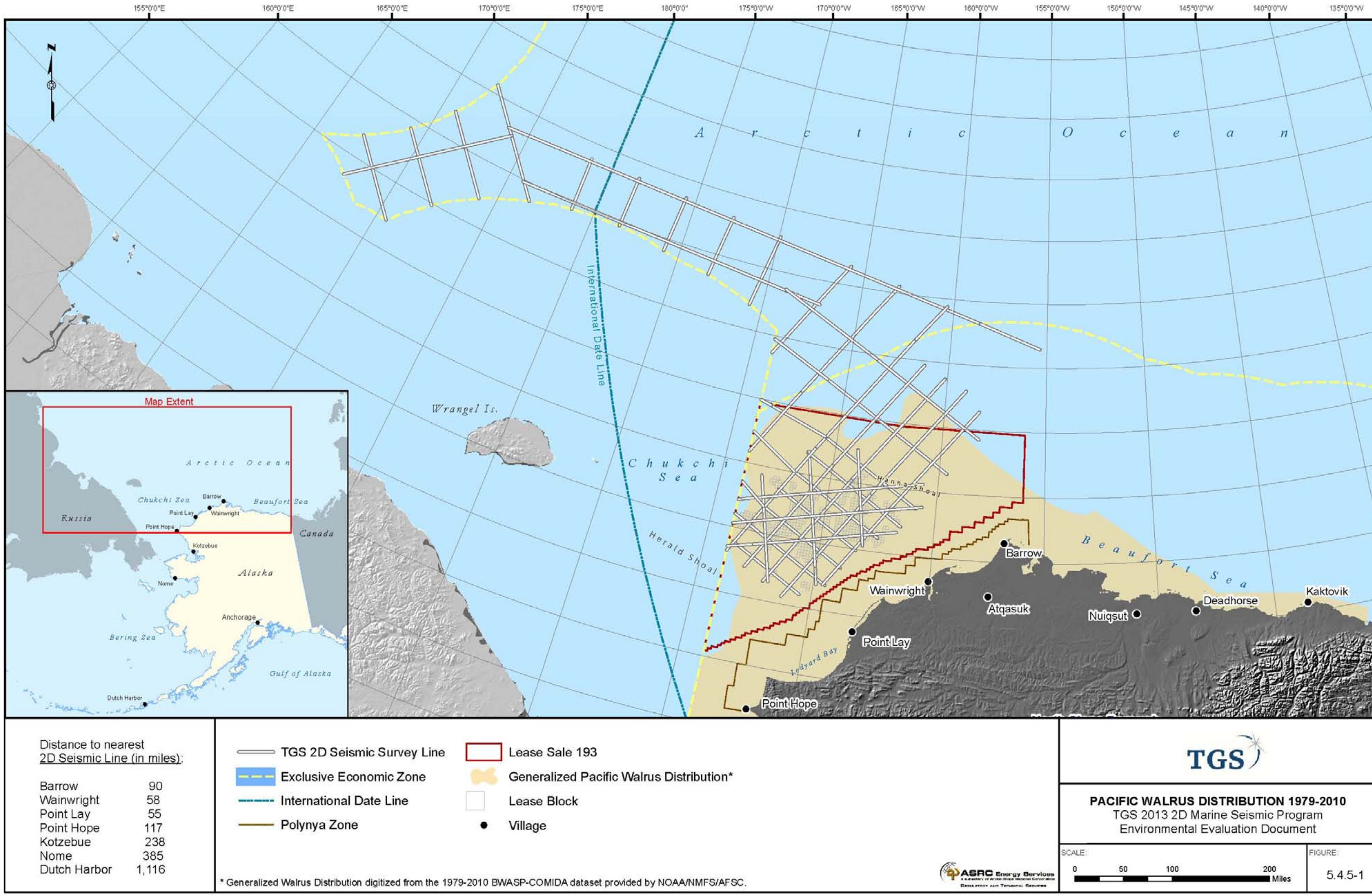

Figure 5.4.5-1. Pacific Walrus Distribution 1979–2010

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5.4.6 Potential Effects on Pacific Walrus

The distribution of Pacific walruses is closely associated with the location of sea ice. If wind and weather conditions bring ice into the TGS project area, there is potential for walrus encounters. In the event of receding ice, a migration to shore may occur for a short period in the Chukchi Sea (Jay and Fischbach 2008; Blees, et al. 2010). TGS will strictly adhere to its mitigation measures as described in Section 8 of this document and the USFWS LOA.

5.4.6.1 Sound from Seismic Activity

Seismic surveys will occur in open water, where walruses may pass through but are not expected in large numbers. There is little information regarding the effects of seismic activity on walrus hearing and behavior, but the sound could potentially result in temporary displacement or TTS in hearing. No lasting effects to hearing are expected (BOEMRE 2010). USFWS uses the received sound pressure level of 180 dB re 1μPa (rms) as the exclusion radius for Pacific walruses. To reduce potential sound exposure to Pacific walruses, TGS will adhere to its mitigation measures and monitor acoustic exclusion radii.

5.4.6.2 Disturbance from Vessels

Vessel traffic could disturb walruses and cause temporary displacement of the animals. These temporary disturbances should not have significant effects on walruses, as walruses are known to have the ability to cover large areas in small amounts of time. However, repeated disturbances may have energetic costs on the animals and potentially separate mothers with calves (BOEMRE 2010). TGS proposes to survey far from the coast and away from sea ice, so their operations will be separated in distance from haulouts.

5.4.7 Polar Bear

The polar bear (*Ursus maritimus*) was listed by USFWS as a threatened species under the ESA on May 15, 2008. Polar bears are also protected under the MMPA. The current size of the Chukchi/Bering Sea stock is estimated to be around 2,000 individuals (ADF&G 2012c).

The USFWS published a final rule on December 7, 2010, designating critical habitat for the threatened polar bear, effective January 6, 2011. The rule designated critical habitat encompassing three areas or units: Unit 1- sea ice, Unit 2 - terrestrial denning habitat, and Unit 3 - barrier island habitat. The total area designated was 187,157 mi^2 (484,734 [km^2]), of which about 96 percent is sea ice habitat. However, on January 11, 2013, the US District Court for the District of Alaska vacated and remanded the final rule to correct for "substantive and procedural" deficiencies in the ruling.

Polar bear females sexually mature at three to six years of age, while males reach maturity at four to five years of age. Polar bears breed in the spring (March–May) and reproduce once every three years. The gestation period is only 4-5 months, and cubs (usually twins) are born in the winter (ADF&G 2012c).

Polar bears have a circumpolar range in the Northern Hemisphere that is determined primarily by seasonal ice. Females den on the mainland near cliffs or river banks where the snow accumulates to sufficient depths, or in areas of stable pack ice with snow depths adequate for denning sites. Polar bears generally live on the pack ice, following the advancing and retreating ice edge, as this is the most productive area for hunting seals.

Polar bears can be found seasonally in the proposed survey region; however, their presence is only during times when sea ice is present. It has also been determined that polar bears have largely been associated with the distribution of polynyas. In the open water season when pack ice retreats, polar bears will either follow it north or swim to land. Polar bear presence will seasonally occur during the late spring/early summer months as they migrate north with receding ice habitat, and again in late fall as they migrate south with the advancing ice pack (Garner, et al. 1990).

Industry-related studies of polar bear sightings are shown in Table 5.4.7-1. Results indicated that most bears were not seen far from the pack ice, unless they were sighted on land near Wainwright or swimming in-between ice floes (Brueggeman, et al. 2009).

Table 5.4.7-1. Number of Individual Polar Bears Sighted in the Chukchi Sea Region for Selected Surveys, Reported by Survey and Year(s)

Study Name and Year(s): Area Surveyed			
Brueggeman, et al. 1990–1992: Chukchi Sea Planning Area[1, 2]	Clarke, et al. 2008–2010 (COMIDA): between 68–72°N, 157–169°W[2]	Funk, et al. 2006–2010 (Joint Industry Monitoring): Lease Sale 193 Area and Nearshore† Waters[1, 2]	Aerts, et al. 2008–2010 (CSESP): Lease Sale 193 Area[1]
112	19	142	16

[1] vessel-based survey
[2] aerial survey
† 20 mi (32 km) offshore

5.4.8 Potential Effects on Polar Bear

Polar bears rarely occur in open water away from the pack ice, so few are expected to be encountered during the TGS 2D seismic program. The activity that may have the greatest chance of potential effects on polar bears is the sound generated from seismic surveys. TGS will not be performing ice management activities; therefore, there should be no disturbance to polar bears on ice. TGS plans to mitigate potential effects to polar bears near the seismic program by using a scout vessel, which will monitor the survey lines prior to the seismic vessel beginning its surveys and alert the seismic vessel of polar bear presence and proximity (see Section 8, Mitigation Measures).

5.4.8.1 Sound from Seismic Activity

Little is known regarding the effects of seismic sounds on polar bears. Additionally, there is no known evidence suggesting that airgun pulses cause serious injury or death to polar bears. USFWS uses the received sound pressure level of 190 dB re 1µPa (rms) as the threshold at which physical injury to polar bears may occur. However, sound produced underwater will not easily transmit to the atmosphere: polar bears spend most of their time out of water and do not typically stay underwater for extended periods. To reduce potential sound exposure to polar bears, TGS will adhere to its mitigation measures and monitor acoustic safety radii for polar bears, as described in Section 8.

5.4.8.2 Disturbance from Vessels

The presence of vessels in polar bear habitat has been known to cause some polar bears to flee from the area (USFWS 2008c). Because TGS will operate in the open-water season and does not plan to use aircraft or icebreakers, the potential effect of vessels on polar bears is unlikely. There is a small chance of encountering bears while in open water, so on-board PSOs will monitor for polar bears and will immediately alert vessel crew to their presence. Any potential effects will likely cause temporary behavioral disturbance or avoidance. Studies near an icebreaker vessel in the Chukchi Sea reported that of the relatively small number of polar bears that ran away from the vessel, all were observed to resume pre-disturbance activities within a matter of minutes (Brueggeman, et al. 1991, 1992b).

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6.0 Socioeconomic Resources

6.1 Traditional Knowledge

Traditional Knowledge (TK) is the communal information that is passed down over multiple generations by a specific group of people. This knowledge is derived from a community's experiences through the environment in which they live and is modified to fit the changes that occur over time allowing the continuance of a sustainable and effective way of life. Not only does the information provided by TK assist a culture in keeping its values and maintaining its presence, but it also supports the vital life skills needed for sustenance such as hunting, fishing, and other subsistence techniques. TK also incorporates unique sets of cultural values responsible for promoting good health, livelihood, and the act of protecting and replenishing the environment from overuse (Hansen and Van Fleet 2003). Many of these lessons are transferred from one person to the next in many different practices. TK can be conveyed through any of the following methods: traditional songs, stories, legends, dreams, and artifacts (ANSC 2012).

The word "traditional" can be defined or thought of as meaning old fashioned or conventional; however, in this specific sense "traditional" refers to the community's traditions and how that information is spread (Hansen and Van Fleet 2003).

The word "Iñupiaq" means 'the real people' (UAF 2007). The Iñupiaq have inhabited the Arctic for thousands of years, traditionally following the animal migrations and subsisting on whales, caribou, walruses, seals, and birds.

Traditional Iñupiat Values (ASRC Federal 2012)

- Qiksiksrautiqaġniq Iñuuniaġvigmun – Respect for Nature
- Aviktuaqatigiigñiq – Sharing
- Iñupiuraallñiq – Knowledge of Language
- Paammaaġigñiq – Cooperation
- Iḷagiigñiq – Family and Kinship
- Piqpakkutiqaġniq suli Qiksiksrautiqaġniq Utuqqanaanun Allanullu – Love and Respect for Our Elders and One Another
- Quvianġuniq – Humor
- Anuniallaniq – Hunting Traditions
- Nagliktuutiqaġniq – Compassion
- Qiñuiññiq – Humility
- Paaqlaktautaiññiq – Avoidance of Conflict
- Ukpiqqutiqaġniq – Spirituality

TK is also known as indigenous knowledge and traditional ecological knowledge or traditional environmental knowledge. The term indigenous knowledge refers to the awareness, exposure, insight, and ideologies individuals appertain on environmental evaluations. Both traditional and non-traditional knowledge comprise indigenous knowledge. Non-traditional knowledge is the information gained by interactions with people from outside the community. This also includes the influences from modern media sources, formal education, and any other way of thinking that differs from what the community accepts as true (Stevenson 1996).

TK is made up of the following three, main, interconnected components (Stevenson 1996):

- Particular environmental knowledge (e.g., weather elements)
- Knowledge of ecosystem relationships (e.g., animal migration patterns)
- A code of ethics governing appropriate human-environmental relationships (e.g., reverence of animal spirits).

While TK incorporates the information from previous generations, it also accommodates change and innovation through accepting and altering techniques that change with the current environment, cultural beliefs, and spiritual views.

TGS is mindful of and respects the efforts by the North Slope communities to gather and document TK.

6.2 North Slope Community Profiles

The proposed survey is situated offshore of four Chukchi Sea communities—Barrow, Wainwright, Point Lay, and Point Hope. All four communities are located within the NSB, which was incorporated in 1972. Encompassing 89,000 mi² (230,509 km²), the NSB has the largest landmass of any borough in Alaska. Figure 6.2-1 shows the North Slope communities of Barrow, Wainwright, Point Lay, Point Hope, and includes the western Alaska coastal communities of Kivalina, Kotzebue, and Nome for information purposes. The following sections provide an overview of the four NSB communities.

6.2.1 Barrow

Barrow is positioned on the Chukchi Sea coast. Barrow is approximately 10 mi (16 km) south of Point Barrow and 725 air mi (1,170 air km) from Anchorage. Encompassing 18.4 mi² (30 km^2) of land and 2.9 mi² (7.5 km^2) of water, Barrow is the largest NSB community and the northernmost community in the US. With nearly 5,000 residents, Barrow also has the highest community population in the NSB. Barrow receives about 5 in (12.7 cm) of precipitation and 20 in (50.8 cm) of snow a year. Temperatures range from -56˚ to 78 ˚F (-48.9˚ to 25.6 ˚C), with a summer average of 40 °F (4.4 °C) (ADCCED 2012).

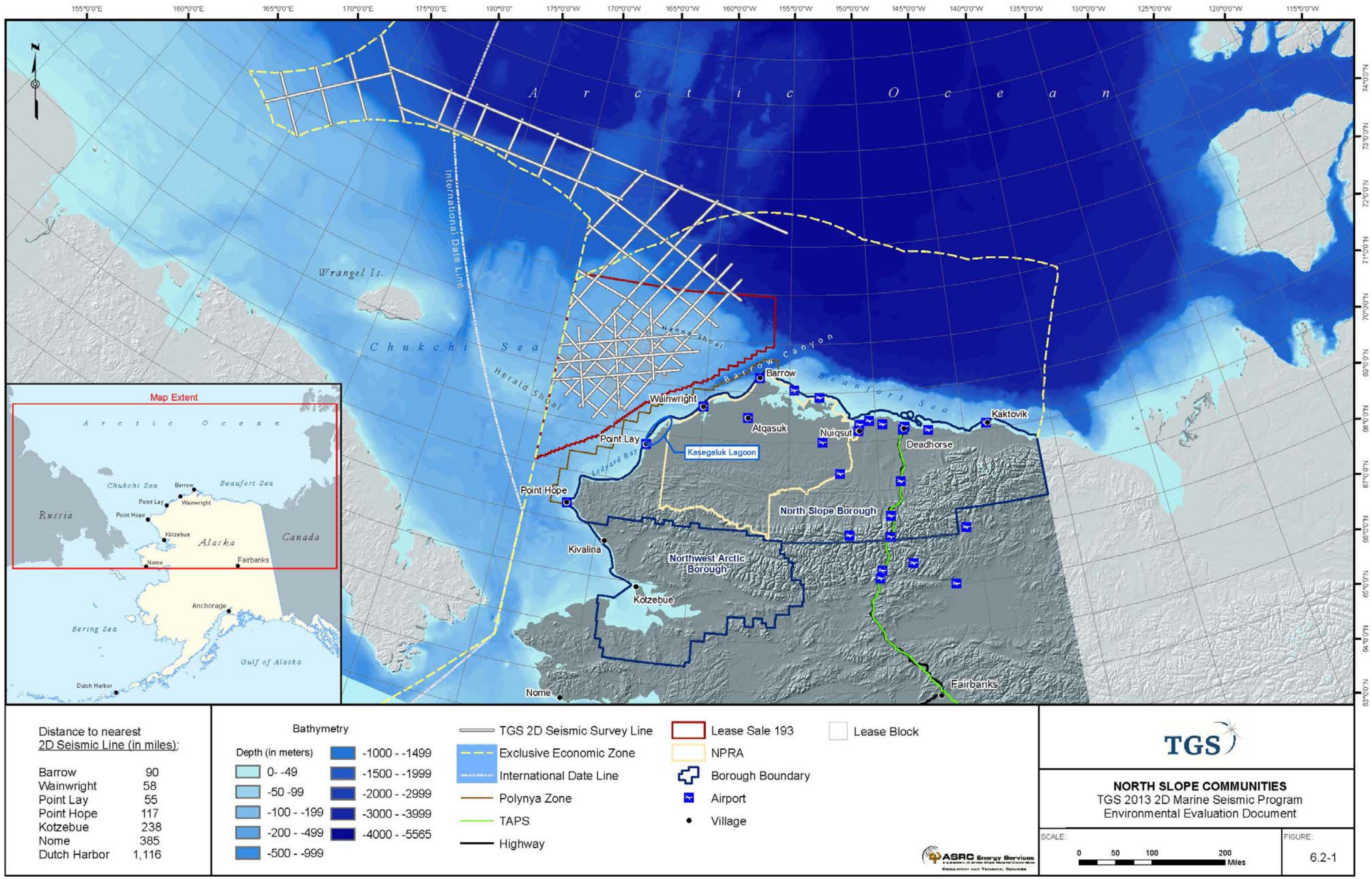

Figure 6.2-1. North Slope Communities

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6.2.1.1 Barrow in the Past

The traditional Iñupiaq name for Barrow is Utqiaġvik, “place where snowy owls are hunted” (NSB 2012). Archaeological site records suggest initial habitation of areas within the vicinity of Barrow took place as early as 500 to 900 A.D. Sixteen dwelling mound remains from the Birnirk archaeological site can still be observed. The Birnirk site proves to be one of the earliest whale and seal hunting villages of Alaska’s Arctic coast (NPS 2011).

The introduction of commercial whaling in the nineteenth and twentieth centuries, along with twentieth-century fur trading and military activities, have played large influencing roles on the community of Barrow and its surrounding area. A meteorological and magnetic research station was established near Barrow by the US Army in 1881. Years later, in 1893, the Cape Smythe Whaling and Trading Station was built. Subsequent momentous construction consisted of a Presbyterian church in 1899 and a post office in 1901 (ADCCED 2012).

6.2.1.2 Modern-day Barrow

The City of Barrow was organized and maintained as a first-class city in 1959. Barrow is the government seat of the NSB and is the center for economy, transportation, and government (NSB 2012).

Subsistence hunting, fishing, and whaling are very important to the local economy. Many residents continue to hunt and fish for their food. The Ukpeaġvik Iñupiat Corporation is Barrow’s village corporation, which provides social and economic resources to its shareholders (NSB 2005).

Since 1939, the community of Barrow has shown a steady growth in population. The population of nearly 5,000 individuals is nearly equal in gender, but there is a marginal amount more of men than women. The 2010 NSB census data indicates 52.2 percent of the population is male and the remaining 47.8 percent is female. Population estimates of the NSB community of Barrow are depicted in Figure 6.2.1.2-1.

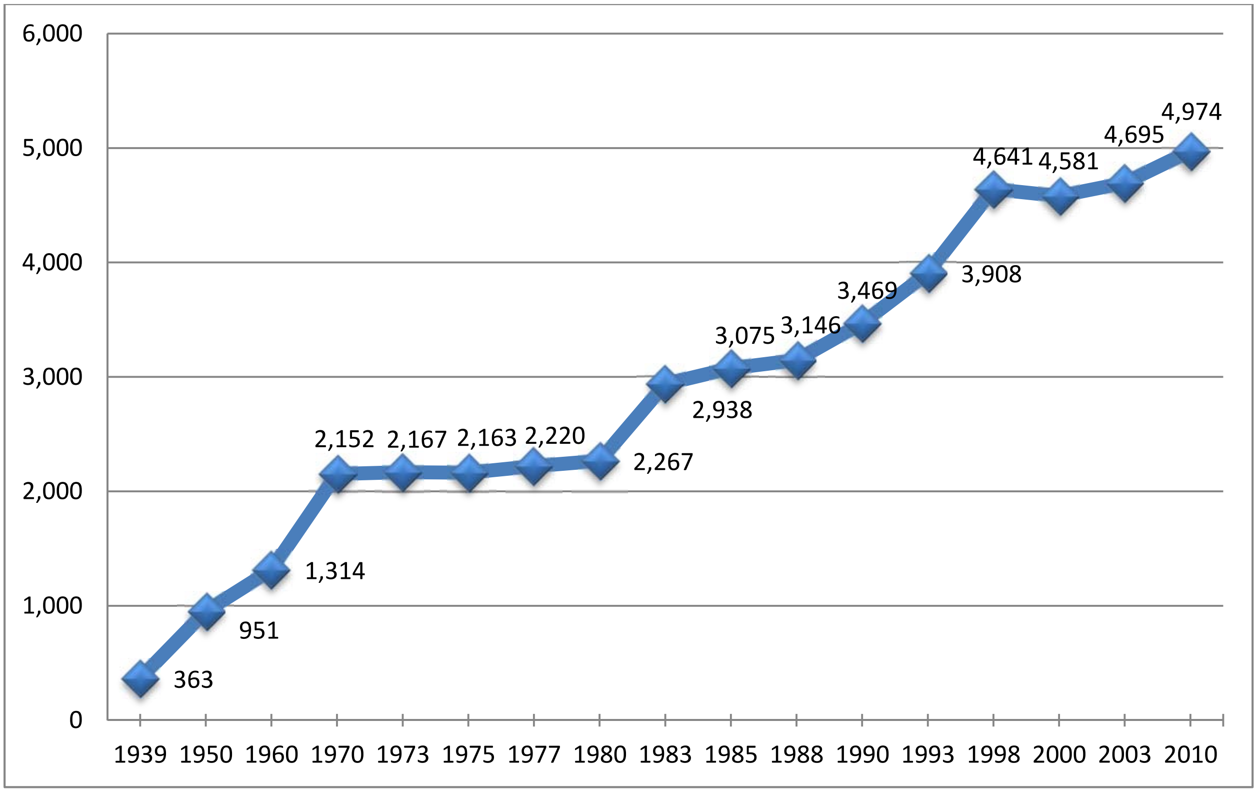

Figure 6.2.1.2-1. Population of Barrow: 1939–2010

Figure 6.2.1.2-2 displays the steady population growth from 1939 to 2010 in the community of Barrow.

Figure 6.2.1.2-3 illustrates the relatively stable ethnicity division of Barrow's population in terms of Iñupiat and non-Iñupiat individuals from 1998 to 2003.

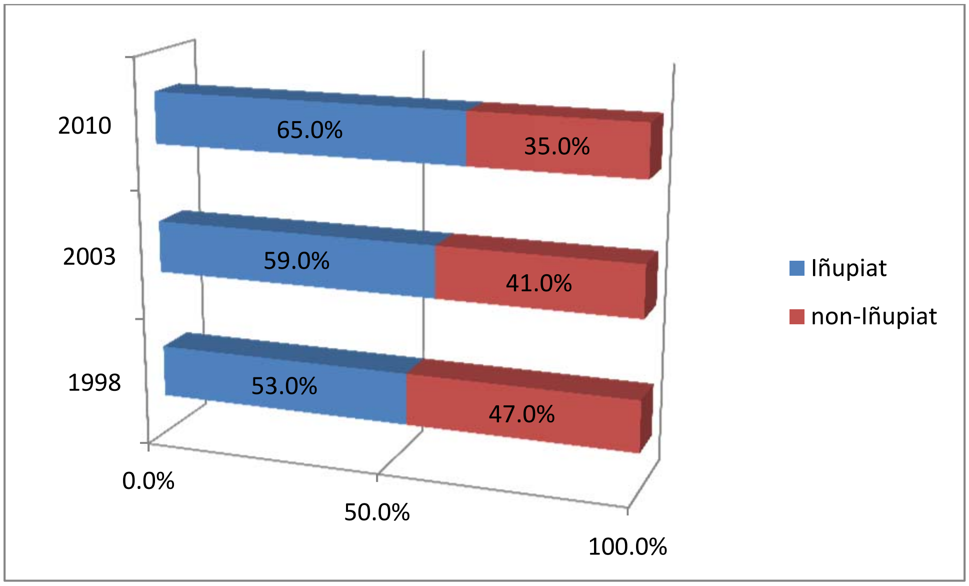

Figure 6.2.1.2-3. Barrow Population Trends by Ethnicity: 1998-2010

Barrow's age cohorts and dependency ratios between the years 2003 and 2010 are shown in Table 6.2.1.2-4 (NSB 2010).

Table 6.2.1.2-4 shows the large percentage of youth present in the community of Barrow.

Table 6.2.1.2-4. Barrow Age Cohorts and Dependency Ratios (NBS 2010)

Category	2003 Percentage of Population	2010 Percentage of Population
Individuals 15 years & under	30.5%	29.3%
Individuals 18 and under	37.4%	34.2%
Individuals 18-24	8.2%	11.3%
Individuals 55-64	5.6%	8.3%
Individuals 62 and over	5.9%	5.6%
Individuals 65 and over	5%	3.7%
Individuals 16-64	62%	64.6%
Individuals 18-64	57.2%	61.4%
Youth Dependency Ratio	49.2%	45.4%
Age Dependency Ratio	8%	5.7%
Total Dependency Ratio	57.2%	51.1%

6.2.2 Wainwright

The NSB community of Wainwright can be found along the wave-eroded coastal bluff separating Wainwright Inlet from the Chukchi Sea. Wainwright is located approximately 72 mi (116 km) southwest of Barrow (NSB 2012). Temperatures range from -56° to 80 °F (-48.9˚ to 26.7 ˚C). Wainwright receives about 5 in (12.7 cm) of precipitation and 12 in (30.5 cm) of snow annually (ADCCED 2012).

6.2.2.1 Wainwright in the Past

The traditional Iñupiaq name for the community of Wainwright is Ulġuniq. In 1826, the inlet was named by Captain F.W. Beechey for the officer Lt. John Wainwright (ADCCED 2012). The sea and coastal environment play an integral part in the identity of Wainwright's Native population. The local Iñupiat residents call themselves Tagiumiut, which means people of the sea (NSB 2005). The area of Wainwright has been occupied and used in subsistence practices by the Iñupiat people for many generations. With the construction of a school by the Alaska Native Service, the present village was established in 1904. In 1962, the community was incorporated as a second-class city (NSB 2012).

6.2.2.2 Modern-day Wainwright

Wainwright is currently the third-largest NSB community with a population of 572. Utilities and facilities in Wainwright are provided by the NSB. The primary water source for the community of Wainwright is Merekrauk Lake located approximately 3 mi (4.8 km) northeast of the community. Water used by the community is treated then stored in tanks. The NSB also provides water-hauling trucks to the community (ADCCED 2012). Figure 6.2.2.2-1 shows the fluctuation in population of Wainwright from 1939–2010 (NSB 2010). The Olgoonik

Corporation is the village corporation for Wainwright. The NSB and OC provide the principal employment for Wainwright (NSB 2005).

Life in Wainwright is centered around school, village services, community activities, and subsistence. Wainwright has a strong and healthy subsistence economy that relies on the fall caribou migration and spring whaling (NSB 2012).

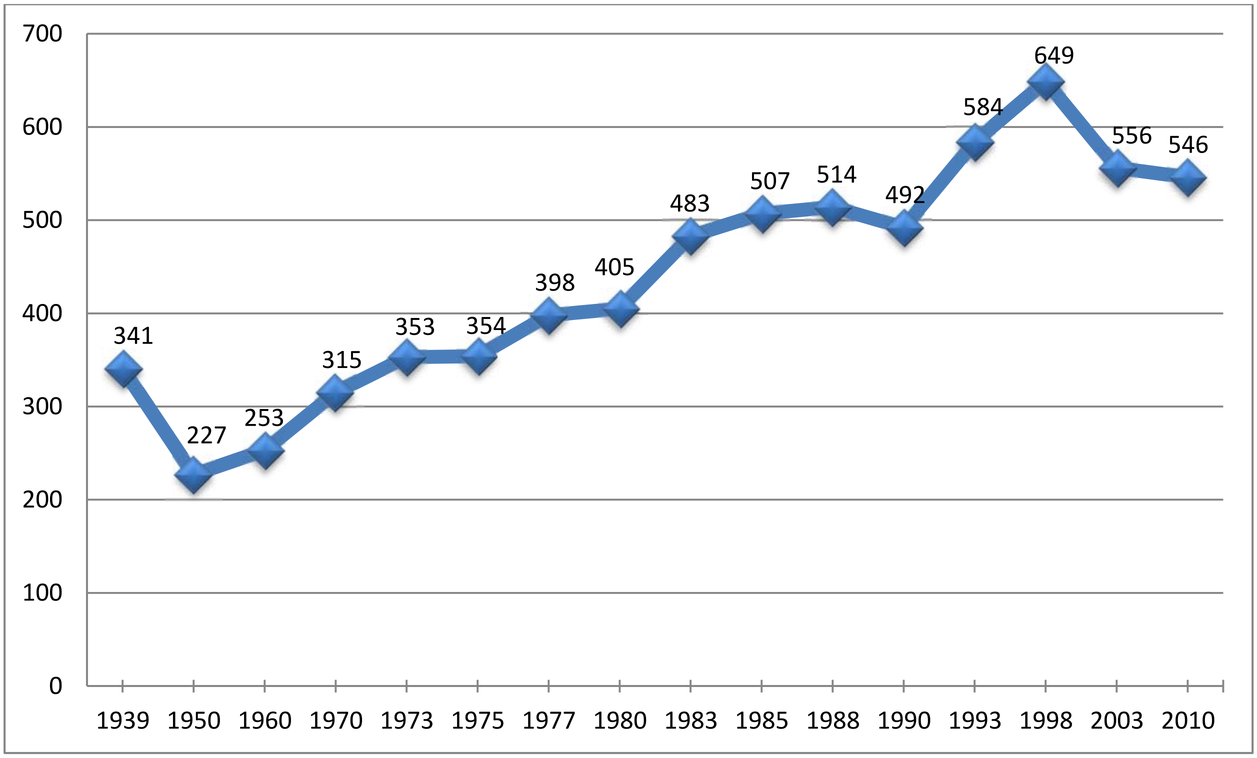

Figure 6.2.2.2-1. Wainwright Population Growth Chart: 1939-2010

The majority of the population in Wainwright is Iñupiat. Information gathered in 2010 indicates the gender and age distribution is nearly equal with approximately 234 males to 225 females (NSB 2010). Figure 6.2.2.2-2 captures gender information for the community of Wainwright.

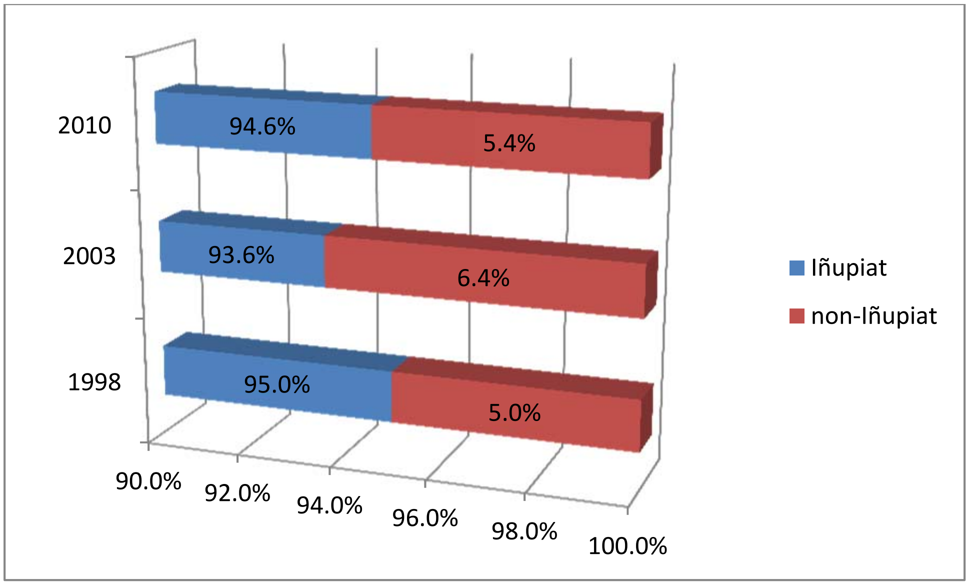

Figure 6.2.2.2-2. Wainwright Population Trends by Ethnicity: 1998–2010

Table 6.2.2.2-1 shows cohorts and dependency ratios for the years 2003 and 2010 of the NSB community of Wainwright.

Table 6.2.2.2-1. Wainwright Age Cohorts and Dependency Ratios (NBS 2010)

Category	2003 Percentage of Population	2010 Percentage of Population
Individuals 15 years and under	33.9%	32.0%
Individuals 18 and under	39.9%	38.3%
Individuals 18–24	10.9%	12.4%
Individuals 55–64	2.7%	8.3%
Individuals 62 and over	-	8.7%
Individuals 65 and over	8.9%	6.7%
Individuals 16–64	57.4%	61.4%
Individuals 18–64	51.4%	57.7%
Youth Dependency Ratio	52.1%	49.8%
Age Dependency Ratio	15%	10.5%
Total Dependency Ratio	67.1%	60.3%

Wainwright comparative dependency ratios are depicted below in Table 6.2.2.2-2.

Table 6.2.2.2-2. Wainwright Comparative Dependency Ratios (NSB 2010)

Area	Total (or Age) Dependency	Youth or Child Dependency	Old Age or Age Dependency
United States*	59%	38.7%	20.3%
Alaska*	50.5%	39.4%	11%
Wainwright	60.3%	49.8%	10.5%

*2008 data from statistical abstract [2010 Issue]

6.2.3 Point Lay

The community of Point Lay rests on the Chukchi Sea coast approximately 150 mi (241 km) southwest of the northernmost NSB community of Barrow (NSB 2012). Established more recently than many of the other Inupiaq villages, Point Lay has a population of less than 300. Figure 6.2.3-1 shows the changes in population from 1939–2010 (NSB 2010).

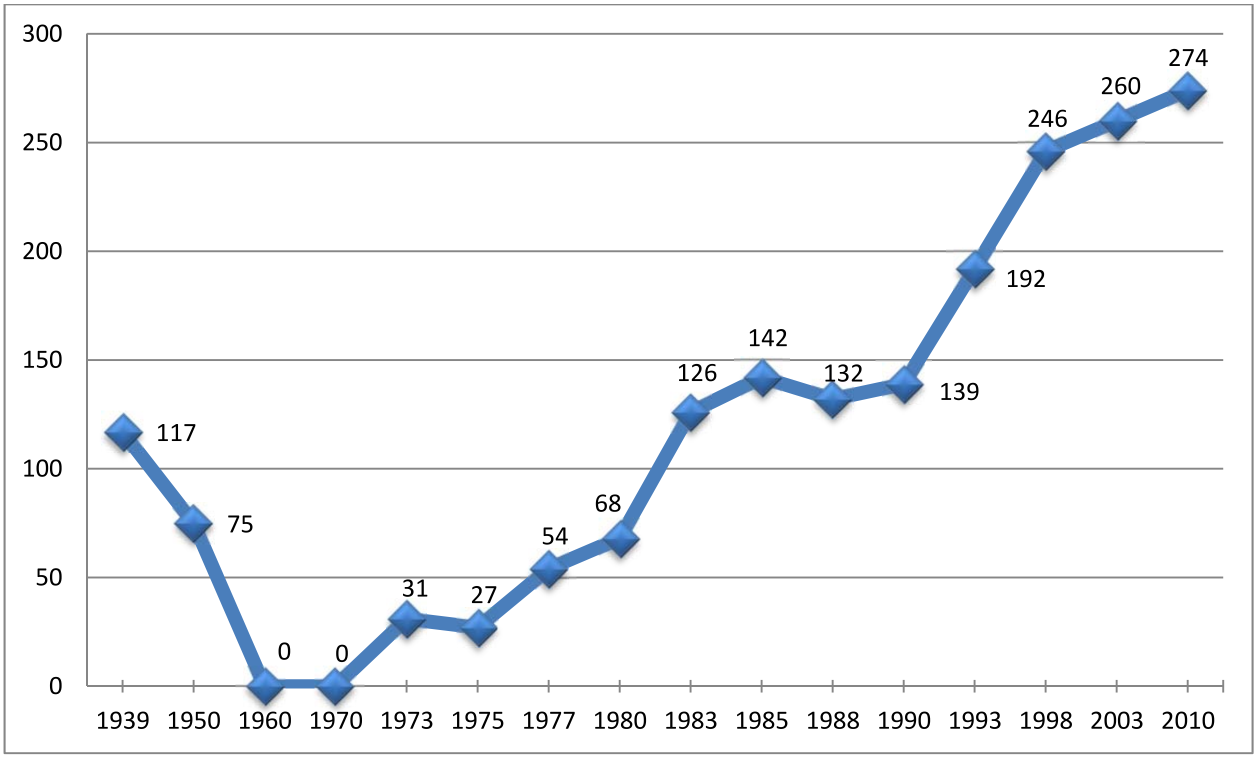

Figure 6.2.3-1. Point Lay Population Growth Chart: 1939–2010

Source: NSB 2010

Point Lay is located away from the open ocean and is sheltered by the Kasegaluk Lagoon (NSB 2012). Seasonal flooding from the Kokolik River has caused the village to be relocated farther south away from the potentially dangerous rising waters (ADCCED 2012).

The traditional Iñupiaq name for Point Lay is Kali, meaning "mound" and refers to the elevated mound on which it stands. The Native Village of Point Lay is a federally recognized tribe and the village corporation for Point Lay is Cully Corporation. Like other communities in the NSB, water from a nearby source is treated and stored in tanks and delivered to homes by truck. North Slope Borough Power and Lights Systems provides village homes with electricity. Many of the year-round jobs are supplied by the borough government (NSB 2012).

Subsistence activities play a vital role in the success of the village; the community depends primarily on beluga whale hunting (NSB 2012). Older research shows that subsistence activities are conducted by approximately 77 percent of the Point Lay households (Shepro, et al. 2003). The AEWC lifted restrictions in 2008 allowing the community to participate in bowhead whaling. A more in-depth discussion of subsistence activities is addressed in Section 6.3.

Population trends by ethnicity between the years 1998–2010 are shown below in Figure 6.2.3-2.

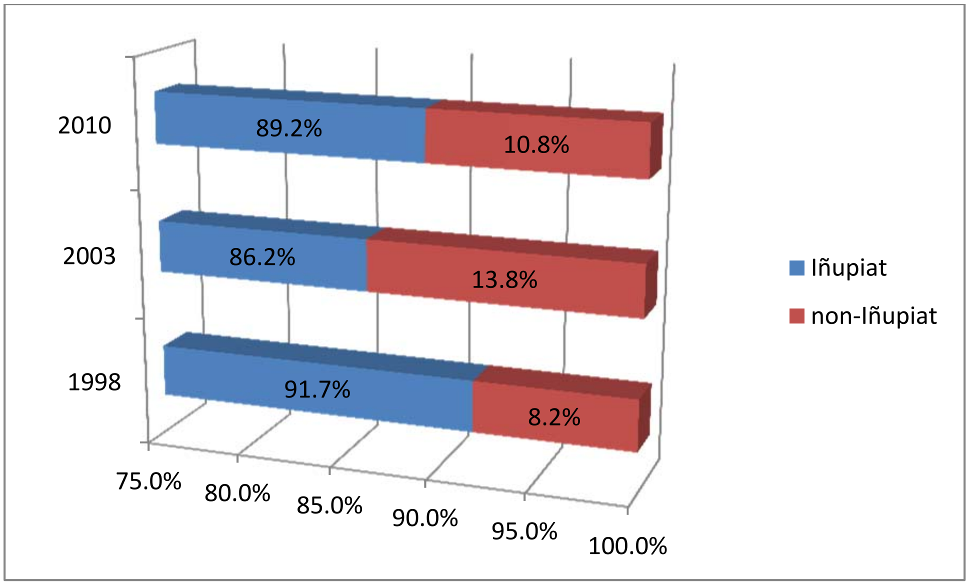

Figure 6.2.3-2. Point Lay Population Trends by Ethnicity: 1998–2010

Age cohorts and dependency ratios for the community of Point Lay are depicted below in Table 6.2.3-1.

Table 6.2.3-1. Point Lay Age Cohorts and Dependency Ratios (NBS 2010)

Category	2003 Percentage of Population	2010 Percentage of Population
Individuals 15 years and under	46%	36.5%
Individuals 18 and under	52.2%	43.1%
Individuals 18–24	11.1%	15.5%
Individuals 55–64	7%	7.2%
Individuals 62 and over	2.2%	3.3%
Individuals 65 and over	1.8%	3.3%
Individuals 16–64	50%	56.9%
Individuals 18–64	45.6%	53.6%
Youth Dependency Ratio	92%	64.1%
Age Dependency Ratio	4%	5.8%
Total Dependency Ratio	95.6%	69.9%

Source: NSB 2010

6.2.4 Point Hope

The community of Point Hope is located approximately 330 mi (531 km) southwest of Barrow. Positioned near the tip of the Point Hope peninsula on the western-most extension of the northwest Alaska coast, Point Hope encompasses 6.3 mi^2 (10.1 km^2) of land (ADCCED 2012).

Iñupiat Eskimos have inhabited Point Hope peninsula continuously for longer than most any other area in Alaska. Over the past 2,500 years, several settlements have occupied the peninsula. This community thrives because of its location near open water and the abundance of marine mammals (ADCCED 2012).

The traditional Iñupiaq name for Point Hope is Tikiġaq, meaning “index finger,” which refers to the geographic point in which it is located near (NSB 2012).

Incorporated in 1966 as a fourth-class city, Point Hope achieved its second-class status in 1972. Erosion to the north side of the spit caused the village to be relocated farther south in 1978 and 1979. Along with having a Native village corporation, Tikigaq Corporation, the Native Village of Point Hope is a federally recognized tribe (NSB 2005).

Point Hope is provided with utilities by the NSB. Water from a nearby lake is treated and stored before being delivered to a number of homes with storage tanks. This provides running water to the households in the community. Electricity is provided by North Slope Borough Power and Lights Systems. Besides providing water and electricity to the community, the NSB offers trash pick-up, a health clinic, city hall, public safety building, fire station, senior citizen center, and a daycare center (NSB 2012). Point Hope population growth between the years 1939–2010 is depicted below in Figure 6.2.4-1.

Point Hope has strong subsistence ties to the land and sea and is dependent upon fishing, gathering and hunting of marine mammals for food. The bowhead whale is the primary subsistence resource and annual activities vary from preparation to hunting and to sharing with the community (NSB 2005).

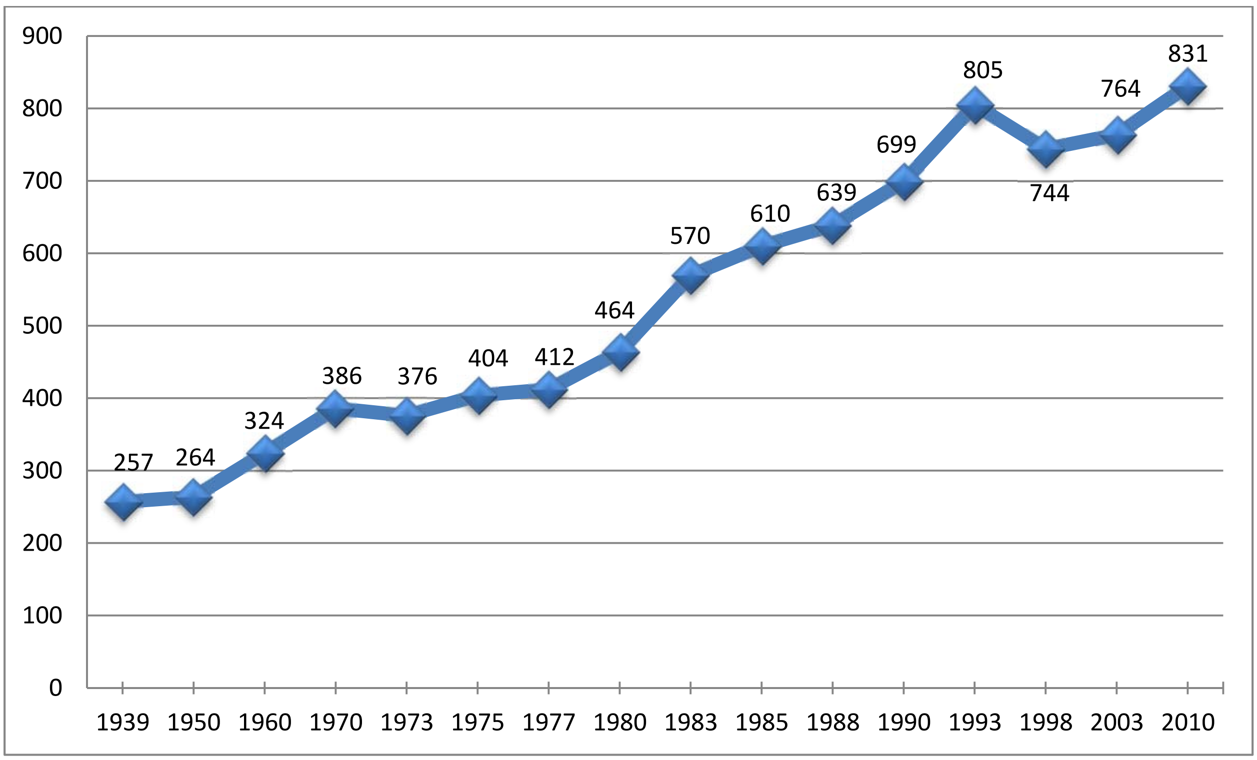

Figure 6.2.4-1. Point Hope Population Growth Chart: 1939–2010

Point Hope population trends by ethnicity from the year 1998–2010 are depicted below in Figure 6.2.4-2.

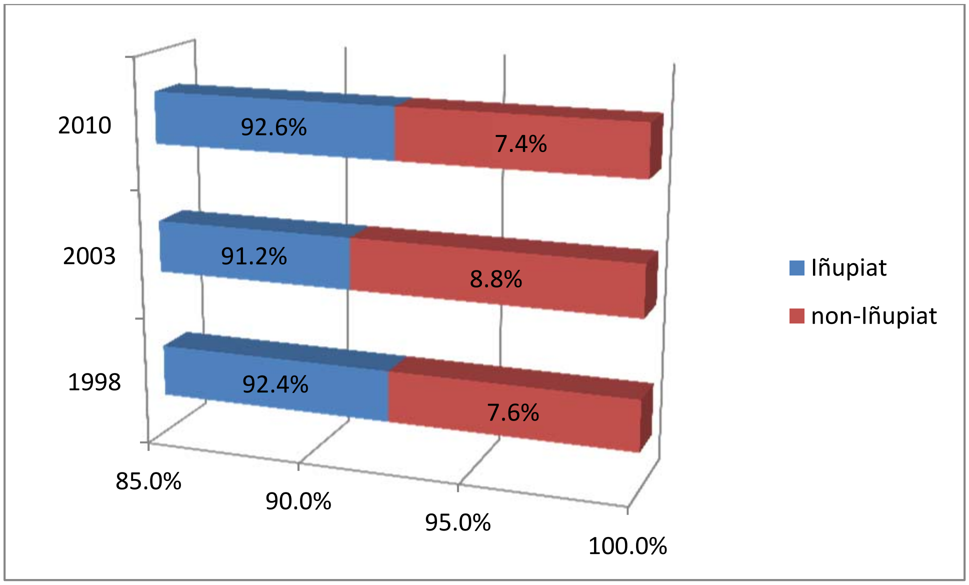

Figure 6.2.4-2. Point Hope Population Trends by Ethnicity: 1998–2010

Table 6.2.4-1 shows the age cohorts and dependency ratios for the community of Point Hope.

Table 6.2.4-1. Point Hope Age Cohorts and Dependency Ratios*

Category	2003 Percentage of Population	2010 Percentage of Population
Individuals 15 years & under	30.6%	33.8%
Individuals 18 and under	36%	40.2%
Individuals 18-24	-	14.6%
Individuals 55-64	4.7%	9%
Individuals 62 and over	-	8.3%
Individuals 65 and over	3.9%	5.6%
Individuals 16-64	43.7%	60.3%
Individuals 18-64	40%	57.1%
Youth Dependency Ratio	108.5%	61.6%
Age Dependency Ratio	7.9%	9.6%
Total Dependency Ratio	116.4%	71.2%
*2003 and 2010 sample populations		

Source: NSB 2010

Table 6.2.4-2 shows the comparative dependency ratios for the community of Point Hope.

Table 6.2.4-2. Point Hope Comparative Dependency Ratios

Area	Total (or Age) Dependency	Youth or Child Dependency	Old Age or Age Dependency
United States*	59%	38.7%	20.3%
Alaska*	50.5%	39.4%	11%
Point Hope	71.2%	61.6%	9.6%
*2008 data from statistical abstract [2010 Issue]			

Source: NSB 2010

6.3 Subsistence Resources

Subsistence is defined in Alaska Statutes 16.05.940 as:

> "The noncommercial, customary, and traditional use of wild, renewable resources by a resident domiciled in a rural area of the state for direct personal or family consumption as food, shelter, fuel, clothing, tools, or transportation, for the making and selling of handicraft articles out of non-edible by-products of the fish and wildlife resources taken for personal or family consumption and for customary trade, barter, or sharing for personal or family consumption . . ."

Subsistence is more than a means of obtaining food to the Iñupiat peoples of the NSB. Subsistence is an essential part of their way of life. Iñupiat culture is heavily dependent on the subsistence efforts passed on from one season to the next. These life lessons learned over multiple generations play a vital role in not only the success of their culture but also their ability to flourish for years to come. While local economies in the Arctic are heavily dependent on the resources obtained from subsistence, the people participating in these activities and lifestyle place value on the spiritual and cultural beliefs associated with this way of life (Brower 2004). The harsh Arctic environment in which the peoples of northern Alaska live, require knowledge of the ever-changing environment and the ability to adapt their subsistence methods in order to continue to thrive as they have done for thousands of years. The purpose and significance behind subsistence remains a constant (Alaska Federation of Natives ND). This section will discuss the subsistence resources, cultural values, harvest patterns, use areas, and the potential effects on subsistence in the communities located near the TGS Chukchi seismic survey project area. Not all subsistence research and its correlating data are publically available. In cases where information has not been published, the descriptions and level of detail may vary by community.

Terrestrial mammals are not discussed in the following subsistence sections because the proposed survey will be conducted in open water an onshore-based activities are proposed.

6.3.1 Barrow

Whaling, more than any other activity, fundamentally underlies the total way of life of Alaska's coastal Arctic communities (AEWC 2012). Whales are harvested for their meat, oil, baleen, and bone by the Iñupiat. The table below identifies the subsistence resources, location of harvest, and time of year harvesting occurs. Table 6.3.1-1 shows the different marine mammal subsistence resources, their approximate location and time of harvest for the community of Barrow.

Table 6.3.1-1. Barrow Marine Mammal Subsistence Species, Estimated Location and Harvest Season

Species	Estimated Location	Harvest Season
Bowhead Whale (*Balaena mysticetus*)	Ice leads offshore of the community; 15 miles (mi) (24 kilometers [km]) southwest to 30 mi (48 km) northeast of community and up to 15 mi (24 km) offshore. Some years, hunting has taken place as far south as Icy Cape. East of the community and northwest of Peard Bay.	Spring: Between late April to late May Fall: October
Beluga (*Delphinapterus leucas*)	Along the coastal lagoons.	June to August
Pacific Walrus (*Odobenus rosmarus*)	Local haulouts near Milliktagvik and as far north as Point Franklin.	Mid-June to August August to September
Bearded Seal (*Erignathus barbatus*)	Along the coastal shore of Wainwright and south to the mouth of the Kuk Lagoon	April to August and December to January
Ringed Seal (*Phoca hispida*)	This species is rarely harvested; Spring and Fall hunts take place within close proximity of shore from Point Lay to Point Franklin	April to August and December to January
Spotted Seal (*Phoca largha*)	Along the coastal shore as far southwest as Point Lay northeast to Point Franklin; most taken at Kuk Lagoon	September to October
Ribbon Seal (*Histriophoca fasciata*)	Along the coastal shore as far southwest as Point Lay northeast to Point Franklin	April to August
Polar Bear (*Ursus maritimus*)	Near Icy Cape, from Point Belcher to Point Franklin; also at Seahorse Island	Between August and March

Source: Bacon, et al. 2009

Residents of Barrow also harvest waterfowl and fish. In Barrow, the spring harvest of these particular birds typically takes place in the month of May and provides a different source of protein following the long winter. Geese are typically hunted along inland rivers and lakes; whereas eiders are usually found along the coast. Fall migration of ducks and geese comes in late August and September and are harvested from Point Franklin to Admiralty Bay and Dease Inlet. Both spring and fall migration is used for harvesting these birds. Point Barrow separates the Chukchi Sea from Elson Lagoon providing a very successful bird hunting ground (MMS 2008).

Several species of birds are harvested for subsistence needs. These include but are not limited to the following: brant, Canada goose, common eider, king eider, long-tailed duck, northern pintail, ptarmigan, snow goose, snowy owl, and white-fronted goose (Bacon, et al. 2009).

Many different species of fish are harvested in Barrow to supplement their diet. Five Pacific salmon species (chum, silver, king, pink, and sockeye) are fished. Whitefish and grayling are harvested in overwintering areas where these under-ice fish are found in the month of October (MMS 2008). Whitefish, least cisco, broad whitefish, Arctic cisco, and Arctic grayling are the most-fished species by the people of Barrow.

Subsistence resources are broken down by species and percentage of each resource harvested in Figure 6.3.1-2.

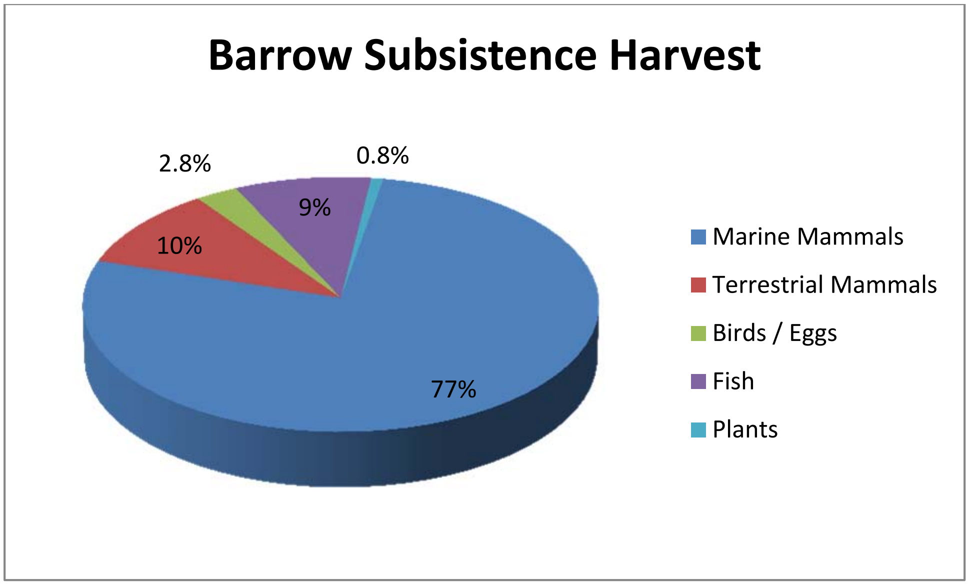

Figure 6.3.1-2. Barrow Subsistence Harvest by Percentage

Note: Data represented in terms of edible pounds harvested.
Source: Fuller and George 1997

6.3.2 Wainwright

Table 6.3.2-1 shows the different marine mammal subsistence resources and there estimated location and time of harvest for the community of Wainwright.

Table 6.3.2-1. Wainwright Marine Mammal Subsistence Species, Estimated Location, and Harvest Season

Species	Estimated Location	Harvest Season
Bowhead Whale (*Balaena mysticetus*)	Ice leads offshore of the community; 15 mi (24 km) southwest to 30 mi (48 km) northeast of community and up to 15 mi (24 km) offshore. Some years hunting has taken place as far south as Icy Cape East of the community and northwest of Peard Bay	Spring: Between late April to late May Fall: October
Beluga (*Delphinapterus leucas*)	Along the coastal lagoons	June to August
Pacific Walrus (*Odobenus rosmarus*)	Local haulouts near Milliktagvik and as far north as Point Franklin	Mid-June to August August to September
Bearded Seal (*Erignathus barbatus*)	Along the coastal shore of Wainwright and south to the mouth of the Kuk Lagoon	April to August And December to January
Ringed Seal (*Phoca hispida*)	This species is rarely harvested; Spring and Fall hunts take place within close proximity of shore from Point Lay to Point Franklin	April to August And December to January
Spotted Seal (*Phoca largha*)	Along the coastal shore as far southwest as Point Lay northeast to Point Franklin; most taken at Kuk Lagoon	September to October
Ribbon Seal (*Histriophoca fasciata*)	Along the coastal shore as far southwest as Point Lay northeast to Point Franklin	April to August
Polar Bear (*Ursus maritimus*)	Near Icy Cape, from Point Belcher to Point Franklin; also at Seahorse Island	Between August and March

Source: Bacon, et al. 2009

Similar to Barrow, waterfowl is an important subsistence resource to Wainwright. The majority of all birds harvested are done after the spring migration between the months of April and July.

These species include but are not limited to: brant, Canada goose, common eider, duck, king eider, northern pintail, ptarmigan, rock ptarmigan, snow goose, spectacled eider, Steller's eider, tundra swan, white-fronted goose, and willow ptarmigan. White-fronted goose eggs are also harvested (Bacon, et al. 2009).

Smelt, Arctic grayling, burbot, broad whitefish, and least cisco are the species that make up the majority of fish harvested by residents of Wainwright. However, many other species are harvested, including but not limited to: salmon (king, chum, pink, and silver), tomcod, flounder, char, lake trout, pike, Bering cisco, humpback whitefish, and round whitefish (Bacon, et al. 2009; Fuller and George 1997).

Figure 6.3.2-1 shows the subsistence resources and the percentage harvested by the community of Wainwright.

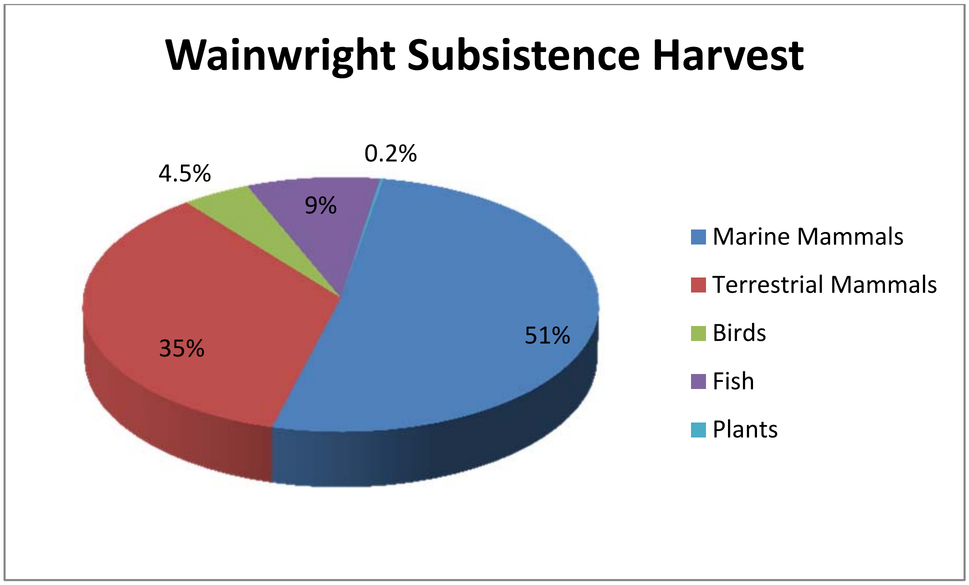

Figure 6.3.2-1. Wainwright Subsistence Harvest by Percentage

Note: Data represented in terms of edible pounds harvested.
Source: Fuller and George 1997

6.3.3 Point Lay

Table 6.3.3-1 identifies the subsistence resources, location of harvest, and time of year harvesting occurs in Point Lay.

Table 6.3.3-1. Point Lay Marine Mammal Subsistence Species, Estimated Location, and Harvest Season

Species	Estimated Location	Harvest Season
Bowhead Whale (*Balaena mysticetus*)	Ice leads offshore of Point Lay. Whale landed in 2009 was taken from an ice lead 10 miles (mi) (16 kilometers [km]) northwest of community.	Spring: Between April and June
Beluga (*Delphinapterus leucas*)	South of Point Lay, hunters herd whales from Naokak and Kukpowruk passes into the shallow waters of Kasegaluk Lagoon. Waters are also used as far north as Icy Cape and as far south as Cape Beaufort; up to 20 mi (32 km) offshore.	Mid-June to Mid-July
Pacific Walrus (*Odobenus rosmarus*)	Between Cape Beaufort and Icy Cape and as far as 25 mi (40 km) offshore	June to August
Bearded Seal (*Erignathus barbatus*)	Between Cape Beaufort and Icy Cape; up to 25 mi (40 km) offshore	June
Ringed Seal (*Phoca hispida*)	Between Cape Beaufort and Icy Cape; up to 20 mi (32 km) offshore	March to May
Spotted Seal (*Phoca largha*)	Between 10 mi (16 km) east of Cape Lisburne and as far west as Icy Cape; up to 25 mi (40 km) offshore	July to September
Ribbon Seal (*Histriophoca fasciata*)	Between Cape Beaufort and Icy Cape and as far as 25 mi (40 km) offshore	March to May
Polar Bear (*Ursus maritimus*)	As far out as 10 mi (16 km) offshore between Cape Beaufort and Icy Cape	January to April

Source: Bacon, et al. 2009

More than 60 percent of Point Lay residents report harvesting birds, including waterfowl. The majority of these birds are harvested along the coast to Icy Cape and as far south as Ledyard Bay and as far as 20 mi (32 km) offshore. Migratory birds primarily harvested are white-fronted geese, brant, eiders, and ptarmigans. Brant and white-fronted goose eggs, mallard, and northern pintail are also harvested (Bacon, et al. 2009).

Chum salmon, king salmon, smelt, tomcod, trout, grayling, humpback whitefish, and saffron cod are some of the species of fish harvested to fulfill the subsistence needs by the community members of Point Lay. Fishing takes place both inland in lakes and rivers as well as along the shoreline.

Figure 6.3.3-1 displays the percentages of subsistence resources harvested for the community of Point Lay.

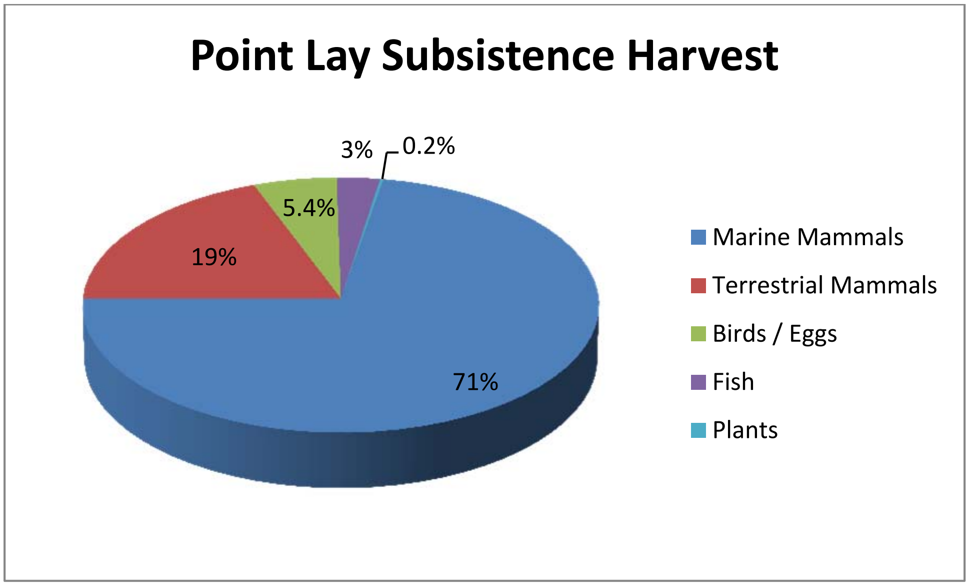

Figure 6.3.3-1. Point Lay Subsistence Harvest by Percentage

Note: Data represented in terms of edible pounds harvested.
Source: ADF&G 2009

6.3.4 Point Hope

Table 6.3.4-1 below identifies the subsistence resources, location of harvest, and time of year harvesting occurs in Point Hope.

Table 6.3.4-1. Point Hope Marine Mammal Subsistence Species, Estimated Location, and Harvest Season

Species	Location	Harvest Season
Bowhead Whale (*Balaena mysticetus*)	South and southeast of the point to the extent that reaches Point Thompson. Hunting rarely takes place more than 15 miles (mi) (24 kilometers [km]) offshore.	Spring: Mid-April to Early June
Beluga (*Delphinapterus leucas*)	Same area as bowhead and open water near the shorelines and as far north as Cape Dyer.	March to June July to August
Pacific Walrus (*Odobenus rosmarus*)	Between Cape Thompson and Cape Lisburne and as far east as Ayugatak Lagoon (up to 20 mi [32 km] offshore).	May to July
Bearded Seal (*Erignathus barbatus*)	Between Cape Thompson and Cape Lisburne and as far east as Ayugatak Lagoon (up to 20 mi [32 km] offshore).	January to June
Ringed Seal (*Phoca hispida*)	Between Cape Thompson and Cape Lisburne and as far east as Ayugatak Lagoon (up to 20 mi [32 km] offshore).	January to June November to December
Spotted Seal (*Phoca largha*)	Between Cape Thompson and Cape Lisburne and as far east as Ayugatak Lagoon (up to 20 mi [32 km] offshore).	January to June November to December
Ribbon Seal (*Histriophoca fasciata*)	Between Cape Thompson and Cape Lisburne and as far east as Ayugatak Lagoon (up to 20 mi [32 km] offshore).	January to June November to December
Polar Bear (*Ursus maritimus*)	South of the point as far out as 10 mi (16 km) offshore.	January to April and October to January

Source: Bacon, et al. 2009

Many species of birds including waterfowl are harvested in the community of Point Hope with the most important of these being eiders, snow geese, and murre eggs. Some of the other species harvested are brant, greater white-fronted geese, willow ptarmigan, and snowy owls (Bacon, et al. 2009).

Point Hope residents harvest fish year-round. Open waters are fished during the summer and ice leads are fished during months producing colder temperatures (NSB 2005). Whitefish, lake trout, flounder, sculpin, and several species of salmon make up the many species of fish harvested throughout the community of Point Hope (Fuller and George 1997).

Figure 6.3.4-1 displays the percentages of subsistence resources harvested by the community of Point Hope.

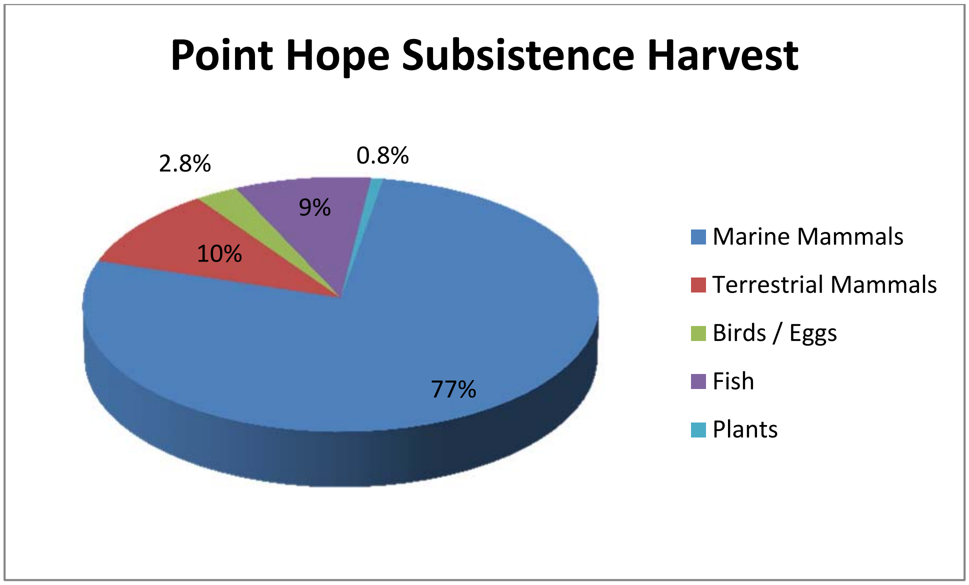

Figure 6.3.4 -1. Point Hope Subsistence Harvest by Percentage

Note: Data represented in terms of edible pounds harvested.
Source: Fuller and George 1997

6.3.5 Potential Effects on Subsistence

TGS has designed its 2D seismic survey to minimize effects on marine mammal species and subsistence hunting by:

- Beginning seismic operations in late July or early August (depending on ice conditions and weather) after the spring whale hunt has ended
- Remaining in ice-free waters throughout the survey, thus avoiding close encounters with ice habitat preferred by seals, walruses, belugas, and polar bears
- Operating a distance of at least 55 mi (88 km) from shore, thereby limiting interactions with primarily coastal species such as beluga and bowhead whales, and subsistence vessels that remain in closer coastal waters
- Planning to, if conditions allow, survey southern-most transects south of 72 °N first (July-August) while bowhead and most beluga whales are in the Beaufort Sea, thus avoiding bowhead whales and subsistence hunting activities
- Planning survey efforts to extend northward and away from the fall migration path of bowhead whales as sea-ice recedes (September and October). By approximately mid-September, seismic operations are expected to be located in international waters over 200 nm north/northwest from shore, and thus well outside the more coastal main fall whale migration and hunt.

In an effort to avoid or mitigate potential effects on marine mammals, fish, and birds, TGS will adhere to all mitigation measures included in Sections 5.2 through 5.4.

TGS anticipates no effects on terrestrial mammals during the duration of this project.

6.4 North Slope Economy

This section provides baseline information and data related to the economy of the NSB. The development of natural resources, especially the discovery of oil in Prudhoe Bay in 1968 has played a significant role in the current economic infrastructure of the NSB. Subsequently, the Alaska Native Claims Settlement Act (1971) and the establishment of the NSB (1972) resulted. This drastically changed the economy of the NSB. Increased activities in construction and oil and gas industries diversified the economy and created a substantial number of jobs in the NSB. However, much of the money created from these enterprises did not benefit the communities of the North Slope since most of the money was earned by non-residents, with the majority of it being spent outside the local economy (MMS 2006a). Revenue-sharing from oil and gas exploration may result in direct and indirect economic benefits to the local people, governments and village corporations. The NSB has been able to finance large infrastructure projects as a result of revenues created from property taxes levied on the oil and gas industry.

Employment opportunities for the residents of the NSB are limited. The borough itself provides the majority of the employment opportunities for the North Slope. The NSB is the largest employer for North Slope Inupiat, accounting for slightly over 50 percent of employment after including the NSB school district, the Illisagvik College, and the NSB Capital Improvement Program. The Arctic Slope Regional Corporation and village corporations, private businesses as well as local, state, and federal governments also provide numerous employment opportunities in the region. Village corporations and their subsidiaries account for 13.8 percent of the workforce (NSB 2010). Since 2003, employment by the federal government has decreased by over 30 percent; employment by the state government has remained constant and city government employment has increased by 71 percent (NSB 2010). Between 2003 and 2010, private sector business employment has remained level (NSB 2010).

6.4.1 Potential Effects on Economy

Potential effects on the economy of the NSB from the proposed 2D seismic survey are expected to be minimal and temporary. Of the three phases of OCS development (exploration, development, and production), seismic exploration has the lowest potential for employment opportunities and economic effects (MMS 2007). The prospects for economic growth will be mostly through a few temporary hires of local residents for the proposed project such as PSOs and communication center staff.

Other effects on the economy will be the purchasing of supplies and groceries locally and when practicable, including during local community and leadership meetings, and the use of local labor, businesses, and facilities when possible. Crew changes and minor resupply will be conducted from established onshore facilities, either in Wainwright or Nome. Crew changes will have minor economic effects on local employment. Most of the project personnel will be based on the seismic vessel and its scout/monitoring vessel.

6.5 Coastal and Marine Uses

The annual presence of sea ice in the Chukchi Sea restricts the amount of vessel movement. Private fishing, maritime, and tourism activities are minimal throughout the Chukchi Sea. Very little sport fishing takes place in the rivers flowing into the northeastern Chukchi Sea. However, the coastal communities of Barrow, Wainwright, Point Lay, and Point Hope all participate in subsistence fishing and whaling activities. Commercial fishing in the Chukchi Sea was officially closed by the NMFS in 2009 (NOAA 2009).

During summer months, when the Chukchi Sea is ice-free, local communities and the Prudhoe Bay region are provided goods by barges. This short time frame only allows communities to be provided with fuel up to two times a year (ADEC 2012).

Records of vessel traffic in the Arctic are incomplete; however, the Arctic Council reports fewer than 50 vessels operate in the eastern Chukchi Sea each season (Arctic Council 2009). Scientific, safety, and security operations are performed by USCG vessels along the Chukchi coast.

Two cruise ships, the *Hanseatic* and the *Bremen*, traversed the Chukchi Sea in 2009, making stops in Barrow, Point Hope, and Nome (AES 2009). In 2011, two tourism vessels transited the Chukchi Sea, but did not dock in any Alaska community. These tours typically begin in late July or August and end in September (USCG 2012).

The military does very little testing, evaluation, and training in the Chukchi Sea. No military vessels are stationed there and the Federal Aviation Administration has not designated any airspace over the Chukchi Sea for "special use" by the military.

In the summer of 2012, the USCG kicked off its most recent program for the Arctic, known as "Arctic Shield 2012". This program focused on outreach, operations, and assessment of their capabilities in Arctic Alaska. The Arctic Shield program allowed the USCG to station two helicopters in Barrow to provide an increased presence and awareness of sea activities (Slattery 2012). The primary focus of Arctic Shield 2012 actions was to increase coastal security, environmental protection, and emergency response.

Marine shipping to coastal communities of the Chukchi Sea only occurs approximately four months out of the year because of sea ice. However, air cargo services are available to these communities year-round.

Deposits of coal, industrial minerals, and metallic minerals have been discovered in the NSB through previous exploration and mineral assessments. The NSB also has large industrial deposits of sand and gravel. These materials are used in road-building projects, oilfield roads, and facility and drill pads.

6.5.1 Potential Effects on Coastal and Marine Uses

TGS anticipates minimal effects on the coastal and marine uses in the project area. Projected seismic activities will take place at an ample distance from the coastal areas and communities, thus avoiding and minimizing potential conflict with marine activities such as shipping, military activities, fishing, recreational boating, or any oil and gas activities. TGS will coordinate closely with BOEM and other industrial operators to avoid interactions during the survey activity.

6.6 Environmental Justice

EJ is defined by the EPA as "the fair treatment and meaningful involvement of all people, regardless of race, color, national origin or income with respect to the development, implementation, and enforcement of environmental laws, regulations, and policies". This essentially means that industrial, governmental, or commercial operations or policies will not have the ability to place an unequal share of negative environmental consequences on any group of people. EJ affords people the chance be active in the decisions that are made about environmental and health activities.

In 1994, the Federal Government issued Executive Order (EO) 12898, which provided federal attention to be given to environmental justice in minority and low-income populations. EO 12898 provides minority and low-income communities with public information and opportunities to participate in decisions being made about public health or the environment (EPA 2012).

Standards have been established to decide whether a population is considered to be a minority or low-income population. On the basis of these criteria, a community is considered to be an EJ population if when compared to the reference population of an area the potentially affected communities have ethnic or economic characteristics 1.2 times or more than the reference population (MMS 2008).

7.0 Cumulative Effects

The following reports were examined to evaluate the cumulative effects associated with TGS's 2013 Chukchi Sea 2D seismic survey project include:

- *ION Geophysical 2012 Seismic Survey Beaufort Sea and Chukchi Sea, Alaska, Environmental Assessment* (BOEM 2012b).
- *Statoil USA E&P Inc. Geological & Geophysical Permit 2010 3D/2D Seismic Acquisition Chukchi Sea, Alaska* (BOEMRE 2010)
- *Chukchi Sea Planning Area Oil and Gas Lease Sale 193 in the Chukchi Sea, Alaska, Final Supplemental Environmental Impact Statement* (BOEMRE 2011)
- *Chukchi Sea Planning Area-Oil and Gas Lease Sale 193 and Seismic Surveying Activities in the Chukchi Sea, Final Environmental Impact Statement* (MMS 2007)
- *Arctic Ocean Outer Continental Shelf Seismic Surveys, Final Programmatic Environmental Assessment* (MMS 2006b)

7.1 Physical Environment

Cumulative effects associated with TGS's seismic program relative to the physical environment are expected to be negligible. Seismic surveys are expected to result in negligible to no direct effects and no indirect effects on the physical resources in the Chukchi Sea. Furthermore, BOEM does not expect seismic surveys to add significantly to the impacts from past, present, or future activities (MMS 2006, 2007; BOEMRE 2010). TGS expects effects to the physical environment to be primarily temporary direct effects as described in the following paragraphs.

The planned survey may result in a minor cumulative effect to air quality and meteorology, but it is not expected to result in adverse impacts. BOEM considers the overall air quality of the North Slope and Chukchi Sea to be relatively pristine, even though oil- and gas-related activities have occurred for over 40 years (MMS 2007; BOEMRE 2011; BOEM 2012). Activities and thus emissions in and near the project area are limited, and TGS expects any air pollutants to be diluted and dispersed when combined with other air emission sources. BOEM expects air quality to remain better than the national standards during and after seismic surveys (MMS 2007; BOEM 2012; BOEMRE 2011).

TGS's planned seismic survey should result in no cumulative effects to physical oceanography, geology, and geomorphology, sea ice, water quality, or the acoustic environment. Negligible or minor effects on these environmental elements may result. The survey is not expected to disturb the seafloor and thus should have no measureable effect on physical oceanography, geology, and geomorphology. Effects to sea ice would be direct and limited to the immediate vicinity of TGS's vessels, if at all. Similar to other analyses, effects to ice are expected to be negligible when combined with other activities (BOEM 2012) particularly since TGS operations will be limited to ice-free open waters to avoid potential damage to the hydrophone streamer towed by the seismic vessel.

TGS's seismic survey will not significantly degrade water quality. Effects will be direct and temporary because of permitted discharge practices. Similar to other cumulative effects analyses, potential effects on water quality are expected to be in the vessels' immediate area, mitigated through standard practices, and negligible (BOEM 2012; BOEMRE 2011; MMS 2007). Sound generated by seismic airguns and transiting vessels may result in temporary and localized effects, but such effects are not expected to result in cumulative effects. For a more detailed discussion on the direct and indirect effects on the physical environment, see Section 4.0, Physical Environment.

7.2 Biological Environment

TGS anticipates that its 2D seismic survey will have no more than a negligible increase in cumulative effects on the biological environment. Past seismic surveys in the Chukchi Sea are not known to have had harmful lasting effects on biological resources (BOEM 2012; BOEMRE 2010). Direct effects on marine mammals, marine birds, and fishes are expected to be restricted to temporary changes in behavior and displacement from disturbance caused by the seismic survey (BOEMRE 2010). Direct effects on lower trophic organisms are expected to be temporary and localized and thus negligible (BOEM 2012). Thus, effects are not expected to contribute to cumulative effects. For a more detailed discussion about direct and indirect effects, see Section 5.0, Biological Environment.

TGS's seismic survey poses a negligible risk of introducing marine invasive species to the Chukchi Sea. The survey is planned for a limited time, and TGS will adhere to the USCG requirements for ballast water management. The USCG reviews and approves ballast water management plans, regulating and limiting the introduction of invasive species (BOEMRE 2010).

TGS has planned the project schedule for seismic acquisition to minimize potential effects on marine mammals migrating through the Chukchi Sea. PSOs will be stationed on the scout vessel and seismic vessel in order to prevent and mitigate interaction with marine mammals. TGS will adhere to the NMFS and USFWS guidelines and exclusion and monitoring zones for marine mammals. Additionally, ramp up procedures will include a single sound source of low volume to warn cetaceans of the pending seismic operations.

7.3 Socioeconomic Resources

Socioeconomic effects from TGS's seismic survey will be mostly minor and limited to temporary direct and indirect effects. Cumulative effects will be negligible. The scout and seismic vessels will be self-contained and will operate at least 55 miles (89 km) from the closest community. TGS will refuel and conduct crew changes in Nome or Wainwright. Seismic acquisition is scheduled to minimize potential effects to subsistence hunting activities and the migration of subsistence animals. Furthermore, operational activities are planned so that potential effects to subsistence marine mammals are limited (see Sections 5.0 and 7.3 for more detail.)

Minor cumulative effects in Wainwright's transient population may result if TGS changes crew and refuels in Wainwright. This project should not affect the profiles of any of the other North Slope communities. There could be an incremental addition of people in Wainwright should TGS or other seismic, oil and gas operators, or research operators refuel or stage out of Wainwright. It is assumed that like TGS's, these other activities will result in temporary population fluxes. Thus, cumulative effects will be minor. TGS will conduct crew changes and refueling every 35 days.

TGS's contribution to cumulative effects on the North Slope economy is expected to be negligible similar with other seismic survey activities (BOEM 2012; BOEMRE 2010; MMS 2006). Potential economic effects, if any, will likely be short term. Potential for economic growth will likely be limited to temporary PSO positions and communication center staff. The seismic survey will likely result in negligible cumulative effects to low-income or minority populations. TGS does not expect this project to result in disproportionate effects on these populations because effects to subsistence resources and activities and the local economy will be negligible. The seismic survey will result in negligible cumulative effects to subsistence resources and subsistence activities. As discussed in Section 7.3, Cumulative Effects to Biological Resources, seismic surveys in the Chukchi Sea are not known to have had harmful lasting effects on biological resources (BOEM 2012; BOEMRE 2010). TGS's seismic survey should be no different. Furthermore, TGS has proposed seismic acquisition scheduling to minimize potential effects on and interaction with subsistence hunting activities and with the migration of subsistence animals.

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8.0 Mitigation Measures

The planned 2D seismic survey has been designed to minimize effects to marine mammal species and subsistence hunts by:

- Operating at a distance of at least 55 mi (88 km) from shore, limiting interactions with predominant coastal species, such as beluga whales, and subsistence vessels that remain in coastal waters
- Adjusting survey location to avoid heavy use areas of Pacific walruses, specifically around the Hanna Shoal and the potential migration path between Hanna Shoal and the Chukchi coast of Alaska
- Planning to, if conditions allow, survey southern-most transects south of 72 °N first (July-August) while bowhead whales and most belugas are in the Beaufort Sea, thus avoiding effects to bowhead whales and subsistence efforts
- Planning survey efforts to extend northward and away from the fall migration path of bowhead whales as sea ice recedes (September and October).

Mitigation methods summarized here will be employed to ensure minimal effect to marine mammals and subsistence activities. Additionally, TGS does not anticipate interaction with other operators. However, as required by NMFS and USFWS incidental take regulations, TGS will maintain a minimum spacing of 15 mi (24 km) between all active seismic vessels. TGS will make every effort to acquire the seismic lines that are located nearest to any projected drilling locations before the arrival of a drilling vessel. If a drilling vessel is occupying a location before the acquisition of the seismic line, TGS will maintain an agreed upon (with the operator of the drilling vessel) safety radius from the drilling vessel.

TGS anticipates supporting a Com Center in Point Lay. The Com Center provides vessel operators with information about the presence of marine mammals and subsistence activity in the area. PSOs will be placed onboard the seismic and scout vessels to implement mitigation measures minimizing exposure to the seismic sound source.

Vessel-based mitigation measures include ramp-up procedures while initiating seismic operations and power-down and a shut-down procedure if a marine mammal is detected approaching or within designated distances from the seismic source. These distances have been determined by acoustic propagation modeling, provided by JASCO Applied Sciences. Actual distances to each exclusion zone will be measured using SSV and adjusted accordingly at the beginning of the field season.

8.1 Vessel-based Visual Monitoring

Vessel-based PSOs will observe from both the seismic and scout vessels to monitor the presence of marine mammals during all daylight seismic operations. The primary purpose of the PSOs will be to monitor the exclusion and monitoring zones and implement mitigation measures (e.g., ramp-ups, power-downs, and shut-downs of the seismic source) as described below. PSOs will be selected by TGS and approved by NMFS and USFWS. At least one PSO on each vessel will be an Iñupiaq resident knowledgeable about the marine mammals of the area. The vessel-based monitoring will provide:

- The foundation for real-time mitigation as required by the permitting agencies
- Information necessary to estimate the number of “takes” of marine mammals that must and will be reported to NMFS or USFWS

- Information necessary to evaluate the impact of activities authorized by the IHA and LOA on marine mammals and local subsistence activities
- Marine mammal distribution, movement, and behavioral data in the survey area when seismic activities are taking place or not.

8.2 Protected Species Observer Protocol

TGS intends to begin operations in July or August (depending on ice conditions) when there are approximately 24 hours of daylight. To adequately monitor proposed exclusion zones during all daylight seismic operations, five PSOs are proposed to be based aboard the seismic vessel with at least three aboard the scout vessel. As daylight decreases during the survey, the number of PSOs aboard the seismic vessel may be reduced. At least one observer will be on duty during all daylight seismic source operations; however, two observers will be on duty whenever possible. Two observers will be on duty during all 30-minute periods before seismic source ramp-up and during all ramp-ups. PSOs will be on duty for no longer than four consecutive hours with a maximum of 12 hours on duty per day per PSO.

Before mobilization, PSOs will attend a NMFS- and USFWS- approved survey-specific training program and receive a detailed manual that summarizes the observer protocol and mitigation procedures as stipulated in the permits and issued IHA and LOA. Once onboard the vessels and before the start of the survey, the lead PSO aboard the seismic vessel will communicate the role of the PSO teams to the vessel crew(s) and establish a method of communication for relaying mitigation requests to the seismic source operators.

8.3 Data Recording

The operator of the seismic vessel will maintain a log of seismic surveys, noting the date and time of all changes in seismic activity (ramp up, power down, changes in the active seismic source, shutdowns, etc.) and any corresponding changes in monitoring radii. In addition, PSOs will use a standardized format to record all marine mammal observations and mitigation actions (seismic source power downs, shut downs, and ramp ups). Information collected during marine mammal observations will include the following:

- Vessel speed, position, and activity
- Date, time, and location of each marine mammal sighting
- Number of marine mammals observed, and group size, sex, and age categories
- Observer's name, company name, vessel name, IHA/LOA number, and contact information
- Weather, visibility, and ice conditions at the time of observation
- Estimated distance of marine mammals at closest approach
- Activity at the time of observation, including possible attractants present
- Animal behavior
- Detailed description of the encounter
- Duration of the encounter
- Mitigation action taken

8.4 Establishment and Monitoring of Exclusion Zones

Current NMFS and USFWS guidelines (NMFS 2000; 50 CFR 18.118 2008) define "exclusion radii", hereafter referred to as exclusion zones, for marine mammals around industrial sound to be 180 dB re 1 μPa (rms) for cetaceans and Pacific walruses, and 190 dB re 1 μPa (rms) for pinnipeds and polar bears. Such guidelines are in place to minimize disturbance or behavioral effects to marine mammals on the basis of the assumption that sound energy at lower received levels will not impair their abilities to hear, but higher received levels may have such effects.

PSOs aboard the seismic and scout vessels will perform a substantial role in monitoring for marine mammals and the implementation of mitigation measures. PSOs aboard the seismic vessel will monitor for marine mammals before initiation of the seismic source to ensure none are detected within the specified exclusion zones for a 30-minute period. The scout-vessel will be used to detect aggregations of baleen whales and Pacific walruses (12 or more) within the ≥160 dB re 1 μPa (rms) zone.

8.5 Mitigation during Operations

TGS will adhere to the following mitigation measures during seismic operations, when mobilizing to the project area, when demobilizing from the project area, and in the performance of any other operations in support of the 2D seismic program:

- Speed or course alterations, provided that doing so will not compromise safety of the operations
- The seismic and scout vessel will be staffed with PSOs who will alert the crew to the presence of marine mammals so that vessel crews can initiate appropriate mitigation measures, including power-down, shut-down, and ramp-up procedures
- Initiation of the seismic source will occur only after the 180 dB re 1 μPa (rms) zone is visible for 30 minutes during day or night.

During periods of poor visibility or nighttime, TGS will adhere to the following:

- During limited visibility because of fog and/or darkness, the entire 180 dB re 1 μPa (rms) exclusion zone may not be visible. If the entire zone is not visible for a minimum of 30 minutes, initiation of the seismic source will not occur.
- During nighttime, initiation of the seismic source will only occur if the entire 180 dB re 1 μPa (rms) exclusion zone is visible for 30 minutes using night-vision devices and/or vessel lights.
- If a single airgun seismic source or a seismic source array has been operational before visibility to the exclusion zone boundary decreased or nightfall, the seismic source operations may continue even though the entire exclusion zone may not be visible.

8.5.1 Power-down Procedures

Power-down procedures include reducing the seismic source array volume (by reducing the number of active airguns) thereby reducing the 180 dB re 1 μPa (rms) and 190 dB re 1 μPa (rms) exclusion zones to an extent that the marine mammal(s) are no longer within the applicable zone. Power-downs may also occur when the seismic vessel is transitioning between survey lines. In this case, the seismic source array will be reduced to a single 60 in^3 (152 cm^3) (or smaller) mitigation airgun or shut down completely. The single mitigation airgun seismic source is intended to alert marine mammals of the presence of a sound source in the environment and retain the option to initiate seismic source ramp-up procedures under conditions of poor visibility or darkness.

Once powered down, seismic source operations will only resume once the marine mammal has been confirmed outside the exclusion zone. A marine mammal is considered to have cleared the zone if:

- It has been visually detected outside of the exclusion zone
- It has not been observed for 15 minutes (pinnipeds, small odontocetes, or polar bears in water)
- It has not been observed for 30 minutes (mysticetes or walruses [on ice or in water]; large odontocetes do not occur in the survey area).

8.5.2 Shut-down Procedures

Shut-down procedures include a complete cessation of the seismic source. These procedures will be implemented if a marine mammal is observed within the appropriate exclusion zone of the single mitigation airgun. Once shut down, the seismic source operations will only resume once the marine mammal has been confirmed outside the exclusion zone as described for power-downs.

8.5.3 Ramp-up Procedures

Ramp-up procedures involve a step-wise increase in number and volume of the seismic source to provide a gradual increase of sound levels into the environment. This procedure is intended to alert marine mammals of seismic activity in the area and allow them time to leave the area so as to avoid injury or hearing impairment. PSOs will be on duty during the 30-minute observation period before ramp ups, during ramp ups, and during all seismic source operations.

8.6 Reporting

During the field season, brief summary reports will be provided to NMFS and USFWS if required per the IHA and LOA. A report summarizing the preliminary results of the SSV and refined monitoring exclusion zones for the seismic sources will be submitted shortly after the measurements are complete at the beginning of the field season.

Results of the vessel-based PSO program, including estimates of takes by harassment, will be described in a report to be submitted within 90 days of the end of the program. This report will adhere to the requirements established by the NMFS IHA and USFWS LOA and will include the following:

- A summary of the monitoring effort
- Analysis of factors affecting the visibility and detectability of marine mammals by monitoring
- Analysis of distribution and abundance of marine mammal sightings, and description of marine mammal behavior in relation to date, location, ice conditions, and operations
- Estimates of takes based upon density estimates derived from monitoring and survey efforts
- Reporting of acoustic monitoring results to include: sound source levels of source and scout vessels and seismic surveys; acoustic detections of marine mammals, and continuous sound levels at the stationary recording locations
- Estimates of "take by harassment."

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