Draft Environmental Assessment For the Issuance of Incidental Harassment Authorizations for the Take of Marine Mammals by Harassment Incidental to Conducting Open-water Seismic and Geohazard Surveys in the U.S. Beaufort Sea

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ABSTRACT: National Marine Fisheries Service proposes to issue Incidental Harassment Authorizations (IHAs) to SA Exploration, Inc. (SAE) and Hilcorp Alaska, LLC (Hilcorp) for the take of marine mammals incidental to conducting open-water seismic and geohazard surveys in the U.S. Beaufort Sea in 2015.

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List of Acronyms, Abbreviations, and Initialisms

2D	2-dimensional
3D	3-dimensional
4MP	Marine Mammal Monitoring and Mitigation Plan
ABWC	Alaska Beluga Whale Committee
ACIA	Arctic Climate Impact Assessment
ADEC	Alaska Department of Environmental Conservation
ADFG	Alaska Department of Fish and Game
AEWC	Alaska Eskimo Whaling Commission
AHD	Acoustic Harassment Device
ANO	Alaska Native Organization
BCB	Bering-Chukchi-Beaufort Seas (stock of bowhead whale)
BOEM	Bureau of Ocean Energy Management
BOEMRE	Bureau of Ocean Energy Mangement, Regulation and Enforcement
BP	BP Exploration Alaska
BSEE	Bureau of Safety and Environmental Enforcement
CFR	Code of Federal Regulations
CEQ	President's Council on Environmental Quality
COMIDA	Chukchi Offshore Monitoring in Drilling Area
CZMA	Coastal Zone Management Act
DASAR	Directional Autonomous Seafloor Acoustic Recorder
dB	decibel
DOI	Department of the Interior
DPS	Distinct Population Segment
EA	Environmental Assessment
EEZ	Exclusive Economic Zone
EFH	Essential Fish Habitat
EIS	Environmental Impact Statement
EO	Executive Order
EPA	Environmental Protection Agency
ESA	Endangered Species Act
FMP	Fishery Management Plan
ft	foot/feet
FR	Federal Register
hr	hour
Hz	hertz
IHA	Incidental Harassment Authorization
IMO	International Maritime Organization
IMP	Ice Management Plan
ION	ION Geophysical
IPCC	Intergovernmental Panel on Climate Change
IWC	International Whaling Commission
L-DEO	Lamont-Doherty Earth Observatory
LME	Large Marine Ecosystem
MMO	Marine Mammal Observer
MMPA	Marine Mammal Protection Act
MMS	Minerals Management Service

MSFCMA	Magnuson-Stevens Fishery Conservation and Management Act
NAO	NOAA Administrative Order
NEPA	National Environmental Policy Act
NMFS	National Marine Fisheries Service
NOAA	National Oceanic and Atmospheric Administration
NPDES	National Pollution Discharge Elimination System
NPFMC	North Pacific Fisheries Management Council
NRC	National Research Council
NSB	North Slope Borough
NSR	New Source Review
OMB	Office of Management and Budget
p-p	peak-to-peak
POC	Plan of Cooperation
psi	pounds per square inch
PSO	Protected Species Observer
psu	practical salinity units
PTS	Permanent Threshold Shift
rms	root-mean-square
SAE	SA Exploration, Inc.
SEL	Sound Exposure Level
SPL	Sound Pressure Level
TS	Threshold Shift
TTS	Temporary Threshold Shift
UAS	Unmanned Aerial Surveys
U.S.C.	United States Code
USCG	United States Coast Guard
USGS	United States Geological Survey
USFWS	United States Fish and Wildlife Service

Chapter 1 INTRODUCTION AND PURPOSE AND NEED

1.1 Description of Proposed Action

The Marine Mammal Protection Act (MMPA) prohibits the incidental taking of marine mammals. The incidental take of a marine mammal falls under three categories: mortality, serious injury, or harassment, which includes injury and behavioral effects. The MMPA defines harassment as any act of pursuit, torment, or annoyance which: (1) has the potential to injure a marine mammal or marine mammal stock in the wild (Level A harassment); or (2) has the potential to disturb a marine mammal or marine mammal stock in the wild by causing disruption of behavioral patterns, including, but not limited to, migration, breathing, nursing, breeding, feeding, or sheltering (Level B harassment). There are exceptions to the MMPA's prohibition on take, such as the authority at issue here for us to authorize the incidental taking of small numbers of marine mammals by harassment upon the request of a U.S. citizen provided we follow certain statutory and regulatory procedures and make determinations. This exception is discussed in more detail in Section 1.2.

We propose to issue Incidental Harassment Authorizations (IHAs) to the SA Exploration, Inc. (SAE) and Hilcorp Alaska, LLC (Hilcorp) under the MMPA for the taking of small numbers of marine mammals, incidental to 3D ocean bottom nodes (OBN) seismic survey and shallow geohazard survey, respectively, in the U.S. Beaufort Sea during 2015 Arctic open-water season. We do not have the authority to permit, authorize, or prohibit SAE or Hilcorp's seismic and shallow geohazard survey activities.

Our proposed action is a direct outcome of SAE and Hilcorp requesting IHAs under Section 101(a)(5)(D) of the MMPA to take marine mammals, by harassment, incidental to conducting the seismic and shallow geohazard surveys. Underwater noises associated with the seismic and geohazard surveys have the potential to take, by harassment, marine mammals. SAE and Hilcorp therefore require IHAs for their incidental takes.

Our issuance of IHAs to SAE and Hilcorp would be major federal actions under the National Environmental Policy Act (NEPA), the Council on Environmental Quality (CEQ) regulations in 40 CFR §§ 1500-1508, and NOAA Administrative Order (NAO) 216-6. Thus, we are required to analyze the effects of our proposed action.

This Draft Environmental Assessment (Draft EA), titled "*Issuance of Incidental Harassment Authorizations for the Take of Marine Mammals by Harassment Incidental to Conducting Seismic and Geohazard Surveys in the U.S. Beaufort Sea*," (hereinafter, Draft EA) addresses the potential environmental impacts of two alternatives, namely:

- Issue the Authorizations to SAE and Hilcorp under the MMPA for Level B harassment of marine mammals during SAE and Hilcorp's seismic and geohazard surveys, taking into account the prescribed means of take, mitigation measures, and monitoring requirements required in the proposed Authorizations; or

- Not issue Authorizations to SAE and Hilcorp, in which case, for the purposes of NEPA analysis only, we assume that SAE and Hilcorp would forego the proposed respective seismic and shallow hazard surveys in the Beaufort Sea.

1.2.1 Background on SAE and Hilcorp's MMPA Applications

On December 2, 2014, NMFS received an application from SAE for the taking of marine mammals incidental to a 3D OBN seismic survey program in the Beaufort Sea. After receiving NMFS comments, SAE made revisions and updated its IHA application on December 5, 2014, January 21, 2015, January 29, 2015, and again on February 16, 2015. In addition, NMFS received the marine mammal mitigation and monitoring plan (4MP) from SAE on December 2, 2014, with an updated version on January 29, 2015.

SAE proposes to conduct 3D OBN seismic surveys in the state and federal waters of the U.S. Beaufort Sea during the 2015 Arctic open-water season. The proposed activity would occur between July 1 and October 15, 2015. The actual seismic survey is expected to take approximately 70 days, dependent of weather. The following specific aspects of the proposed activities are likely to result in the take of marine mammals: seismic airgun operations and associated navigation sonar and vessel movements. Take, by Level A and/or Level B harassments, of individuals of 6 species of marine mammals is anticipated to result from the specified activity.

On December 1, 2014, NMFS received an application from Hilcorp for the taking of marine mammals incidental to shallow geohazard surveys in the Beaufort Sea. After receiving NMFS comments, Hilcorp submitted a revised IHA application on January 5, 2015. In addition, Hilcorp submitted a 4MP on January 21, 2015.

Hilcorp proposes to conduct a shallow geohazard survey in state and federal waters of Foggy Island Bay in the U.S. Beaufort Sea during the open-water season of 2015. The proposed activity would occur between July 1 and September 30, 2015. The actual survey is expect to complete in 45 days, including weather and equipment downtime. Underwater noises generated from the sonar used for the survey are likely to result Level B harassment of indivisuals of 6 species of marine mammals.

1.2.2 Marine Mammals in the Action Area

SAE has requested an authorization to take nine marine mammal species by Level B harassment. These species are: beluga whale (*Delphinapterus leucas*), bowhead whale (*Balaena mysticetus*), humpback whale (*Megaptera novaeangliae*), gray whale (*Eschrichtius robustus*), narwhal (*Monodon monoceros*), bearded seal (*Erignathus barbatus*), ringed seal (*Phoca hispida*), spotted seal (*P. largha*), and ribbon seal (*Histriophoca fasciata*). However, NMFS consider it unlikely that humpback whale, narwhal, and ribbon seal would be taken because their extremely rare occurrence at SAE's proposed survey site.

SAE did not request authorization for Level A take of any marine mammals. However, given that the exclusion zones from SAE's airgun array are too large to ensure 100% detection, and given that based on past monitoring reports, marine mammals had occurred within the exclusion zones during the survey, NMFS considers that a small number of 6 marine mammal species could be exposed to noise levels by Level A harassment. These species are: bowhead whale, beluga whale, ringed seal, spotted seal, and bearded seal.

Hilcorp has requrested an authorization to take 11 marine mammal species by Level B harassment. These species are: bowheas whale, beluga whale, gray whale, killer whale (*Orcinus orca*), harbor porpoise (*Phocoena phocoena*), humpback whale, minke whale (*Balaenoptera acutorostrata*), ringed seal, bearded seal, spotted seap, and ribbon seal. Hoever, NMFS considers it unlikely that humpback whale, minke whale, killer whale, harbor porpoise, and ribbon seal would be taken because their extremely rare occurrence at Hilcorp's survey site.

1.2 Purpose and Need

The MMPA prohibits "takes" of marine mammals, with a number of specific exceptions. The applicable exception in this case is an authorization for incidental take of marine mammals in section 101(a)(5)(D) of the MMPA.

Section 101(a)(5)(D) of the MMPA directs the Secretary of Commerce (Secretary) to authorize, upon request, the incidental, but not intentional, taking of small numbers of marine mammals of a species or population stock, by United States citizens who engage in a specified activity (other than commercial fishing) within a specified geographical region if we make certain findings and provide a notice of a proposed authorization to the public for review. Entities seeking to obtain authorization for the incidental take of marine mammals under our jurisdiction must submit such a request (in the form of an application) to us.

We have issued regulations to implement the Incidental Take Authorization provisions of the MMPA (50 CFR Part 216) and have produced Office of Management and Budget (OMB)-approved application instructions (OMB Number 0648-0151) that prescribe the procedures necessary to apply for authorizations. All applicants must comply with the regulations at 50 CFR § 216.104 and submit applications requesting incidental take according to the provisions of the MMPA.

Purpose: The primary purpose of our proposed action—the issuance of Authorizations to SAE and Hilcorp—is to authorize (pursuant to the MMPA) the take of marine mammals incidental to SAE and Hilcorp's proposed activities. The IHAs, if issued, would exempt SAE and Hilcorp from the take prohibitions contained in the MMPA.

To authorize the take of small numbers of marine mammals in accordance with Section 101(a)(5)(D) of the MMPA, we must evaluate the best available scientific information and determine the take would have a negligible impact on marine mammals or stocks and not have an unmitigable adverse impact on the availability of affected marine mammal species for certain subsistence uses. We cannot issue an IHA if it would result in more than a negligible impact on marine mammal species or stocks or if it would result in an unmitigable adverse impact on subsistence uses.

In addition, we must prescribe, where applicable, the permissible methods of taking and other means of effecting the least practicable impact on the species or stocks of marine mammals and their habitat (i.e., mitigation), paying particular attention to rookeries, mating grounds, and other areas of similar significance. If appropriate, we must prescribe means of effecting the least practicable impact on the availability of the species or stocks of marine mammals for subsistence uses. Authorizations must also include requirements or conditions pertaining to the monitoring and reporting of such taking, in large part to better understand the effects of such taking on the species. Also, we must publish a notice of a proposed Authorization in the *Federal Register* for public notice and comment.

The underlying purpose of this action is therefore to determine whether the take resulting from SAE and Hilcorp's seismic and shallow geohazard surveys in the Beaufort Sea during the 2015 Arctic open-water season would have a negligible impact on affected marine mammal species or stocks and would not have an unmitigable adverse impact on the availability of marine mammals for taking for subsistence uses, and to develop mitigation and monitoring measures to reduce the potential impacts.

Need: On January 6 and February 16, 2015, respectively, Hilcorp and SAE submitted adequate and complete applications demonstrating both the need and potential eligibility for issuance of IHAs in connection with the activities described in section 1.1.1. We now have a corresponding duty to determine whether and how we can authorize take by Level A and Level B harassments incidental to the activities described in SAE and Hilcorp's applications. Our responsibilities under section 101(a)(5)(D) of the MMPA and its implementing regulations establish and frame the need for this proposed action.

Any alternatives considered under NEPA must meet the agency's statutory and regulatory requirements. Our described purpose and need guide us in developing reasonable alternatives for consideration, including alternative means of mitigating potential adverse effects.

1.3 Environmental Review Process

NEPA compliance is necessary for all "major" federal actions with the potential to significantly affect the quality of the human environment. Major federal actions include activities fully or partially funded, regulated, conducted, authorized, or approved by a federal agency. Because our issuance of an Authorization would allow for the taking of marine mammals consistent with provisions under the MMPA and incidental to the applicant's activities, we consider this as a major federal action subject to NEPA.

Under the requirements of NAO 216-6 section 6.03(f)(2)(b) for incidental harassment authorizations, we prepared this EA to determine whether the direct, indirect and cumulative impacts related to the issuance of two IHAs for incidental take of marine mammals during the conduct of SAE and Hilcorp's open-water seismic and shallow geohazard surveys, respectively, in the Beaufort Sea, could be significant. If we deem the potential impacts to be not significant, this analysis, in combination with other analyses incorporated by reference, may support the issuance of one or both Finding of No Significant Impact (FONSI) for the proposed Authorizations.

1.3.1 Laws, Regulations, or Other NEPA Analyses Influencing the EA's Scope

We have based the scope of the proposed action and nature of the two alternatives considered in this EA on the relevant requirements in section 101(a)(5)(D) of the MMPA. Thus, our authority under the MMPA bounds the scope of our alternatives. We conclude that this analysis—when combined with the analyses in the following documents—fully describes the impacts associated with the proposed seismic and geohazard surveys with mitigation and monitoring for marine mammals. After conducting a review of the information and analyses for sufficiency and adequacy, we incorporate by reference the relevant analyses on SAE and Hilcorp's proposed surveys as well as discussions of the affected environment and environmental consequences within the following documents, per 40 CFR §1502.21 and NAO 216-6 § 5.09(d):

- *Application for the Incidental Harassment Authorization for the Taking of Marine Mammals in Conjunction with SAE's Proposed 3D Seismic Survey in the Beaufort Sea, Alaska, 2015* (Owl Ridge Natural Resource Consultants, Inc., 2015).
- *Incidental Harassment Authorization Request for the Non-leathal Harassment of Marine Mammals during the Liberty Unit Shallow Geohazard Surveys, Beaufort Sea, Alaska, 2015* (ERM Alaska, Inc., 2014).

MMPA APPLICATION AND NOTICE OF THE PROPOSED AUTHORIZATION

The CEQ regulations (40 CFR § 1502.25) encourage federal agencies to integrate NEPA's environmental review process with other environmental reviews. We rely substantially on the public process for developing proposed Authorizations and evaluating relevant environmental information and provide a meaningful opportunity for public participation as we develop corresponding EAs. We fully consider public comments received in response to our publication of the notice of proposed Authorization during the corresponding NEPA process.

We considered SAE and Hilcorp's proposed mitigation and monitoring measures and determined that they would help ensure that the surveys would effect the least practicable impact on marine mammals. These measures include:

- Establishing and monitoring exclusion zones within which marine mammals could be exposed to received sound levels associated with injury;
- Implementing vessel speed or course alteration when a marine mammal appears likely to enter the exclusion zone, provided that doing so will not compromise operational safety requirements;
- Implementing airgun and sonar power-down or shut-down procedures when marine mammals are detected within or about to enter the exclusion zone, to reduce the noise exposure level to below that which could cause injury to the animals; and
- Implementing airgun and sonar ramp-up procedures so that marine mammals not visually detected within the exclusion zone prior to start-up would be warned and vacate the area.

Through the MMPA process, we preliminarily determined that, provided that SAE and Hilcorp implement the required mitigation and monitoring measures, the impact of the activities on marine mammals would be, at worst, a temporary modification in behavior of small numbers of certain species of marine mammals, and limited hearing threshold shifts of even smaller numbers of certain species of marine mammals when exposed to certain received noise levels from the proposed surveys.

We will also prepare two *Federal Register* notices on the proposed activities and request that the public submit comments, information, and suggestions concerning SAE and Hilcorp's requests, the content of our proposed IHAs, and potential environmental effects related to the proposed issuance of the Authorizations. This Draft EA incorporates by reference and relies on SAE and Hilcorp's applications (ERM Alaska, Inc., 2014; Owl Ridge Natural Resource Consultants, Inc., 2015).

In summary, the analyses referenced above support our conclusion that, with the incorporation of the proposed monitoring and mitigation measures, the issuance of IHAs to SAE and Hilcorp for the 3D seismic and shallow geohazard surveys, respectively, would not result in any significant direct, indirect, or cumulative impacts. Based on our MMPA analysis, the limited harassment from the proposed seismic and geohazard surveys would allow adequate time for the marine mammals to recover from potentially adverse effects. Furthermore, the referenced analyses concluded that additive or cumulative effects of the surveys on their own or in combination with other activities, are not expected to occur. Finally, the environmental analyses did not identify any significant environmental issues or impacts.

1.3.2 Scope of Environmental Analysis

Given the limited scope of the decision for which we are responsible (*i.e.*, issue the IHAs including prescribed means of take, mitigation measures, and monitoring requirements, or not issue the IHAs), this Draft EA provides more focused information on the primary issues and impacts of environmental concern related specifically to our issuance of the IHAs. This Draft EA does not further evaluate effects to the elements of the human environment listed in Table 1, because the issuance of IHAs for SAE and Hilcorp's proposed activities would not significantly affect those components of the human environment. Moreover, those analyses are consistent with our MMPA analysis concluding that there would be no significant impacts to marine mammals.

Table 1. Components of the human environment not affected by our issuance of an IHA.

Biological	Physical	Socioeconomic / Cultural
Lower trophic organisms	Air Quality	Commercial Fishing
Fish	Essential Fish Habitat	Military Activities
Mammal species not under NMFS jurisdiction	Geography	Recreational Fishing
Seabirds	Oceanography	Shipping and Boating
		National Historic Preservation Sites
		Low Income Populations
		Minority Populations
		Indigenous Cultural Resources

		Public Health and Safety
		Historic and Cultural Resources

1.3.3 Comments on This Draft EA

NAO 216-6 established NOAA procedures for complying with NEPA and the implementing NEPA regulations issued by the CEQ. Consistent with the intent of NEPA and the clear direction in NAO 216-6 to involve the public in NEPA decision-making, we are releasing this Draft EA for public comment on the potential environmental impacts of our issuance of IHAs, as well as comment on the activities described in SAE and Hilcorp's MMPA applications and in the *Federal Register* notices of the proposed IHAs. The CEQ regulations further encourage agencies to integrate the NEPA review process with review under other environmental statutes. Consistent with agency practice, we integrated our NEPA review and preparation of this Draft EA with the public process required by the MMPA for the proposed issuance of the IHAs.

The Draft EA and *Federal Register* notices of the proposed IHAs, combined with our preliminary determinations, supporting analyses, and corresponding public comment period are instrumental in providing the public with information on relevant environmental issues and offering the public a meaningful opportunity to provide comments to us for consideration in both the MMPA and NEPA decision-making processes.

1.4 Other Permits, Licenses, or Consultation Requirements

This section summarizes federal, state, and local permits, licenses, approvals, and consultation requirements necessary to implement the proposed action.

1.4.1 National Environmental Policy Act

Issuance of an Authorization is subject to environmental review under NEPA. NMFS may prepare an EA, an EIS, or determine that the action is categorically excluded from further review. While NEPA does not dictate substantive requirements for an Authorization, it requires consideration of environmental issues in federal agency planning and decision making. The procedural provisions outlining federal agency responsibilities under NEPA are provided in CEQ's implementing regulations (40 CFR §§ 1500-1508).

1.4.2 Marine Mammal Protection Act

The MMPA and its provisions that pertain to the proposed action are discussed above in section 1.2.

1.4.3 Endangered Species Act

The bowhead whale and ringed seal are the only marine mammal species currently listed under the ESA that could occur in the vicinity of SAE and Hilcorp's proposed 3D seismic and shallow geohazard surveys. NMFS' Permits and Conservation Division has initiated consultation with NMFS' Alaska Regional Protected Resources Division under section 7 of the ESA on the issuance of IHAs to SAE and Hilcorp under section 101(a)(5)(D) of the MMPA for this activity. Consultation will be concluded prior to a determination on the issuance of the IHAs.

1.4.4 Magnuson-Stevens Fishery Conservation and Management Act

Under the Magnuson-Stevens Fishery Conservation and Management Act (MSFCMA), "Essential Fish Habitat" (EFH) is defined as "those waters and substrate necessary to fish for spawning, breeding, feeding, or growth to maturity" (16 U.S.C. § 1802(10)). The EFH provisions of the MSFCMA offer resource managers means to accomplish the goal of giving heightened consideration to fish habitat in resource management.

A summary of NMFS' and the Minerals Management Service's[1] (MMS') EFH consultation with the NMFS Office of Habitat Conservation regarding the conduct of seismic surveys in the Arctic is provided in Section VI of the 2006 Final Programmatic Environmental Assessment (PEA; MMS 2006). In a June 6, 2006, response, the NMFS Office of Habitat Conservation stated that further EFH consultation is not necessary unless implementation of the plan or operational conditions change. NMFS has reviewed the scope of the project descriptions forand SAE's and Hilcorp's 2015 activities. Based on that review, the projects fall within the scope of the consultation. Therefore, additional consultation for EFH is not necessary.

1.4.5 Coastal Zone Management Act

The Coastal Zone Management Act (CZMA) encourages coastal states to develop comprehensive programs to manage and balance competing uses of and impacts to coastal resources. The CZMA emphasizes the primacy of state decision-making regarding the coastal zone. Section 307 of the CZMA (16 U.S.C. § 1456), called the Federal consistency provision, is a major incentive for states to join the national coastal management program and is a powerful tool that states use to manage coastal uses and resources and to facilitate cooperation and coordination with Federal agencies.

Federal consistency is the CZMA requirement where Federal agency activities that have reasonably foreseeable effects on any land or water use or natural resource of the coastal zone (also referred to as coastal uses or resources and coastal effects) must be consistent to the maximum extent practicable with the enforceable policies of a coastal state's Federally-approved coastal management program. On July 1, 2011, the Federally-approved Alaska Coastal Management Program expired, resulting in a withdrawal from participation in CZMA's National Coastal Management Program. The Federal CZMA consistency provision in Section 307 no longer applies in Alaska.

[1] Currently the Bureau of Ocean Energy Management, or BOEM, under the Department of the Interior. Since all cited references by the current BOEM were issued under the name MMS, MMS is used in this document.

Chapter 2 ALTERNATIVES

2.1 Introduction

NEPA and the CEQ implementing regulations (40 CFR §§ 1500-1508) require consideration of alternatives to proposed major federal actions and NAO 216-6 provides NOAA policy and guidance on the consideration of alternatives to our proposed action. An EA must consider all reasonable alternatives, including the Preferred Alternative. It must also consider the No Action Alternative, even if it that alternative does not meet the stated purpose and need. This provides a baseline analysis against which we can compare the other alternatives.

To warrant detailed evaluation as a reasonable alternative, an alternative must meet our purpose and need. In this case, as we previously explained in Chapter 1 of this EA, an alternative only meets the purpose and need if it satisfies the requirements under section 101(a)(5)(D) the MMPA. We evaluated each potential alternative against these criteria; identified one action alternative along with the No Action Alternative; and carried these forward for evaluation in this EA. This chapter describes the alternatives and compares them in terms of their environmental impacts and their achievement of objectives.

As described in Section 1.2, the MMPA requires that we must prescribe the means of effecting the least practicable impact on the species or stocks of marine mammals and their habitat. In order to do so, we must consider SAE and Hilcorp's proposed mitigation measures, as well as other potential measures, and assess how such measures could benefit the affected species or stocks and their habitat. Our evaluation of potential measures includes consideration of the following factors in relation to one another: (1) the manner in which, and the degree to which, we expect the successful implementation of the measure to minimize adverse impacts to marine mammals; (2) the proven or likely efficacy of the specific measure to minimize adverse impacts as planned; and (3) the practicability of the measure for applicant implementation.

Any additional mitigation measure proposed by us beyond what the applicant proposes should be able to or have a reasonable likelihood of accomplishing or contributing to the accomplishment of one or more of the following goals:

- Avoidance or minimization of marine mammal injury, serious injury, or death, wherever possible;
- A reduction in the numbers of marine mammals taken (total number or number at biologically important time or location);
- A reduction in the number of times the activity takes individual marine mammals (total number or number at biologically important time or location);
- A reduction in the intensity of the anticipated takes (either total number or number at biologically important time or location);
- Avoidance or minimization of adverse effects to marine mammal habitat, paying special attention to the food base; activities that block or limit passage to or from biologically

important areas; permanent destruction of habitat; or temporary destruction/disturbance of habitat during a biologically important time; and

- For monitoring directly related to mitigation, an increase in the probability of detecting marine mammals, thus allowing for more effective implementation of the mitigation.

Alternative 1 (the Preferred Alternative) includes a suite of mitigation measures intended to minimize potentially adverse interactions with marine mammals.

2.2 Description of SAE and Hilcorp's Proposed Activities

SAE and Hilcorp plan to conduct seismic and shallow geohazard surveys, respectively, during the 2015 Arctic open-water season in the U.S. Beaufort Sea.

2.2.1 SAE's 3D Seismic Survey

2.2.1.1 Dates and Duration

SAE's proposed 3D OBN seismic survey is planned for the 2015 open-water season (July 1 to October 15). The actual data acquisition is expected to take approximately 70 days, dependent of weather. Based on past similar seismic shoots in the Beaufort Sea, SAE expects that effective shooting would occur over about 70% of the 70 days (or about 49 days).

2.2.1.2 Specific Geographic Region

SAE's planned 3D seismic survey would occur in the nearshore waters of the Beaufort Sea between Harrison Bay and the Sagavanirktok River delta. SAE plans to survey a maximum of 777 km^2 (300 mi^2) in 2015, although the exact location is currently unknown other than it would occur somewhere within the 4,562-km^2 (1,761-m^2) box shown in Figure 1.

2.2.1.3 Detailed Description of the Activity

I. Survey Design

The proposed marine seismic operations will be based on a "recording patch" or similar approach. Patches are groups of six receiver lines and 32 source lines. Each receiver line has submersible marine sensor nodes tethered equidistant (50 m; 165 ft) from each other along the length of the line. Each node is a multicomponent system containing three velocity sensors and a hydrophone. Each receiver line is approximately 8 km (5 mi) in length, and are spaced approximately 402 m (1,320 ft) apart. Each receiver patch is 19.4 km^2 (7.5 mi^2) in area. The receiver patch is oriented such that the receiver lines run parallel to the shoreline.

Source lines, 12 km (7.5 mi) long and spaced 502 m (1,650 ft) apart, run perpendicular to the receiver lines (and perpendicular to the coast) and, where possible, will extend approximately 5 km (3 mi) beyond the outside receiver lines and approximately 4 km (2.5 mi) beyond each of the ends of the receiver lines. The outside dimensions of the maximum shot area during a patch shoot will be 12 km by 16 m (7.5 mi by 10 mi) or 192 km^2 (75 mi^2). It is expected to take three to five days to shoot a patch, or 49 km^2 (18.75 mi^2) per day. Shot intervals along each source line will be 50 m (165 ft). All shot areas will be wholly contained within the 4,562-km^2 survey box (Figure 1), and, because of the tremendous overlap in shot area between adjacent patches, no more than 777 km^2 (300 mi^2) of actual area will be shot in 2015.

During recording of one patch, nodes from the previously surveyed patch will be retrieved, recharged, and data downloaded prior to redeployment of the nodes to the next patch. As patches are recorded, receiver lines are moved side to side or end to end to the next patch location so that receiver lines have continuous coverage of the recording area.

Autonomous recording nodes lack cables but will be tethered together using a thin rope for ease of retrieval. This rope will lay on the seabed surface, as will the nodes, and will have no effect on marine traffic. Primary vessel positioning will be achieved using GPS with the antenna attached to the airgun array. Pingers deployed from the node vessels will be used for positioning of nodes. The geometry/patch could be modified as operations progress to improve sampling and operational efficiency.

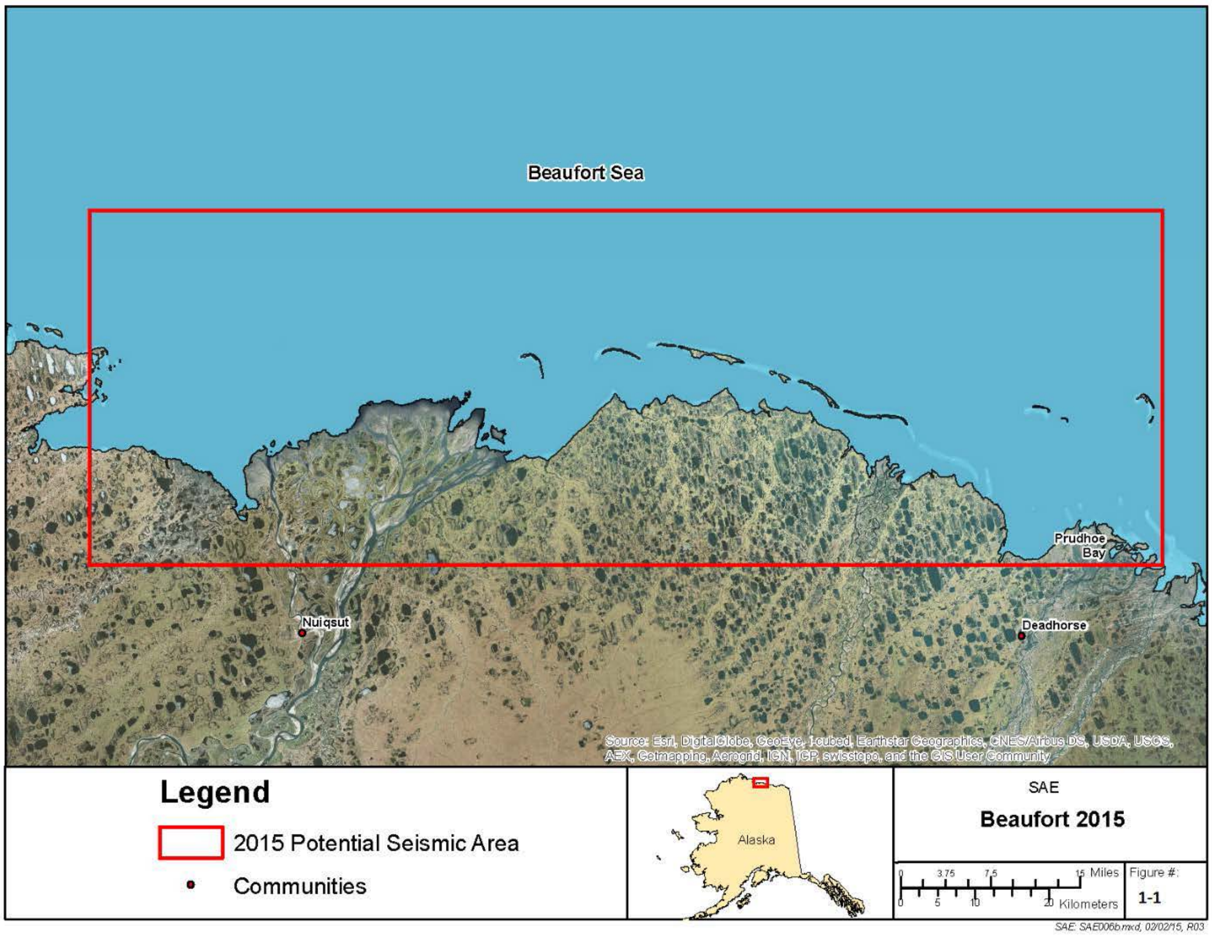

Figure 1. Location map SAE's 3D seismic survey in the U.S. Beaufort Sea

II. Acoustical Sources

The acoustic sources of primary concern are the airguns that will be deployed from the seismic source vessels. However, there are other noise sources to be addressed including the pingers and transponders associated with locating receiver nodes, as well as propeller noise from the vessel fleet.

Seismic Source Array

The primary seismic source for offshore recording consists of a 620-cubic-inch (in^3), 8-cluster array, although a 2 x 620-in^3 array, totaling 1,240 in^3, may be used in deeper waters (> 15 m). For conservative purposes, exposure estimates are based on the sound pressure levels associated with the larger array. The arrays will be centered approximately 15 m (50 ft) behind the source vessel stern, at a depth of 4 m (12 ft), and towed along predetermined source lines at speeds between 7.4 and 9.3 km/hr (4 and 5 knots). Two vessels with full arrays will be operating simultaneously in an alternating shot mode; one vessel shooting while the other is recharging. Shot intervals are expected to be about 16 s for each array resulting in an overall shot interval of 8 s considering the two alternating arrays. Operations are expected to occur 24 hrs a day, with actual daily shooting to total about 12 hrs.

Based on manufacturer specifications, the 1,240-in^3 array has a zero-peak estimated sound source of 249 dB re 1 μPa @ 1 m (13.8 bar-m), with a root mean square (rms) sound source of 224 dB re 1 μPa, while for the 620-in^3 array the zero-peak is 237 dB re 1 μPa (rms) (6.96 bar-m) with an rms source level of 218 dB re 1 μPa (Table 2).

Table 2. Source characteristics of the proposed seismic survey equipment to be used during SAE's 3D seismic survey.

Equipment	Sample Equipment Model Type	Operating Frequency	Along track beam width	Across track beam width	Source Level (dB re 1 μPa @ 1m, rms)
Airguns	1,240 in^3 airgun array	Broadband	Omni-directional	Omni-directional	224
	620 in^3 airgun array	Broadband	Omni-directional	Omni-directional	218
	10 in^3 single airgun	Broadband	Omni-directional	Omni-directional	195
Transceiver	Sonardyne Scout USBL	35 – 55 kHz	Unknown	Unknown	197
Transponder	Sonardyne TZ/OBC Type 7815-000-06	35 – 55 kHz	Unknown	Unknown	184 – 187

Mitigation Airgun

A 10-in^3 mitigation airgun will be used during poor visibility conditions, and is intended to (a) alert marine mammals to the presence of airgun activity, and (b) retain the option of initiating a ramp-up to full operations under poor visibility conditions. The mitigation gun will be operated at approximately one shot per minute during these periods. The manufacturer specifications indicate a 214 dB re 1 μPa zero-peak (0.5 bar-m) sound source equating to a 195 dB re 1 μPa rms source (Table 2).

Pingers and Transponders

An acoustical positioning (or pinger) system will be used to position and interpolate the location of the nodes. A vessel-mounted transceiver calculates the position of the nodes by measuring the range and bearing from the transceiver to a small acoustic transponder fitted to every third node. The transceiver uses sonar to interrogate the transponders, which respond with short pulses that are used in measuring the range and bearing. The system provides a precise location of every node as needed for accurate interpretation of the seismic data. The transceiver to be used is the Sonardyne Scout USBL, while transponders will be the Sonardyne TZ/OBC Type 7815-000-06. Because the transceiver and transponder communicate via sonar, they produce underwater sound levels. The Scout USBL transceiver has a transmission source level of 197 dB re 1 μPa @ 1 m and operates at frequencies between 35 and 55 kHz. The transponder produces short pulses of 184 to 187 dB re 1 μPa @ 1 m at frequencies also between 35 and 55 kHz (Table 2).

Vessels

Several offshore vessels will be required to support recording, shooting, and housing in the marine and transition zone environments. The exact vessels that will be used have not yet been determined. However, the types of vessels that will be used to fulfill these roles are found in Table 3.

Table 3. Vessels to be used during SAE's 3D OBN seismic surveys.

Vessel	Size (ft)	Activity and Frequency	Source Level (dB)
Source vessel 1	120 x 25	Seismic data acquisition; 24 hr operation	179
Source vessel 2	80 x 25	Seismic data acquisition; 24 hr operation	166
Node equipment vessel 1	80 x 20	Deploying and retrieving nodes; 24 hr operation	165
Node equipment vessel 2	80 x 20	Deploying and retrieving nodes; 24 hr operation	165
Mitigation/Housing vessel	90 x 20	House crew; 24 hr operation	200
Crew transport vessel	30 x 20	Transport crew; intermittent 8 hrs	192
Bow picker 1	30 x 20	Deploying and retrieving nodes; intermittent operation	172
Bow picker 2	30 x 20	Deploying and retrieving nodes; intermittent operation	172

Source Vessels - Source vessels will have the ability to deploy two arrays off the stern using large A-frames and winches and have a draft shallow enough to operate in waters less than 1.5 m (5 ft) deep. On the source vessels the airgun arrays are typically mounted on the stern deck with an umbilical that allow the arrays to be deployed and towed from the stern without having to re-rig or move arrays. A large bow deck will allow for sufficient space for source compressors and additional airgun equipment to be stored. The marine vessels likely to be used will be the same or similar to those that were acoustically measured by Aerts *et al.* (2008). The source vessels were found to have sound source levels of 179.0 dB re 1 μPa (rms) and 165.7 dB re 1 μPa (rms).

Recording Deployment and Retrieval Vessels - Jet driven shallow draft vessels and bow pickers will be used for the deployment and retrieval of the offshore recording equipment. These vessels will be rigged with hydraulically driven deployment and retrieval squirters allowing for automated deployment and retrieval from the bow or stern of the vessel. These vessels will also carry the recording equipment on the deck in fish totes. Aerts *et al.* (2008) found the recording and deployment vessels to have a source level of approximately 165.3 dB re 1 μPa (rms), while the smaller bow pickers produce more cavitation resulting in source levels of 171.8 dB re 1 μPa (rms).

Housing and Transfer Vessels - Housing vessel(s) will be larger with sufficient berthing to house crews and management. The housing vessel will have ample office and bridge space to facilitate the role as the mother ship and central operations. Crew transfer vessels will be sufficiently large to safely transfer crew between vessels as needed. Aerts *et al.* (2008) found the housing vessel to produce the loudest propeller noise of all the vessels in the fleet (200.1 dB re 1 μPa [rms]), but this vessel is mostly anchored up once it gets on site. The crew transfer vessel also travels only infrequently relative to other vessels, and is usually operated at different speeds. During higher speed runs shore the vessel produces source noise levels of about 191.8 dB re 1 μPa (rms), while during slower on-site movements the vessel source levels are only 166.4 dB re 1 μPa (rms) (Aerts *et al.* 2008).

2.2.2 Hilcorp's Shallow Geohazard Survey

2.2.2.1 Dates and Duration

Hilcorp seeks incidental harassment authorization for the period July 1 to September 30, 2015. The survey is expected to take approximately 45 days to complete, including weather and equipment downtime.

2.2.2.2 Specific Geographic Region

The project area of the proposed Liberty shallow geohazard survey lies within Foggy Island Bay as shown in Figure 2.

2.2.2.3 Detailed Description of the Activity

I. Survey Design

The proposed sonar survey vessel (M/V *Sidewinder* or equivalent) is about 40 x 14 feet in size. The sub-bottom profilers and magnetometer will be deployed from the vessel. The echosounder and side scan sonar will be hull-mounted. No equipment will be placed on the sea floor as part of survey activities. Because of the extremely shallow project area, additional small vessel(s) may be utilized to safely extend vessel operations for data collection.

The total planned survey lines are approximately 300 miles, not including turns and cross-lines. The project area is 2.5 mi^2 in water depths ranging from 3 to 20 ft. The open water pipeline route geohazard and strudel scour / ice gouge survey period is expected to take approximately 45 days to complete, including weather and equipment change out downtime. About 25% of downtime is included in this total, so the actual number of days that equipment are expected to be operating is estimated at 34, based on a continuous 24-hr operation. Data will be acquired along the subsea pipeline corridor area using the single-beam or multibeam echosounder, side scan sonar, sub-bottom profilers, and the magnetometer. Because of the shallow nature of the project area and small size of the vessel, systems will be towed in optimal groupings that best facilitate safe operations and data quality. As necessary, a small vessel may be used to extend data collection into shallow waters. Planned survey lines will be designed to acquire 150% side scan sonar data coverage or as mandated, with line spacing dependent upon water depth. A 300 m corridor around the centerline of the proposed pipeline area will be covered.

II. Acoustical Sources

Multibeam echo sounder and side scan sonar

A single-beam or multibeam echosounder and side scan sonar will be used to obtain high accuracy information regarding bathymetry of the seafloor. For accurate object detection, a side scan sonar survey is required to complement a multibeam echosounder survey.

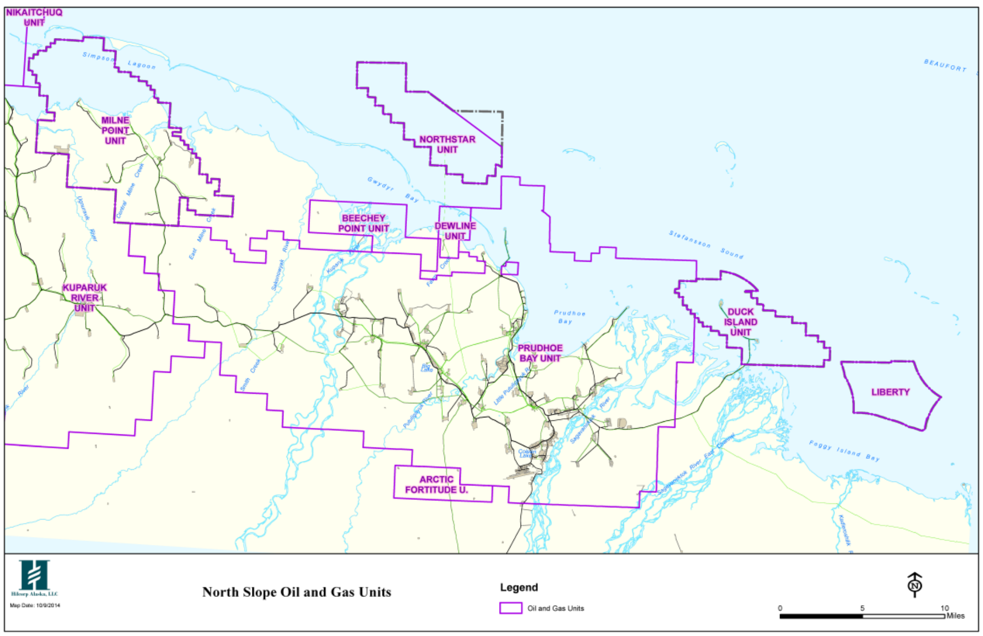

Figure 2. Location map Hilcorp's shallow geohazard survey in the U.S. Beaufort Sea

The proposed multibeam echosounder operates at an rms source level of a maximum of 220 dB re 1 µPa @1m. The multibeam echosounder emits high frequency (240 kHz) energy in a fan-shaped pattern of equidistant or equiangular beam spacing (Table 4). The beam width of the emitted sound energy in the along-track direction is 1.5 degrees, while the across track beam width is 1.8 degrees. The maximum ping rate of the multibeam echosounder is 40 Hz.

The proposed single-beam echosounder operates at an rms source level of approximately 220 dB re 1 µPa @1m (Table 4). The transducer selected uses a frequency of 210 kHz and has a ping rate of up to 20 Hz. The transducer's beam width is approximately 3 degrees.

The proposed side scan sonar system will operate at about 400 kHz and 900 kHz. The rms source level is 215 dB re 1µPa @1m. The sound energy is emitted in a narrow fan-shaped pattern, with a horizontal beam width of 0.45 degrees for 400 kHz and 0.25 degrees at 900 kHz, with a vertical beam width of 50 degrees (Table 4). The maximum ping rate is 75 Hz.

Sub-bottom profiler
The proposed high-resolution sub-bottom profiler operates at an rms source level of 210db re 1 μPa @1m. The proposed system emits energy in the frequency bands of 2 to 24 kHz. The beam width is 15 to 24 degrees (Table 4). Typical pulse rate is between 3 and 10 Hz.

The proposed low-resolution sub-bottom profiler operates at an rms source level of 212db re 1 μPa @1m. This secondary sub-bottom profiler will be utilized as necessary to increase sub-bottom profile penetration. The proposed system emits energy in the frequency bands of 1 to 4 kHz.

Table 4. Source characteristics of the proposed geophysical survey equipment to be used during the Liberty geohazard survey.

Equipment	Sample Equipment Model Type	Operating Frequency	Along track beam width	Across track beam width	Source Level (dB re 1 μPa @ 1m, rms)
Multibeam echosounder	Reson 7101 SV	240 kHz	1.5°	1.8°	220
Single-beam echosounder	Odom	210 kHz	3°	3°	220
Side scan sonar	Edgetech 4125	400 kHz/900 kHz	0.5°	50°	215
High resolution (CHIRP) sub-bottom profiler	Edgetech 3200	2 to 24 kHz	15° to 24°	15° to 24°	210
Low resolution sub-bottom profiler	Applied Acoustics AA251	1 to 4 kHz	n/a	n/a	212

2.3 Description of Alternatives

2.3.1 Alternative 1 – Issuance of an Authorization with Mitigation Measures (Preferred Alternative)

Under this alternative, NMFS would issue IHAs under section 101(a)(5)(D) of the MMPA to SAE and Hilcorp, allowing the take, by Level A and Level B harassments, of small numbers of marine mammal species incidental to conducting seismic and geohazard surveys in the Beaufort Sea during the 2015 open-water season. In order to reduce the incidental harassment of marine mammals to the lowest level practicable, SAE and Hilcorp will be required to implement the mitigation, monitoring, and reporting measures described below.

PROPOSED MITIGATION MEASURES
Both SAE and Hilcorp submitted Marine Mammal Monitoring and Mitigation Plans (4MPs) along with their IHA applications.

2.3.1.1 Proposed Mitigation Measures for SAE

In the 4MP, SAE proposed a suite of mitigation measures to minimize any adverse impacts associated with the 3D seismic survey in the Beaufort Sea. These include: (1) establishing and monitoring exclusion and disturbance zones; (2) vessel movement to minimize potential marine mammal impacts; (3) airgun ramping up before seismic survey, and (4) power-down and shutdown measures. The following is a summary of mitigaiton measures proposed for SAE:

(a) Establishing Exclusion Zones and Zone of Influence (ZOI)
- (i) Establish exclusions where the received levels are 180 dB for cetaceans and 190 dB for pinnipeds
- (ii) Establish a ZOI where the received level is 160 dB.

(b) Vessel Movement Mitigation:
- (i) Avoid concentrations or groups of whales by all vessels under the direction of SAE.
- (ii) If any vessel approaches within 1.6 km (1 mi) of observed bowhead whales, except when providing emergency assistance to whalers or in other emergency situations, the vessel operator will take reasonable precautions to avoid potential interaction with the bowhead whales.
- (iii) When weather conditions require, such as when visibility drops, adjust vessel speed accordingly, but not to exceed 5 knots, to avoid the likelihood of injury to whales.

(c) Mitigation Measures for Airgun Operations
- (i) Ramp-up airgun array before the survey, starting with a single airgun with the smallest displacement volume.
- (ii) Power-down/Shutdown:
  - (A) The airgun array shall be immediately powered down whenever a marine mammal is sighted approaching close to or within the applicable exclusion zone of the full array, but is outside the applicable exclusion zone of the single mitigation airgun.
  - (B) If a marine mammal is already within or is about to enter the exclusion zone when first detected, the airguns shall be powered down immediately.
  - (C) Following a power-down, firing of the full airgun array shall not resume until the marine mammal has cleared the exclusion zone.
  - (D) If a marine mammal is sighted within or about to enter the 190 or 180 dB applicable exclusion zone of the single mitigation airgun, the airgun array shall be shutdown.
  - (E) Firing of the full airgun array or the mitigation gun shall not resume until the marine mammal has cleared the exclusion zone of the full array or mitigation gun, respectively.
- (iii) Poor Visibility Conditions:
  - (A) If during foggy conditions, heavy snow or rain, or darkness, the full 180 dB exclusion zone is not visible, the airguns cannot commence a ramp-up procedure from a full shut-down.

(B) If one or more airguns have been operational before nightfall or before the onset of poor visibility conditions, they can remain operational throughout the night or poor visibility conditions.

2.3.1.2 Proposed Mitigation Measures for Hilcorp

In the 4MP, Hilcorp proposed a suite of mitigation measures to minimize any adverse impacts associated with the shallow geohazard survey in the Beaufort Sea. These include: (1) establishing and monitoring exclusion and disturbance zones; and (2) shutdown measures. The following is a summary of mitigaiton measures proposed for Hilcorp:

(a) Establishing ZOI
- (i) Establish a ZOI where the received level is 160 dB.

(b) Mitigation Measures for Sonar Equipment
- (i) Ramp-up sonar equipment before the survey.
- (ii) Power-down/Shutdown:
  - (A) The sonar equipment shall be immediately powered down whenever a marine mammal is sighted approaching close to or within the ZOI.
  - (B) Following a shutdown, sonar shall not be operated at full power until the marine mammal has cleared the ZOI.
- (iii) Poor Visibility Conditions:
  - (A) If during foggy conditions, heavy snow or rain, or darkness, the full 160 dB ZOI is not visible, sonar equipment cannot commence a ramp-up procedure from a full shut-down.
  - (B) If the sub-bottom profiler has been operational before nightfall or before the onset of poor visibility conditions, it can remain operational throughout the night or poor visibility conditions.

PROPOSED MONITORING AND REPORTING MEASURES FOR BOTH SURVEYS

Proposed Monitoring Measures

(1) Protected Species Observers

Vessel-based monitoring for marine mammals will be done by trained protected species observers (PSOs) throughout the period of survey activities. The observers will monitor the occurrence of marine mammals near the survey vessel during all daylight periods during operation, and during most daylight periods when operations are not occurring. PSO duties will include watching for and identifying marine mammals; recording their numbers, distances, and reactions to the survey operations; and documenting "take by harassment."
A sufficient number of PSOs will be required onboard each survey vessel to meet the following criteria:

- 100% monitoring coverage during all periods of survey operations in daylight;
- Maximum of 4 consecutive hours on watch per PSO; and
- Maximum of 12 hours of watch time per day per PSO.

PSO teams will consist of Inupiat observers and experienced field biologists. Each vessel will have an experienced field crew leader to supervise the PSO team. The total number of PSOs may decrease later in the season as the duration of daylight decreases.

(2) Observer Qualifications and Training

Lead PSOs and most PSOs will be individuals with experience as observers during recent seismic, site clearance and shallow hazards, and other monitoring projects in Alaska or other offshore areas in recent years. New or inexperienced PSOs will be paired with an experienced PSO or experienced field biologist so that the quality of marine mammal observations and data recording is kept consistent.

Resumes for candidate PSOs will be provided to NMFS for review and acceptance of their qualifications. Inupiat observers will be experienced in the region and familiar with the marine mammals of the area. All observers will complete a NMFS-approved observer training course designed to familiarize individuals with monitoring and data collection procedures.

(3) Specialized Field Equipment

The PSOs shall be provided with Fujinon 7 X 50 or equivalent binoculars for visual based monitoring onboard survey vessels.

Monitoring Plan Peer Review

The MMPA requires that monitoring plans be independently peer reviewed "where the proposed activity may affect the availability of a species or stock for taking for subsistence uses" (16 U.S.C. 1371(a)(5)(D)(ii)(III)). Regarding this requirement, NMFS' implementing regulations state, "Upon receipt of a complete monitoring plan, and at its discretion, [NMFS] will either submit the plan to members of a peer review panel for review or within 60 days of receipt of the proposed monitoring plan, schedule a workshop to review the plan" (50 CFR 216.108(d)).

NMFS has established an independent peer review panel to review SAE and Hilcorp's 4MPs for their proposed open-water seismic and shallow geohazard surveys. The panel is scheduled to meet in early March 2015, and will provide comments to NMFS shortly after they meet. After completion of the peer review, NMFS will consider all recommendations made by the panel, incorporate appropriate changes into the monitoring requirements of the IHAs (if issued), and publish the panel's findings and recommendations in the final IHA notices of issuance or denial document.

Reporting Measures

(1) Final Report

The results of SAE and Hilcorp's seismic and shallow geohazard surveys monitoring reports will be presented in the "90-day" final reports, as required by NMFS under the proposed IHAs. The initial final reports are due to NMFS within 90 days after the expiration of the IHAs (if issued). The reports will include:

- Summaries of monitoring effort (e.g., total hours, total distances, and marine mammal distribution through the study period, accounting for sea state and other factors affecting visibility and detectability of marine mammals);

- Summaries that represent an initial level of interpretation of the efficacy, measurements, and observations, rather than raw data, fully processed analyses, or a summary of operations and important observations;

- Summaries of all mitigation measures (e.g., operational shutdowns if they occur) and an assessment of the efficacy of the monitoring methods;

- Analyses of the effects of various factors influencing detectability of marine mammals (e.g., sea state, number of observers, and fog/glare);

- Species composition, occurrence, and distribution of marine mammal sightings, including date, water depth, numbers, age/size/gender categories (if determinable), group sizes, and ice cover;

- Data analysis separated into periods when the acoustic source (airgun or sonar) is operating and when it is not, to better assess impacts to marine mammals;

- Sighting rates of marine mammals during periods with and without sound source activities (and other variables that could affect detectability), such as:
    - Initial sighting distances versus airgun activity state;
    - Closest point of approach versus airgun activity state;
    - Observed behaviors and types of movements versus airgun activity state;
    - Numbers of sightings/individuals seen versus airgun activity state;
    - Distribution around the survey vessel versus airgun activity state; and
    - Estimates of take by harassment;

- (viii) Reported results from all hypothesis tests, including estimates of the associated statistical power, when practicable;

- (ix) Estimates of uncertainty in all take estimates, with uncertainty expressed by the presentation of confidence limits, a minimum-maximum, posterior probability distribution, or another applicable method, with the exact approach to be selected based on the sampling method and data available;

- (x) A clear comparison of authorized takes and the level of actual estimated takes; and

- (xi) A complete characterization of the acoustic footprint resulting from various activity states.

The “90-day” reports will be subject to review and comment by NMFS. Any recommendations made by NMFS must be addressed in the final report prior to acceptance by NMFS.

(2) Notification of Injured or Dead Marine Mammals
SAE and Hilcorp will be required to notify NMFS' Office of Protected Resources and NMFS' Stranding Network of any sighting of an injured or dead marine mammal. Based on different circumstances, SAE and HIlcorp may or may not be required to stop operations upon such a sighting. SAE and Hilcorp will provide NMFS with the species or description of the animal(s), the condition of the animal(s) (including carcass condition if the animal is dead), location, time of first discovery, observed behaviors (if alive), and photo or video (if available). The specific language describing what SAE and Hilcorp must do upon sighting a dead or injured marine mammal can be found in the "Proposed Incidental Harassment Authorization" section of their specific proposed IHAs.

2.3.2 Alternative 2 – No Action Alternative

Under the No Action Alternative, NMFS would not issue the requested IHAs to SAE and Hilcorp for the potential take of marine mammals, by harassment, incidental to conducting 3D seismic survey and shallow geohazard survey in the Befort during the 2015 Arctic open-water season. The MMPA prohibits all takings of marine mammals unless authorized by a permit or exemption under the MMPA. The consequences of not authorizing incidental takes are (1) the entity conducting the activity may be in violation of the MMPA if takes do occur, (2) mitigation and monitoring measures cannot be required by NMFS, and (3) mitigation measures might not be performed voluntarily by the applicant. By undertaking measures to further protect marine mammals from incidental take through the authorization program, the impacts of these activities on the marine environment can potentially be lessened. While NMFS does not authorize the seismic and shallow geohazard suveys themselves, NMFS does authorize the unintentional, incidental take of marine mammals (under its jurisdiction) in connection with these activities and prescribes, where applicable, the methods of taking and other means of effecting the least practicable impact on the species and stocks and their habitats. If IHAs are not issued, SAE and Hilcorp would effectively be precluded from engaging in seismic and shallow geohazard surveys in the U.S. Beaufort Sea during the 2015 Arctic open-water season, as any takes of marine mammals under such activities would be violations of the MMPA. Although the No Action Alternative would not meet the purpose and need to allow incidental takings of marine mammals under certain conditions, the CEQ's regulations require consideration and analysis of a No Action Alternative for the purposes of presenting a comparative analysis to the action alternatives.

2.3.5 Alternatives Considered but Rejected from Further Consideration

NMFS considered whether other alternatives could meet the purpose and need and support SAE and Hilcorp's proposed activities.

Issuance of IHAs with No Required Mitigation, Monitoring, or Reporting Measures
An alternative that would allow for the issuance of IHAs with no required mitigation or monitoring was considered but eliminated from consideration, as it would not be in compliance with the MMPA and therefore would not meet the purpose and need. For that reason, this alternative is not analyzed further in this document.

Use of Alternative Technologies

An alternative that would require SAE and Hilcorp to use alternative technologies to conduct seismic and shallow geohazard surveys in the Beaufort Sea was considered but eliminated from further consideration. NMFS is unaware of any alternative techniques currently available that would allow SAE and Hilcorp to conduct the proposed seismic and shallow geohazard surveys in the U.S. Beaufort Sea.

Chapter 3 AFFECTED ENVIRONMENT

This chapter describes existing conditions in the proposed action areas. Complete descriptions of the physical, biological, and social environment of the action area are contained in the documents listed in Section 1.3.1 of this Draft EA. We incorporate those descriptions by reference and briefly summarize or supplement the relevant sections for marine mammals in the following subchapters.

3.1 Physical Environment

We are required to consider impacts to the physical environment under NOAA NAO 216-6. As discussed in Chapter 1, our proposed action and alternatives relate only to the authorization of incidental take of marine mammals and not to the physical environment. Certain aspects of the physical environment are not relevant to our proposed action (see subchapter 1.3.2 - Scope of Environmental Analysis). Because of the requirements of NAO 216-6, we briefly summarize the physical components of the environment here.

3.1.1 Marine Mammal Habitat

The Proposed Action areas in the Beaufort Sea cover the relatively shallow, broad, continental shelf adjacent to the Arctic Ocean. Water depths within the proposed marine and seismic survey areas in the Beaufort and Chukchi Seas range from 0.1 – 50 m (3 - 164 ft).

3.2 Biological Environment

The primary component of the biological environment that would be impacted by the proposed action and alternatives would be marine mammals, which would be directly impacted by the authorization of incidental take. We briefly summarize this component of the biological environment here.

3.2.1 Marine Mammals

The Beaufort Sea supports a diverse assemblage of marine mammals, including: bowhead, gray, beluga, killer, minke, humpback, and fin whales; harbor porpoise; ringed, ribbon, spotted, and bearded seals; narwhals; polar bears; and walruses. Both the walrus and the polar bear are managed by the U.S. Fish and Wildlife Service (USFWS) and are not considered further in this proposed IHA notice.

Among the rest of marine mammal species, only beluga, bowhead, and gray whales, and ringed, spotted, and bearded seals are likely to occur in the proposed activity area. The remaining cetacean species are rare and not likely to be encountered during SAE and Hilcorp's seismic and shallow geohazard surveys, due to their extralimital distribution in the proposed survey areas. Therefore, these species are not further discussed.

The bowhead whale is listed as "endangered" under the Endangered Species Act (ESA) and as depleted under the MMPA. The ringed seal is listed as "threatened" under the ESA. Certain stocks or populations of gray, beluga, and spotted seals are listed as endangered under the ESA; however, none of those stocks or populations occur in the proposed activity area.

Both SAE and Hilcorp's applications contain information on the status, distribution, seasonal distribution, abundance, and life history of each of the species under NMFS jurisdiction mentioned in this document. When reviewing the application, NMFS determined that the species descriptions provided by SAE and Hilcorp correctly characterized the status, distribution, seasonal distribution, and abundance of each species. Please refer to the applications for that information. Additional information can also be found in the NMFS Stock Assessment Reports (SAR) (Allen and Anglyss, 2014). The Alaska 2013 SAR is available at: http://www.nmfs.noaa.gov/pr/sars/pdf/ak2013_final.pdf

Table 5 lists the seven marine mammal species under NMFS jurisdiction with confirmed or possible occurrence in the proposed project area.

Table 5. Marine mammal species and stocks that could be affected by SAE and Hilcorp's seismic and shallow geohazard surveys in the Beaufort Sea.

Common Name	Scientific Name	Status	Occurrence	Seasonality	Range	Abundance
Odontocetes Beluga whale (Eastern Chukchi Sea stock)	*Dephinapterus leucas*	-	Common	Mostly spring and fall with some in summer	Russia to Canada	3,710
Beluga whale (Beaufort Sea stock)	*Delphinapterus leucas*	-	Common	Mostly spring and fall with some in summer	Russia to Canada	39,258
Mysticetes Bowhead whale	*Balaena mysticetus*	Endangered; Depleted	Common	Mostly spring and fall with some in summer	Russia to Canada	19,534
Gray whale	*Eschrichtius robustus*	-	Somewhat common	Mostly summer	Mexico to the U.S. Arctic Ocean	19,126
Pinnipeds Bearded seal (Beringia distinct population segment)	*Erigathus barbatus*	Candidate	Common	Spring and summer	Bering, Chukchi, and Beaufort Seas	155,000
Ringed seal (Arctic stock)	*Phoca hispida*	Threatened; Depleted	Common	Year round	Bering, Chukchi, and Beaufort Seas	300,000
Spotted seal	*Phoca largha*	-	Common	Summer	Japan to U.S. Arctic Ocean	141,479
Ribbon seal	*Histriophoca fasciata*	Species of concern	Occasional	Summer	Russia to U.S. Arctic Ocean	49,000

3.3 Socioeconomic Environment

3.3.1 Subsistence

Subsistence hunting continues to be an essential aspect of Inupiat Native life, especially in rural coastal villages. The Inupiat participate in subsistence hunting activities in and around the Beaufort Sea. The animals taken for subsistence provide a significant portion of the food that will last the community through the year. Marine mammals represent on the order of 60-80% of the total subsistence harvest. Along with the nourishment necessary for survival, the subsistence activities strengthen bonds within the culture, provide a means for educating the younger generation, provide supplies for artistic expression, and allow for important celebratory events.

The main species that are hunted include bowhead and beluga whales, ringed, spotted, and bearded seals, walruses, and polar bears. (As mentioned previously in this document, both the walrus and the polar bear are under the USFWS' jurisdiction.) The importance of each of these species varies among the communities and is largely based on availability.

Chapter 4 ENVIRONMENTAL CONSEQUENCES

This chapter of the EA analyzes the impacts of the two alternatives and addresses the potential direct, indirect, and cumulative impacts of our issuance of two IHAs. SAE and Hilcorp's IHA applications and other related environmental analyses identified previously facilitate this analysis.

Under the MMPA, we have evaluated the potential impacts of SAE and Hilcorp's seismic and shallow geohazard surveys in order to determine whether to authorize incidental take of marine mammals. Under NEPA, we have determined that an EA is appropriate to evaluate the potential significance of environmental impacts resulting from the issuance of two IHAs.

4.1 Effects of Alternative 1— Issuance of an IHA with Mitigation Measures

Under this alternative, NMFS would issue IHAs to SAE for the proposed 3D seismic survey and to Hilcorp for the proposed shallow geohazard survey in the Beaufort Sea during the 2015 Artic open-water season, with required mitigation, monitoring, and reporting requirements as discussed in Chapter 2 of this EA. As part of NMFS' action, the mitigation and monitoring would be undertaken as required by the MMPA, and, as a result, no serious injury or mortality of marine mammals is expected and correspondingly no impact on the reproductive or survival ability of affected species would occur. These analyses are provided in details in the proposed IHAs for the issuance of the IHAs to SAE and Hilcorp. Potentially affected marine mammal species under NMFS' jurisdiction include: bowhead, beluga, whales; and bearded, spotted, and ringed seals. Two of these species (i.e., bowhead whale and ringed seal) are listed under the ESA.

4.1.1 Effects on Marine Mammals

Acoustic Impacts

When considering the influence of various kinds of sound on the marine environment, it is necessary to understand that different kinds of marine life are sensitive to different frequencies of sound. Based on available behavioral data, audiograms have been derived using auditory evoked potentials, anatomical modeling, and other data, Southall *et al.* (2007) designate "functional hearing groups" for marine mammals and estimate the lower and upper frequencies of functional hearing of the groups. The functional groups and the associated frequencies are indicated below (though animals are less sensitive to sounds at the outer edge of their functional range and most sensitive to sounds of frequencies within a smaller range somewhere in the middle of their functional hearing range):

- Low frequency cetaceans (13 species of mysticetes): functional hearing is estimated to occur between approximately 7 Hz and 30 kHz;

- Mid-frequency cetaceans (32 species of dolphins, six species of larger toothed whales, and 19 species of beaked and bottlenose whales): functional hearing is estimated to occur between approximately 150 Hz and 160 kHz;

- High frequency cetaceans (eight species of true porpoises, six species of river dolphins, Kogia, the franciscana, and four species of cephalorhynchids): functional hearing is estimated to occur between approximately 200 Hz and 180 kHz;

- Phocid pinnipeds in Water: functional hearing is estimated to occur between approximately 75 Hz and 100 kHz; and

- Otariid pinnipeds in Water: functional hearing is estimated to occur between approximately 100 Hz and 40 kHz.

As mentioned previously in this document, six marine mammal species (three cetaceans and three phocid pinnipeds) may occur in the proposed seismic survey area. Of the three cetacean species likely to occur in the proposed project area and for which take is requested, two are classified as low-frequency cetaceans (i.e., bowhead and gray whales), one is classified as mid-frequency cetaceans (i.e., beluga whale), and one is classified as a high-frequency cetacean (i.e., harbor porpoise) (Southall *et al.*, 2007). A species functional hearing group is a consideration when we analyze the effects of exposure to sound on marine mammals.

1. Tolerance

Numerous studies have shown that underwater sounds from industry activities are often readily detectable by marine mammals in the water at distances of many kilometers. Numerous studies have also shown that marine mammals at distances more than a few kilometers away often show no apparent response to industry activities of various types (Miller *et al.*, 2005; Bain and Williams, 2006). This is often true even in cases when the sounds must be readily audible to the animals based on measured received levels and the hearing sensitivity of that mammal group. Although various baleen whales, toothed whales, and (less frequently) pinnipeds have been shown to react behaviorally to underwater sound such as airgun pulses or vessels under some conditions, at other times mammals of all three types have shown no overt reactions (e.g., Malme *et al.*, 1986; Richardson *et al.*, 1995). Weir (2008) observed marine mammal responses to seismic pulses from a 24 airgun array firing a total volume of either 5,085 in^3 or 3,147 in^3 in Angolan waters between August 2004 and May 2005. Weir recorded a total of 207 sightings of humpback whales (n = 66), sperm whales (n = 124), and Atlantic spotted dolphins (n = 17) and reported that there were no significant differences in encounter rates (sightings/hr) for humpback and sperm whales according to the airgun array's operational status (i.e., active versus silent). The airgun arrays used in the Weir (2008) study were much larger than the array proposed for use during this seismic survey (total discharge volumes of 620 to 1,240 in^3). In general, pinnipeds and small odontocetes seem to be more tolerant of exposure to some types of underwater sound than are baleen whales. Richardson *et al.* (1995) found that vessel noise does not seem to strongly affect pinnipeds that are already in the water. Richardson *et al.* (1995) went on to explain that seals on haul-outs sometimes respond strongly to the presence of vessels and at other times appear to show considerable tolerance of vessels.

2. Masking

Masking is the obscuring of sounds of interest by other sounds, often at similar frequencies. Marine mammals use acoustic signals for a variety of purposes, which differ among species, but include communication between individuals, navigation, foraging, reproduction, avoiding predators, and learning about their environment (Erbe and Farmer, 2000). Masking, or auditory interference, generally occurs when sounds in the environment are louder than, and of a similar frequency as, auditory signals an animal is trying to receive. Masking is a phenomenon that affects animals that are trying to receive acoustic information about their environment, including sounds from other members of their species, predators, prey, and sounds that allow them to orient in their environment. Masking these acoustic signals can disturb the behavior of individual animals, groups of animals, or entire populations.

Masking occurs when anthropogenic sounds and signals (that the animal utilizes) overlap at both spectral and temporal scales. For the airgun sound generated from the proposed seismic and shallow geohazard surveys, sound will consist of low frequency (under 500 Hz) pulses with extremely short durations (less than one second). Lower frequency man-made sounds are more likely to affect detection of communication calls and other potentially important natural sounds such as surf and prey noise. There is little concern regarding masking near the sound source due to the brief duration of these pulses and relatively longer silence between airgun shots (approximately 5-6 seconds). However, at long distances (over tens of kilometers away), due to multipath propagation and reverberation, the durations of airgun pulses can be "stretched" to seconds with long decays (Madsen *et al.*, 2006), although the intensity of the sound is greatly reduced.

This could affect communication signals used by low frequency mysticetes when they occur near the noise band and thus reduce the communication space of animals (e.g., Clark *et al.*, 2009) and cause increased stress levels (e.g., Foote *et al.*, 2004; Holt *et al.*, 2009). Marine mammals are thought to be able to compensate for masking by adjusting their acoustic behavior by shifting call frequencies, and/or increasing call volume and vocalization rates. For example, blue whales are found to increase call rates when exposed to seismic survey noise in the St. Lawrence Estuary (Di Iorio and Clark, 2010). The North Atlantic right whales exposed to high shipping noise increase call frequency (Parks *et al.*, 2007), while some humpback whales respond to low-frequency active sonar playbacks by increasing song length (Miller el al., 2000). Bowhead whale calls are frequently detected in the presence of seismic pulses, although the number of calls detected may sometimes be reduced (Richardson *et al.*, 1986), possibly because animals moved away from the sound source or ceased calling (Blackwell *et al.*, 2013). Additionally, beluga whales have been known to change their vocalizations in the presence of high background noise possibly to avoid masking calls (Lesage *et al.*, 1999; Scheifele *et al.*, 2005). Although some degree of masking is inevitable when high levels of manmade broadband sounds are introduced into the sea, marine mammals have evolved systems and behavior that function to reduce the impacts of masking. Structured signals, such as the echolocation click sequences of small toothed whales, may be readily detected even in the presence of strong background noise because their frequency content and temporal features usually differ strongly from those of the background noise (Au and Moore, 1990). The components of background noise that are similar in frequency to the sound signal in question primarily determine the degree of masking of that signal.

Redundancy and context can also facilitate detection of weak signals. These phenomena may help marine mammals detect weak sounds in the presence of natural or manmade noise. Most masking studies in marine mammals present the test signal and the masking noise from the same direction. The sound localization abilities of marine mammals suggest that, if signal and noise come from different directions, masking would not be as severe as the usual types of masking studies might suggest (Richardson *et al.*, 1995). The dominant background noise may be highly directional if it comes from a particular anthropogenic source such as a ship or industrial site. Directional hearing may significantly reduce the masking effects of these sounds by improving the effective signal-to-noise ratio. In the cases of higher frequency hearing by the bottlenose dolphin, beluga whale, and killer whale, empirical evidence confirms that masking depends strongly on the relative directions of arrival of sound signals and the masking noise (Dubrovskiy, 1990; Bain and Dahlheim, 1994). Toothed whales, and probably other marine mammals as well, have additional capabilities besides directional hearing that can facilitate detection of sounds in the presence of background noise. There is evidence that some toothed whales can shift the dominant frequencies of their echolocation signals from a frequency range with a lot of ambient noise toward frequencies with less noise (Moore and Pawloski, 1990; Thomas and Turl, 1990; Romanenko and Kitain, 1992; Lesage *et al.*, 1999). A few marine mammal species are known to increase the source levels or alter the frequency of their calls in the presence of elevated sound levels (Dahlheim, 1987; Lesage *et al.*, 1999; Foote *et al.*, 2004; Parks *et al.*, 2007, 2009; Di Iorio and Clark, 2009; Holt *et al.*, 2009).

These data demonstrating adaptations for reduced masking pertain mainly to the very high frequency echolocation signals of toothed whales. There is less information about the existence of corresponding mechanisms at moderate or low frequencies or in other types of marine mammals. For example, Zaitseva *et al.* (1980) found that, for the bottlenose dolphin, the angular separation between a sound source and a masking noise source had little effect on the degree of masking when the sound frequency was 18 kHz, in contrast to the pronounced effect at higher frequencies. Directional hearing has been demonstrated at frequencies as low as 0.5-2 kHz in several marine mammals, including killer whales (Richardson *et al.*, 1995). This ability may be useful in reducing masking at these frequencies. In summary, high levels of sound generated by anthropogenic activities may act to mask the detection of weaker biologically important sounds by some marine mammals. This masking may be more prominent for lower frequencies. For higher frequencies, such as that used in echolocation by toothed whales, several mechanisms are available that may allow them to reduce the effects of such masking.

3. Behavioral Disturbance

Marine mammals may behaviorally react when exposed to anthropogenic sound. These behavioral reactions are often shown as: changing durations of surfacing and dives, number of blows per surfacing, or moving direction and/or speed; reduced/increased vocal activities; changing/cessation of certain behavioral activities (such as socializing or feeding); visible startle response or aggressive behavior (such as tail/fluke slapping or jaw clapping); avoidance of areas where sound sources are located; and/or flight responses (e.g., pinnipeds flushing into water from haulouts or rookeries).

The biological significance of many of these behavioral disturbances is difficult to predict, especially if the detected disturbances appear minor. However, the consequences of behavioral modification have the potential to be biologically significant if the change affects growth, survival, or reproduction. Examples of significant behavioral modifications include:

- Drastic change in diving/surfacing patterns (such as those thought to be causing beaked whale stranding due to exposure to military mid-frequency tactical sonar);

- Habitat abandonment due to loss of desirable acoustic environment; and
- Cessation of feeding or social interaction.

The onset of behavioral disturbance from anthropogenic noise depends on both external factors (characteristics of noise sources and their paths) and the receiving animals (hearing, motivation, experience, demography, current activity, reproductive state) and is also difficult to predict (Gordon *et al.*, 2004; Southall *et al.*, 2007; Ellison *et al.*, 2011).

Mysticetes: Baleen whales generally tend to avoid operating airguns, but avoidance radii are quite variable. Whales are often reported to show no overt reactions to pulses from large arrays of airguns at distances beyond a few kilometers, even though the airgun pulses remain well above ambient noise levels out to much greater distances (Miller *et al.*, 2005). However, baleen whales exposed to strong noise pulses often react by deviating from their normal migration route (Richardson *et al.*, 1999). Migrating gray and bowhead whales were observed avoiding the sound source by displacing their migration route to varying degrees but within the natural boundaries of the migration corridors (Schick and Urban, 2000; Richardson *et al.*, 1999). Baleen whale responses to pulsed sound however may depend on the type of activity in which the whales are engaged. Some evidence suggests that feeding bowhead whales may be more tolerant of underwater sound than migrating bowheads (Miller *et al.*, 2005; Lyons *et al.*, 2009; Christie *et al.*, 2010).

Results of studies of gray, bowhead, and humpback whales have determined that received levels of pulses in the 160–170 dB re 1 µPa rms range seem to cause obvious avoidance behavior in a substantial fraction of the animals exposed. In many areas, seismic pulses from large arrays of airguns diminish to those levels at distances ranging from 2.8-9 mi (4.5-14.5 km) from the source. For the much smaller airgun array used during SAE's proposed survey (total discharge volume of 640 in^3), distances to received levels in the 160 dB re 1 µPa rms range are estimated to be 0.5-3 mi (0.8-5 km). Baleen whales within those distances may show avoidance or other strong disturbance reactions to the airgun array. Subtle behavioral changes sometimes become evident at somewhat lower received levels, and recent studies have shown that some species of baleen whales, notably bowhead and humpback whales, at times show strong avoidance at received levels lower than 160–170 dB re 1 µPa rms. Bowhead whales migrating west across the Alaskan Beaufort Sea in autumn, in particular, are unusually responsive, with avoidance occurring out to distances of 12.4-18.6 mi (20-30 km) from a medium-sized airgun source (Miller *et al.*, 1999; Richardson *et al.*, 1999). However, more recent research on bowhead whales (Miller *et al.*, 2005) corroborates earlier evidence that, during the summer feeding season, bowheads are not as sensitive to seismic sources. In summer, bowheads typically begin to show avoidance reactions at a received level of about 160–170 dB re 1 µPa rms (Richardson *et al.*, 1986; Ljungblad *et al.*, 1988; Miller *et al.*, 2005).

Malme *et al.* (1986) studied the responses of feeding eastern gray whales to pulses from a single 100 in^3 airgun off St. Lawrence Island in the northern Bering Sea. They estimated, based on small sample sizes, that 50% of feeding gray whales ceased feeding at an average received pressure level of 173 dB re 1 µPa on an (approximate) rms basis, and that 10% of feeding whales interrupted feeding at received levels of 163 dB. Those findings were generally consistent with the results of experiments conducted on larger numbers of gray whales that were migrating along the California coast and on observations of the distribution of feeding Western Pacific gray whales off Sakhalin Island, Russia, during a seismic survey (Yazvenko *et al.*, 2007). Data on short-term reactions (or lack of reactions) of cetaceans to impulsive noises do not necessarily provide information about long-term effects. While it is not certain whether impulsive noises affect reproductive rate or distribution and habitat use in subsequent days or years, certain species have continued to use areas ensonified by airguns and have continued to increase in number despite successive years of anthropogenic activity in the area. Gray whales continued to migrate annually along the west coast of North America despite intermittent seismic exploration and much ship traffic in that area for decades (Appendix A in Malme *et al.*, 1984). Bowhead whales continued to travel to the eastern Beaufort Sea each summer despite seismic exploration in their summer and autumn range for many years (Richardson *et al.*, 1987). Populations of both gray whales and bowhead whales grew substantially during this time. In any event, the proposed survey will occur in summer (July through late August) when most bowhead whales are commonly feeding in the Mackenzie River Delta, Canada.

Patenaude *et al.* (2002) reported fewer behavioral responses to aircraft overflights by bowhead compared to beluga whales. Behaviors classified as reactions consisted of short surfacings, immediate dives or turns, changes in behavior state, vigorous swimming, and breaching. Most bowhead reaction resulted from exposure to helicopter activity and little response to fixed-wing aircraft was observed. Most reactions occurred when the helicopter was at altitudes ≤492 ft (150 m) and lateral distances ≤820 ft (250 m; Nowacek *et al.*, 2007).

During their study, Patenaude *et al.* (2002) observed one bowhead whale cow-calf pair during four passes totaling 2.8 hours of the helicopter and two pairs during Twin Otter overflights. All of the helicopter passes were at altitudes of 49-98 ft (15-30 m). The mother dove both times she was at the surface, and the calf dove once out of the four times it was at the surface. For the cow-calf pair sightings during Twin Otter overflights, the authors did not note any behaviors specific to those pairs. Rather, the reactions of the cow-calf pairs were lumped with the reactions of other groups that did not consist of calves.

Richardson *et al.* (1995) and Moore and Clarke (2002) reviewed a few studies that observed responses of gray whales to aircraft. Cow-calf pairs were quite sensitive to a turboprop survey flown at 1,000 ft (305 m) altitude on the Alaskan summering grounds. In that survey, adults were seen swimming over the calf, or the calf swam under the adult (Ljungblad *et al.*, 1983, cited in Richardson *et al.*, 1995 and Moore and Clarke, 2002). However, when the same aircraft circled for more than 10 minutes at 1,050 ft (320 m) altitude over a group of mating gray whales, no reactions were observed (Ljungblad *et al.*, 1987, cited in Moore and Clarke, 2002). Malme *et al.* (1984, cited in Richardson *et al.*, 1995 and Moore and Clarke, 2002) conducted playback experiments on migrating gray whales. They exposed the animals to underwater noise recorded from a Bell 212 helicopter (estimated altitude=328 ft [100 m]), at an average of three simulated passes per minute. The authors observed that whales changed their swimming course and sometimes slowed down in response to the playback sound but proceeded to migrate past the transducer. Migrating gray whales did not react overtly to a Bell 212 helicopter at greater than

1,394 ft (425 m) altitude, occasionally reacted when the helicopter was at 1,000-1,198 ft (305-365 m), and usually reacted when it was below 825 ft (250 m; Southwest Research Associates, 1988, cited in Richardson *et al.*, 1995 and Moore and Clarke, 2002). Reactions noted in that study included abrupt turns or dives or both. Greene *et al.* (1992, cited in Richardson *et al.*, 1995) observed that migrating gray whales rarely exhibited noticeable reactions to a straight-line overflight by a Twin Otter at 197 ft (60 m) altitude.

Odontocetes: Few systematic data are available describing reactions of toothed whales to noise pulses. However, systematic work on sperm whales is underway, and there is an increasing amount of information about responses of various odontocetes to seismic surveys based on monitoring studies (e.g., Stone, 2003). Miller *et al.* (2009) conducted at-sea experiments where reactions of sperm whales were monitored through the use of controlled sound exposure experiments from large airgun arrays consisting of 20-guns and 31-guns. Of 8 sperm whales observed, none changed their behavior when exposed to either a ramp-up at 4-8 mi (7-13 km) or full array exposures at 0.6-8 mi (1-13 km).

Seismic operators and marine mammal observers sometimes see dolphins and other small toothed whales near operating airgun arrays, but, in general, there seems to be a tendency for most delphinids to show some limited avoidance of seismic vessels operating large airgun systems. However, some dolphins seem to be attracted to the seismic vessel and floats, and some ride the bow wave of the seismic vessel even when large arrays of airguns are firing. Nonetheless, there have been indications that small toothed whales sometimes move away or maintain a somewhat greater distance from the vessel when a large array of airguns is operating than when it is silent (e.g., 1998; Stone, 2003). The beluga may be a species that (at least in certain geographic areas) shows long-distance avoidance of seismic vessels. Aerial surveys during seismic operations in the southeastern Beaufort Sea recorded much lower sighting rates of beluga whales within 10–20 km (6.2-12.4 mi) of an active seismic vessel. These results were consistent with the low number of beluga sightings reported by observers aboard the seismic vessel, suggesting that some belugas might have been avoiding the seismic operations at distances of 10–20 km (6.2-12.4 mi) (Miller *et al.*, 2005).

Captive bottlenose dolphins and (of more relevance in this project) beluga whales exhibit changes in behavior when exposed to strong pulsed sounds similar in duration to those typically used in seismic surveys (Finneran *et al.*, 2002, 2005). However, the animals tolerated high received levels of sound (pk–pk level >200 dB re 1 μPa) before exhibiting aversive behaviors.

Observers stationed on seismic vessels operating off the United Kingdom from 1997 - 2000 have provided data on the occurrence and behavior of various toothed whales exposed to seismic pulses (Stone, 2003; Gordon *et al.*, 2004). Killer whales were found to be significantly farther from large airgun arrays during periods of shooting compared with periods of no shooting. The displacement of the median distance from the array was approximately 0.5 km (0.3 mi) or more. Killer whales also appear to be more tolerant of seismic shooting in deeper water.

Reactions of toothed whales to large arrays of airguns are variable and, at least for delphinids, seem to be confined to a smaller radius than has been observed for mysticetes. However, based on the limited existing evidence, belugas should not be grouped with delphinids in the "less responsive” category.

Patenaude *et al.* (2002) reported that beluga whales appeared to be more responsive to aircraft overflights than bowhead whales. Changes were observed in diving and respiration behavior, and some whales veered away when a helicopter passed at ≤820 ft (250 m) lateral distance at altitudes up to 492 ft (150 m). However, some belugas showed no reaction to the helicopter. Belugas appeared to show less response to fixed-wing aircraft than to helicopter overflights.

Pinnipeds: Pinnipeds are not likely to show a strong avoidance reaction to the airgun sources proposed for use. Visual monitoring from seismic vessels has shown only slight (if any) avoidance of airguns by pinnipeds and only slight (if any) changes in behavior. Monitoring work in the Alaskan Beaufort Sea during 1996–2001 provided considerable information regarding the behavior of Arctic ice seals exposed to seismic pulses (Harris *et al.*, 2001; Moulton and Lawson, 2002). These seismic projects usually involved arrays of 6 to 16 airguns with total volumes of 560 to 1,500 in^3. The combined results suggest that some seals avoid the immediate area around seismic vessels. In most survey years, ringed seal sightings tended to be farther away from the seismic vessel when the airguns were operating than when they were not (Moulton and Lawson, 2002). However, these avoidance movements were relatively small, on the order of 100 m (328 ft) to a few hundreds of meters, and many seals remained within 100–200 m (328–656 ft) of the trackline as the operating airgun array passed by. Seal sighting rates at the water surface were lower during airgun array operations than during no-airgun periods in each survey year except 1997. Similarly, seals are often very tolerant of pulsed sounds from seal-scaring devices (Richardson *et al.*, 1995). However, initial telemetry work suggests that avoidance and other behavioral reactions by two other species of seals to small airgun sources may at times be stronger than evident to date from visual studies of pinniped reactions to airguns (Thompson *et al.*, 1998). Even if reactions of the species occurring in the present study area are as strong as those evident in the telemetry study, reactions are expected to be confined to relatively small distances and durations, with no long-term effects on pinniped individuals or populations.

4. Threshold Shift (Noise-induced Loss of Hearing)

When animals exhibit reduced hearing sensitivity (i.e., sounds must be louder for an animal to detect them) following exposure to an intense sound or sound for long duration, it is referred to as a noise-induced threshold shift (TS). An animal can experience temporary threshold shift (TTS) or permanent threshold shift (PTS). TTS can last from minutes or hours to days (i.e., there is complete recovery), can occur in specific frequency ranges (i.e., an animal might only have a temporary loss of hearing sensitivity between the frequencies of 1 and 10 kHz), and can be of varying amounts (for example, an animal’s hearing sensitivity might be reduced initially by only 6 dB or reduced by 30 dB). PTS is permanent, but some recovery is possible. PTS can also occur in a specific frequency range and amount as mentioned above for TTS.

The following physiological mechanisms are thought to play a role in inducing auditory TS: effects to sensory hair cells in the inner ear that reduce their sensitivity, modification of the chemical environment within the sensory cells, residual muscular activity in the middle ear, displacement of certain inner ear membranes, increased blood flow, and post-stimulatory reduction in both efferent and sensory neural output (Southall *et al.*, 2007). The amplitude, duration, frequency, temporal pattern, and energy distribution of sound exposure all can affect the amount of associated TS and the frequency range in which it occurs. As amplitude and duration of sound exposure increase, so, generally, does the amount of TS, along with the recovery time. For intermittent sounds, less TS could occur than compared to a continuous exposure with the same energy (some recovery could occur between intermittent exposures depending on the duty cycle between sounds) (Ward, 1997). For example, one short but loud (higher SPL) sound exposure may induce the same impairment as one longer but softer sound, which in turn may cause more impairment than a series of several intermittent softer sounds with the same total energy (Ward, 1997). Additionally, though TTS is temporary, prolonged exposure to sounds strong enough to elicit TTS, or shorter-term exposure to sound levels well above the TTS threshold, can cause PTS, at least in terrestrial mammals. Although in the case of the proposed seismic and shallow hazard surveys, animals are not expected to be exposed to sound levels high for a long enough period to result in PTS.

PTS is considered auditory injury (Southall *et al.*, 2007). Irreparable damage to the inner or outer cochlear hair cells may cause PTS; however, other mechanisms are also involved, such as exceeding the elastic limits of certain tissues and membranes in the middle and inner ears and resultant changes in the chemical composition of the inner ear fluids (Southall *et al.*, 2007).

Although the published body of scientific literature contains numerous theoretical studies and discussion papers on hearing impairments that can occur with exposure to a loud sound, only a few studies provide empirical information on the levels at which noise-induced loss in hearing sensitivity occurs in nonhuman animals. For marine mammals, published data are limited to the captive bottlenose dolphin, beluga, harbor porpoise, and Yangtze finless porpoise (Finneran *et al.*, 2000, 2002, 2003, 2005, 2007; Finneran and Schlundt, 2010; Lucke *et al.*, 2009; Mooney *et al.*, 2009; Popov *et al.*, 2011a, 2011b; Kastelein *et al.*, 2012a; Schlundt *et al.*, 2006; Nachtigall *et al.*, 2003, 2004). For pinnipeds in water, data are limited to measurements of TTS in harbor seals, an elephant seal, and California sea lions (Kastak *et al.*, 2005; Kastelein *et al.*, 2012b).

Marine mammal hearing plays a critical role in communication with conspecifics, and interpretation of environmental cues for purposes such as predator avoidance and prey capture. Depending on the degree (elevation of threshold in dB), duration (i.e., recovery time), and frequency range of TTS, and the context in which it is experienced, TTS can have effects on marine mammals ranging from discountable to serious (similar to those discussed in auditory masking, above). For example, a marine mammal may be able to readily compensate for a brief, relatively small amount of TTS in a non-critical frequency range that occurs during a time where ambient noise is lower and there are not as many competing sounds present. Alternatively, a larger amount and longer duration of TTS sustained during time when communication is critical for successful mother/calf interactions could have more serious impacts. Also, depending on the degree and frequency range, the effects of PTS on an animal could range in severity, although it is considered generally more serious because it is a permanent condition. Of note, reduced hearing sensitivity as a simple function of aging has been observed in marine mammals, as well as humans and other taxa (Southall *et al.*, 2007), so we can infer that strategies exist for coping with this condition to some degree, though likely not without cost.

5. Non-auditory Physical Effects

Non-auditory physical effects might occur in marine mammals exposed to strong underwater sound. Possible types of non-auditory physiological effects or injuries that theoretically might occur in mammals close to a strong sound source include stress, neurological effects, bubble formation, and other types of organ or tissue damage. Some marine mammal species (i.e., beaked whales) may be especially susceptible to injury and/or stranding when exposed to strong pulsed sounds.

Classic stress responses begin when an animal's central nervous system perceives a potential threat to its homeostasis. That perception triggers stress responses regardless of whether a stimulus actually threatens the animal; the mere perception of a threat is sufficient to trigger a stress response (Moberg, 2000; Sapolsky *et al.*, 2005; Seyle, 1950). Once an animal's central nervous system perceives a threat, it mounts a biological response or defense that consists of a combination of the four general biological defense responses: behavioral responses; autonomic nervous system responses; neuroendocrine responses; or immune responses.

In the case of many stressors, an animal's first and most economical (in terms of biotic costs) response is behavioral avoidance of the potential stressor or avoidance of continued exposure to a stressor. An animal's second line of defense to stressors involves the sympathetic part of the autonomic nervous system and the classical "fight or flight" response, which includes the cardiovascular system, the gastrointestinal system, the exocrine glands, and the adrenal medulla to produce changes in heart rate, blood pressure, and gastrointestinal activity that humans commonly associate with "stress." These responses have a relatively short duration and may or may not have significant long-term effects on an animal's welfare.

An animal's third line of defense to stressors involves its neuroendocrine or sympathetic nervous systems; the system that has received the most study has been the hypothalmus-pituitary-adrenal system (also known as the HPA axis in mammals or the hypothalamus-pituitary-interrenal axis in fish and some reptiles). Unlike stress responses associated with the autonomic nervous system, virtually all neuroendocrine functions that are affected by stress – including immune competence, reproduction, metabolism, and behavior – are regulated by pituitary hormones. Stress-induced changes in the secretion of pituitary hormones have been implicated in failed reproduction (Moberg, 1987), altered metabolism (Elasser *et al.*, 2000), reduced immune competence (Blecha, 2000), and behavioral disturbance. Increases in the circulation of glucocorticosteroids (cortisol, corticosterone, and aldosterone in marine mammals; see Romano *et al.*, 2004) have been equated with stress for many years.

The primary distinction between stress (which is adaptive and does not normally place an animal at risk) and distress is the biotic cost of the response. During a stress response, an animal uses glycogen stores that can be quickly replenished once the stress is alleviated. In such circumstances, the cost of the stress response would not pose a risk to the animal's welfare. However, when an animal does not have sufficient energy reserves to satisfy the energetic costs of a stress response, energy resources must be diverted from other biotic functions, which impair those functions that experience the diversion. For example, when mounting a stress response diverts energy away from growth in young animals, those animals may experience stunted growth. When mounting a stress response diverts energy from a fetus, an animal's reproductive success and fitness will suffer. In these cases, the animals will have entered a pre-pathological or pathological state which is called "distress" (sensu Seyle, 1950) or "allostatic loading" (sensu

McEwen and Wingfield, 2003). This pathological state will last until the animal replenishes its biotic reserves sufficient to restore normal function. Note that these examples involved a long-term (days or weeks) stress response exposure to stimuli.

Relationships between these physiological mechanisms, animal behavior, and the costs of stress responses have also been documented fairly well through controlled experiment; because this physiology exists in every vertebrate that has been studied, it is not surprising that stress responses and their costs have been documented in both laboratory and free-living animals (for examples see, Holberton *et al.*, 1996; Hood *et al.*, 1998; Jessop *et al.*, 2003; Krausman *et al.*, 2004; Lankford *et al.*, 2005; Reneerkens *et al.*, 2002; Thompson and Hamer, 2000). Although no information has been collected on the physiological responses of marine mammals to anthropogenic sound exposure, studies of other marine animals and terrestrial animals would lead us to expect some marine mammals to experience physiological stress responses and, perhaps, physiological responses that would be classified as "distress" upon exposure to anthropogenic sounds.

For example, Jansen (1998) reported on the relationship between acoustic exposures and physiological responses that are indicative of stress responses in humans (e.g., elevated respiration and increased heart rates). Jones (1998) reported on reductions in human performance when faced with acute, repetitive exposures to acoustic disturbance. Trimper *et al.* (1998) reported on the physiological stress responses of osprey to low-level aircraft noise while Krausman *et al.* (2004) reported on the auditory and physiology stress responses of endangered Sonoran pronghorn to military overflights. Smith *et al.* (2004a, 2004b) identified noise-induced physiological transient stress responses in hearing-specialist fish (i.e., goldfish) that accompanied short- and long-term hearing losses. Welch and Welch (1970) reported physiological and behavioral stress responses that accompanied damage to the inner ears of fish and several mammals.

Hearing is one of the primary senses marine mammals use to gather information about their environment and communicate with conspecifics. Although empirical information on the relationship between sensory impairment (TTS, PTS, and acoustic masking) on marine mammals remains limited, we assume that reducing a marine mammal's ability to gather information about its environment and communicate with other members of its species would induce stress, based on data that terrestrial animals exhibit those responses under similar conditions (NRC, 2003) and because marine mammals use hearing as their primary sensory mechanism. Therefore, we assume that acoustic exposures sufficient to trigger onset PTS or TTS would be accompanied by physiological stress responses. More importantly, marine mammals might experience stress responses at received levels lower than those necessary to trigger onset TTS. Based on empirical studies of the time required to recover from stress responses (Moberg, 2000), NMFS also assumes that stress responses could persist beyond the time interval required for animals to recover from TTS and might result in pathological and pre-pathological states that would be as significant as behavioral responses to TTS.

Resonance effects (Gentry, 2002) and direct noise-induced bubble formations (Crum *et al.*, 2005) are implausible in the case of exposure to an impulsive broadband source like an airgun array. If seismic surveys disrupt diving patterns of deep-diving species, this might result in bubble formation and a form of the bends, as speculated to occur in beaked whales exposed to sonar. However, there is no specific evidence of this upon exposure to airgun pulses. Additionally, no beaked whale species occur in the proposed project area.

In general, very little is known about the potential for strong, anthropogenic underwater sounds to cause non-auditory physical effects in marine mammals. Such effects, if they occur at all, would presumably be limited to short distances and to activities that extend over a prolonged period. The available data do not allow identification of a specific exposure level above which non-auditory effects can be expected (Southall *et al.*, 2007) or any meaningful quantitative predictions of the numbers (if any) of marine mammals that might be affected in those ways. There is no definitive evidence that any of these effects occur even for marine mammals in close proximity to large arrays of airguns, which are not proposed for use during this program. In addition, marine mammals that show behavioral avoidance of industry activities, including bowheads, belugas, and some pinnipeds, are especially unlikely to incur non-auditory impairment or other physical effects.

6. Stranding and Mortality

Marine mammals close to underwater detonations of high explosive can be killed or severely injured, and the auditory organs are especially susceptible to injury (Ketten *et al.*, 1993; Ketten, 1995). Airgun pulses are less energetic and their peak amplitudes have slower rise times. To date, there is no evidence that serious injury, death, or stranding by marine mammals can occur from exposure to airgun pulses, even in the case of large airgun arrays. Additionally, SAE and Hilcorp’s proposed surveys will use small and medium sized airgun arrays and low-intensity sonar in shallow water. NMFS does not expect any marine mammals will incur serious injury or mortality in the shallow waters off Beaufort Sea or strand as a result of the proposed seismic or shallow geohazard surveys.

7. Potential Effects from Pingers on Marine Mammals

Active acoustic sources other than the airguns have been proposed for SAE’s 2015 seismic survey in Beaufort Sea, Alaska. In general, the potential effects of this equipment on marine mammals are similar to those from the airguns, except the magnitude of the impacts is expected to be much less due to the lower intensity of the source.

Vessel Impacts

Vessel activity and noise associated with vessel activity will temporarily increase in the action area during SAE’s seismic survey as a result of the operation of about 8 vessels. To minimize the effects of vessels and noise associated with vessel activity, SAE will alter speed if a marine mammal gets too close to a vessel. In addition, source vessels will be operating at slow speed (4-5 knots) when conducting surveys. Marine mammal monitoring observers will alert vessel captains as animals are detected to ensure safe and effective measures are applied to avoid coming into direct contact with marine mammals. Therefore, NMFS neither anticipates nor authorizes takes of marine mammals from ship strikes.

McCauley *et al.* (1996) reported several cases of humpback whales responding to vessels in Hervey Bay, Australia. Results indicated clear avoidance at received levels between 118 to 124 dB in three cases for which response and received levels were observed/measured.

Palka and Hammond (2001) analyzed line transect census data in which the orientation and distance off transect line were reported for large numbers of minke whales. The authors developed a method to account for effects of animal movement in response to sighting platforms. Minor changes in locomotion speed, direction, and/or diving profile were reported at ranges from 1,847 to 2,352 ft (563 to 717 m) at received levels of 110 to 120 dB.

Odontocetes, such as beluga whales, killer whales, and harbor porpoises, often show tolerance to vessel activity; however, they may react at long distances if they are confined by ice, shallow water, or were previously harassed by vessels (Richardson *et al.*, 1995). Beluga whale response to vessel noise varies greatly from tolerance to extreme sensitivity depending on the activity of the whale and previous experience with vessels (Richardson *et al.*, 1995). Reactions to vessels depends on whale activities and experience, habitat, boat type, and boat behavior (Richardson *et al.*, 1995) and may include behavioral responses, such as altered headings or avoidance (Blane and Jaakson, 1994; Erbe and Farmer, 2000); fast swimming; changes in vocalizations (Lesage *et al.*, 1999; Scheifele *et al.*, 2005); and changes in dive, surfacing, and respiration patterns.

There are few data published on pinniped responses to vessel activity, and most of the information is anecdotal (Richardson *et al.*, 1995). Generally, sea lions in water show tolerance to close and frequently approaching vessels and sometimes show interest in fishing vessels. They are less tolerant when hauled out on land; however, they rarely react unless the vessel approaches within 100-200 m (330-660 ft; reviewed in Richardson *et al.*, 1995).

The addition of the vessels and noise due to vessel operations associated with the seismic survey is not expected to have effects that could cause significant or long-term consequences for individual marine mammals or their populations.

4.1.2 Effects on Marine Mammals Habitat

The primary potential impacts to marine mammal habitat and other marine species are associated with elevated sound levels produced by airguns and other active acoustic sources. However, other potential impacts to the surrounding habitat from physical disturbance are also possible. This section describes the potential impacts to marine mammal habitat from the specified activity. Because the marine mammals in the area feed on fish and/or invertebrates there is also information on the species typically preyed upon by the marine mammals in the area.

With regard to fish as a prey source for odontocetes and seals, fish are known to hear and react to sounds and to use sound to communicate (Tavolga *et al.*, 1981) and possibly avoid predators (Wilson and Dill, 2002). Experiments have shown that fish can sense both the strength and direction of sound (Hawkins, 1981). Primary factors determining whether a fish can sense a sound signal, and potentially react to it, are the frequency of the signal and the strength of the signal in relation to the natural background noise level.

Fishes produce sounds that are associated with behaviors that include territoriality, mate search, courtship, and aggression. It has also been speculated that sound production may provide the means for long distance communication and communication under poor underwater visibility conditions (Zelick *et al.*, 1999), although the fact that fish communicate at low-frequency sound levels where the masking effects of ambient noise are naturally highest suggests that very long distance communication would rarely be possible. Fishes have evolved a diversity of sound generating organs and acoustic signals of various temporal and spectral contents. Fish sounds vary in structure, depending on the mechanism used to produce them (Hawkins, 1993). Generally, fish sounds are predominantly composed of low frequencies (less than 3 kHz).

Since objects in the water scatter sound, fish are able to detect these objects through monitoring the ambient noise. Therefore, fish are probably able to detect prey, predators, conspecifics, and physical features by listening to environmental sounds (Hawkins, 1981). There are two sensory systems that enable fish to monitor the vibration-based information of their surroundings. The two sensory systems, the inner ear and the lateral line, constitute the acoustico-lateralis system.

Although the hearing sensitivities of very few fish species have been studied to date, it is becoming obvious that the intra- and inter-specific variability is considerable (Coombs, 1981). Nedwell *et al.* (2004) compiled and published available fish audiogram information. A noninvasive electrophysiological recording method known as auditory brainstem response is now commonly used in the production of fish audiograms (Yan, 2004). Generally, most fish have their best hearing in the low-frequency range (i.e., less than 1 kHz). Even though some fish are able to detect sounds in the ultrasonic frequency range, the thresholds at these higher frequencies tend to be considerably higher than those at the lower end of the auditory frequency range.

Literature relating to the impacts of sound on marine fish species can be divided into the following categories: (1) pathological effects; (2) physiological effects; and (3) behavioral effects. Pathological effects include lethal and sub-lethal physical damage to fish; physiological effects include primary and secondary stress responses; and behavioral effects include changes in exhibited behaviors of fish. Behavioral changes might be a direct reaction to a detected sound or a result of the anthropogenic sound masking natural sounds that the fish normally detect and to which they respond. The three types of effects are often interrelated in complex ways. For example, some physiological and behavioral effects could potentially lead to the ultimate pathological effect of mortality. Hastings and Popper (2005) reviewed what is known about the effects of sound on fishes and identified studies needed to address areas of uncertainty relative to measurement of sound and the responses of fishes. Popper *et al.* (2003/2004) also published a paper that reviews the effects of anthropogenic sound on the behavior and physiology of fishes.

Potential effects of exposure to sound on marine fish include TTS, physical damage to the ear region, physiological stress responses, and behavioral responses such as startle response, alarm response, avoidance, and perhaps lack of response due to masking of acoustic cues. Most of these effects appear to be either temporary or intermittent and therefore probably do not significantly impact the fish at a population level. The studies that resulted in physical damage to the fish ears used noise exposure levels and durations that were far more extreme than would be encountered under conditions similar to those expected during SAE's proposed survey.

The level of sound at which a fish will react or alter its behavior is usually well above the detection level. Fish have been found to react to sounds when the sound level increased to about 20 dB above the detection level of 120 dB (Ona, 1988); however, the response threshold can depend on the time of year and the fish's physiological condition (Engas *et al.*, 1993). In general, fish react more strongly to pulses of sound rather than a continuous signal (Blaxter *et al.*, 1981), such as the type of sound that will be produced by the drillship, and a quicker alarm response is elicited when the sound signal intensity rises rapidly compared to sound rising more slowly to the same level.

Investigations of fish behavior in relation to vessel noise (Olsen *et al.*, 1983; Ona, 1988; Ona and Godo, 1990) have shown that fish react when the sound from the engines and propeller exceeds a certain level. Avoidance reactions have been observed in fish such as cod and herring when vessels approached close enough that received sound levels are 110 dB to 130 dB (Nakken, 1992; Olsen, 1979; Ona and Godo, 1990; Ona and Toresen, 1988). However, other researchers have found that fish such as polar cod, herring, and capeline are often attracted to vessels (apparently by the noise) and swim toward the vessel (Rostad *et al.*, 2006). Typical sound source levels of vessel noise in the audible range for fish are 150 dB to 170 dB (Richardson *et al.*, 1995a). In calm weather, ambient noise levels in audible parts of the spectrum lie between 60 dB to 100 dB.

Short, sharp sounds can cause overt or subtle changes in fish behavior. Chapman and Hawkins (1969) tested the reactions of whiting (hake) in the field to an airgun. When the airgun was fired, the fish dove from 82 to 180 ft (25 to 55 m) depth and formed a compact layer. The whiting dove when received sound levels were higher than 178 dB re 1 µPa (Pearson *et al.*, 1992).

Pearson *et al.* (1992) conducted a controlled experiment to determine effects of strong noise pulses on several species of rockfish off the California coast. They used an airgun with a source level of 223 dB re 1 µPa. They noted:

- Startle responses at received levels of 200–205 dB re 1 µPa and above for two sensitive species, but not for two other species exposed to levels up to 207 dB;
- Alarm responses at 177–180 dB for the two sensitive species, and at 186 to 199 dB for other species;
- An overall threshold for the above behavioral response at about 180 dB;
- An extrapolated threshold of about 161 dB for subtle changes in the behavior of rockfish; and
- A return to pre-exposure behaviors within the 20-60 minute exposure period.

In summary, fish often react to sounds, especially strong and/or intermittent sounds of low frequency. Sound pulses at received levels of 160 dB re 1 µPa may cause subtle changes in behavior. Pulses at levels of 180 dB may cause noticeable changes in behavior (Chapman and Hawkins, 1969; Pearson *et al.*, 1992; Skalski *et al.*, 1992). It also appears that fish often habituate to repeated strong sounds rather rapidly, on time scales of minutes to an hour. However, the habituation does not endure, and resumption of the strong sound source may again elicit disturbance responses from the same fish.

Some of the fish species found in the Arctic are prey sources for odontocetes and pinnipeds. A reaction by fish to sounds produced by SAE's proposed survey would only be relevant to marine mammals if it caused concentrations of fish to vacate the area. Pressure changes of sufficient magnitude to cause that type of reaction would probably occur only very close to the sound source, if any would occur at all. Impacts on fish behavior are predicted to be inconsequential. Thus, feeding odontocetes and pinnipeds would not be adversely affected by this minimal loss or scattering, if any, of reduced prey abundance.

Some mysticetes, including bowhead whales, feed on concentrations of zooplankton. Some feeding bowhead whales may occur in the Alaskan Beaufort Sea in July and August, but feeding bowheads are more likely to occur in the area after the cessation of airgun operations. Reactions of zooplankton to sound are, for the most part, not known. Their ability to move significant distances is limited or nil, depending on the type of zooplankton. Behavior of zooplankters is not expected to be affected by the survey. These animals have exoskeletons and no air bladders. Many crustaceans can make sounds, and some crustacea and other invertebrates have some type of sound receptor. A reaction by zooplankton to sounds produced by the seismic survey would only be relevant to whales if it caused concentrations of zooplankton to scatter. Pressure changes of sufficient magnitude to cause that type of reaction would probably occur only very close to the sound source, if any would occur at all. Impacts on zooplankton behavior are predicted to be inconsequential. Thus, feeding mysticetes would not be adversely affected by this minimal loss or scattering, if any, of reduced zooplankton abundance.

Based on the preceding discussion, the proposed activity is not expected to have any habitat-related effects that could cause significant or long-term consequences for individual marine mammals or their populations.

4.1.3 Effects on Subsistence

4.1.3.1 Subsistence Activities in the Action Area

NMFS has defined “unmitigable adverse impact” in 50 CFR 216.103 as: “an impact resulting from the specified activity: (1) That is likely to reduce the availability of the species to a level insufficient for a harvest to meet subsistence needs by: (i) Causing the marine mammals to abandon or avoid hunting areas; (ii) Directly displacing subsistence users; or (iii) Placing physical barriers between the marine mammals and the subsistence hunters; and (2) That cannot be sufficiently mitigated by other measures to increase the availability of marine mammals to allow subsistence needs to be met.

4.1.3.2 SAE Seismic Survey

Noise and general activity during SAE’s proposed 3D OBN seismic survey have the potential to impact marine mammals hunted by Native Alaskans. In the case of cetaceans, the most common reaction to anthropogenic sounds (as noted previously) is avoidance of the ensonified area. In the case of bowhead whales, this often means that the animals divert from their normal migratory path by several kilometers. Additionally, general vessel presence in the vicinity of traditional hunting areas could negatively impact a hunt. Native knowledge indicates that bowhead whales become increasingly “skittish” in the presence of seismic noise. Whales are more wary around the hunters and tend to expose a much smaller portion of their back when surfacing, which makes harvesting more difficult. Additionally, natives report that bowheads exhibit angry behaviors, such as tail-slapping, in the presence of seismic activity, which translate to danger for nearby subsistence harvesters.

Responses of seals to seismic airguns are expected to be negligible. Bain and Williams (2006) studied the responses of harbor seals, California sea lions, and Steller sea lions to seismic airguns and found that seals at exposure levels above 170 dB re 1 μPa (peak-peak) often showed avoidance behavior, including generally staying at the surface and keeping their heads out of the water, but that the responses were not overt, and there were no detectable responses at low exposure levels.

SAE has prepared a draft Plan of Cooperation (POC), which was developed by identifying and evaluating any potential effects the proposed seismic survey might have on seasonal abundance that is relied upon for subsistence use. For the proposed project, SAE states that it is working closely with the North Slope Borough (NSB) and its partner Kuukpik Corporation, to identify subsistence communities and activities that may take place within or near the project area. The draft POC is attached to SAE's IHA application.

As a joint venture partner with Kuukpik, SAE will be working closely with them and the communities on the North Slope to plan operations that will include measures that are environmentally suitable and that do not impact local subsistence use. A Conflict Avoidance Agreement (CAA) will be developed that will include such measures.

4.1.3.3 Hilcorp Shallow Geohazard Survey

Hilcorp's proposed shallow geohazard survey will take place between 1 July and 30 September, with data acquisition occurring in July and August. The project area is located >200 mi east from Barrow, approximately 55 mi northeast from Nuiqsut (20 mi southeast of Cross Island), and 120 mi west from Kaktovik. Potential impact on the subsistence hunt from the planned activities is expected mainly from sounds generated by sonar equipment. Due to the timing of the project and the distance from the surrounding communities, there will be no effects on spring harvesting and little or no effects on the occasional summer harvest of beluga and subsistence seal hunts (ringed and spotted seals are primarily harvested in winter while bearded seals are hunted during July-September in the Beaufort Sea). The community of Nuiqsut may begin fall whaling activities in late August to early September from Cross Island (northwest of the survey area). As part of the planned mitigation measures, Hilcorp will complete all operations at a date agreed upon by the Nuiqsut whaling captains as captured in the CAA. No or little impact on the fall bowhead hunt from the proposed activities is therefore expected to occur.

Hilcorp will participate in CAA discussions to meet the requirements for a POC as specified in 50 CFR 216.104(12). The CAA will identify what measures have been or will be taken to minimize adverse impacts of the planned activities on subsistence harvesting (see Section 12 for more details). Hilcorp will meet with the AEWC and communities' Whaling Captains' Associations as part of the CAA development, to establish avoidance guidelines and other mitigation measures to be followed where the proposed activities may have an impact on subsistence.

4.2 Effects of Alternative 2—No Action Alternative

Under the No Action Alternative, NMFS would not issue IHAs to SAE and Hilcorp for the proposed seismic and shallow hazard surveys in the Beaufrot Sea. Therefore, the No Action

Alternative would effectively preclude SAE and Hilcorp from engaging in these survey activities in the Beaufort Sea during the 2015 Arctic open-water season, as any takes of marine mammals under such activities would be violations of the MMPA. If this alternative were selected, the impact on the environment and to SAE and Hilcorp from not conducting the proposed seismic and geohazard surveys in the 2015 open-water season mean that:

1) Adverse impacts on marine mammals, principally bowhead whales, would not be expected as the associated noise generated from these activities would not exist; and

2) Adverse impacts on the Inupiat subsistence hunts would not occur as marine mammals would not be affected and would not have cause to temporarily vacate the area due to underwater noises from seismic and geohaard surveys;

4.3 Estimation of Takes

For purposes of evaluating the potential significance of the "takes" by harassment, estimations of the number of potential takes are discussed in terms of the populations present. The specific number of takes considered for the authorizations is developed via the MMPA process, and the analysis in this Draft EA provides a summary of the anticipated numbers that would be authorized to give a relative sense of the nature of impact of NMFS' proposed action. The methods to estimate take by harassment and present estimates of the numbers of marine mammals that might be affected during SAE and Hilcorp's proposed seismic and shallow geohazard surveys are described in detail in the applicants' IHA applications and the *Federal Register* notices of proposed IHA, which can be accessed at NMFS website at: http://www.nmfs.noaa.gov/pr/permits/incidental/oilgas.htm.

Estimates of the takes of marine mammals by Level A and Levels B harassment from SAE's proposed 3D seismic survey and Level B harassment from Hilcorp's shallow geohazard survey are presented in Tables 6 and 7, respectively. Detailed descriptions of take estimates are presented in the *Federal Register* notices for the proposed IHAs for these two actions.

Table 6. The estimated Level A and Level B harassments and requested take of marine mammals by SAE.

Species	Stock Abundance	Estimated Level B Exposures	Level B Take Requested	% Request Level B Take by Stock	Estimated Level A Exposure	% Level A Exposure by Stock
Bowhead whale	19,534	9	15	0.08%	5	0.03%
Beluga whale (Beaufort Sea stock)	39,258	7	15	0.04%	4	0.01%
Beluga whale (E. Chukchi Sea stock)	3,710	7	15	0.40%	4	0.11%
Gray whale	19,126	0	2	0.01%	0	0.00%

Ringed seal	300,000	443	500	0.17%	246	0.08%
Spotted seal	141,479	22	500	0.35%	12	0.01%
Bearded seal	155,000	22	25	0.02%	12	0.01%

Table 7. The estimated Level B harassments and requested take of marine mammals by Hilcorp.

Species	Stock Abundance	Estimated Level B Exposures	Level B Take Requested	% Request Level B Take by Stock
Bowhead whale	19,534	4	12	0.01%
Beluga whale (Beaufort Sea stock)	39,258	1	75	0.19%
Beluga whale (E. Chukchi Sea stock)	3,710	1	75	2.02%
Gray whale	19,126	0	3	0.02%
Ringed seal	300,000	100	350	0.17%
Spotted seal	141,479	27	100	0.07%
Bearded seal	155,000	32	120	0.08%

4.4 Cumulative Effects

Cumulative effect is defined as “the impact on the environment which results from the incremental impact of the action when added to other past, present, and reasonably foreseeable future actions regardless of what agency (Federal or non-federal) or person undertakes such other actions” (40 CFR §1508.7). Cumulative impacts may occur when there is a relationship between a proposed action and other actions expected to occur in a similar location or during a similar time period, or when past or future actions may result in impacts that would additively or synergistically affect a resource of concern. In other words, the analysis takes into account the incremental impact of the proposed action when added to other past, present, and reasonably foreseeable future actions (40 CFR §1508.7). These relationships may or may not be obvious. Actions overlapping within close proximity to the proposed action can reasonably be expected to have more potential for cumulative effects on “shared resources” than actions that may be geographically separated. Similarly, actions that coincide temporally will tend to offer a higher potential for cumulative effects.

Actions that might permanently remove a resource would be expected to have a potential to act additively or synergistically if they affected the same population, even if the effects were separated geographically or temporally. Note that the proposed action considered here would not be expected to result in the removal of individual cetaceans or pinnipeds from the population or to result in harassment levels that might cause animals to permanently abandon preferred feeding areas or other habitat locations, so concerns related to removal of viable members of the populations are not implicated by the proposed action. This cumulative effects analysis considers these potential impacts, but more appropriately focuses on those activities that may temporally or geographically overlap with the proposed activity such that repeat harassment effects warrant consideration for potential cumulative impacts to the potentially affected 7 marine mammal species and their habitats.

Cumulative effects may result in significant effects even when the Federal action under review is insignificant when considered by itself. The CEQ guidelines recognize that it is not practical to analyze the cumulative effects of an action on the universe but to focus on those effects that are truly meaningful. This section analyzes the addition of the effects of the proposed action (i.e., the issuance of IHA to SAE and Hilcorp for the take of marine mammals incidental to conducting 3D seismic and shallow geohazard surveys in the U.S. Beaufort Sea) to the potential direct and indirect effects of other factors that may, in combination with the proposed action, result in greater effects on the environment than those resulting solely from the proposed action. Cumulative effects on affected resources that may result from the following activities—seismic survey activities, vessel and air traffic, oil and gas exploration and development in Federal and state waters, subsistence harvest activities, military activities, industrial development, community development, and climate change—within the proposed project area are discussed in the following subsections.

4.6.1 Past Commercial Whaling

Commercial hunting between 1848 and 1915 caused severe depletion of the bowhead population(s) that inhabits the Bering, Chukchi, and Beaufort (BCB) Seas. This hunting is no longer occurring and is not expected to occur again. Woodby and Botkin (1993) estimated that the historic abundance of bowheads in this population was between 10,400 and 23,000 whales in 1848, before the advent of commercial whaling. Woodby and Botkin (1993) estimated between 1,000 and 3,000 animals remained in 1914, near the end of the commercial-whaling period. Data indicate that what is currently referred to as the BCB Seas stock of bowheads is increasing in abundance.

Similar to bowhead whales, most stocks of fin whales were depleted by commercial whaling (Reeves et al., 1998) beginning in the second half of the mid-1800s (Schmitt et al., 1980; Reeves and Barto, 1985). In the 1900s, hunting for fin whales continued in all oceans for about 75 years (Reeves et al., 1998) until it was legally ended in the North Pacific in 1976. Commercial hunting for humpback whales resulted in the depletion and endangerment of this species. Prior to commercial hunting, humpback whales in the North Pacific may have numbered approximately 15,000 individuals (Rice, 1978). Unregulated hunting legally ended in the North Pacific in 1966.

The end of commercial whaling has seen the increase in whale numbers in the Arctic, particularly for bowhead and gray whales, despite of increased industrial and commercial activities in the region. Since the proposed seismic and shallow geohaard surveys will not have lethal takes of marine mammals, therefore, there is no potential additive or cumulative effects on marine mammal population level with the proposed action.

4.6.2 Subsistence Hunting

4.6.2.1 Bowhead Whales

Indigenous peoples of the Arctic and Subarctic have been hunting bowhead whales for at least 2,000 years (Stoker and Krupnik, 1993). Thus, subsistence hunting is not a new contributor to cumulative effects on this population. There is no indication that, prior to commercial whaling, subsistence whaling caused significant adverse effects at the population level. However, modern technology has changed the potential for any lethal hunting of this whale to cause population-level adverse effects if unregulated. Under the authority of the IWC, the subsistence take from this population has been regulated by a quota system since 1977. Federal authority for cooperative management of the Eskimo subsistence hunt is shared with the AEWC through a cooperative agreement between the AEWC and NMFS.

The sustainable take of bowhead whales by indigenous hunters represents the largest known human-related cause of mortality in this population at the present time. Available information suggests that it is likely to remain so for the foreseeable future. While other potential effectors primarily have the potential to cause, or to be related to, behavioral or sublethal adverse effects to this population, or to cause the deaths of a small number of individuals, little or no evidence exists of other common human-related causes of mortality. Subsistence take, which all available evidence indicates is sustainable, is monitored, managed, and regulated, and helps to determine the resilience of the population to other actions that could potentially cause lethal takes. The sustained growth of the BCB Seas bowhead population indicates that the level of subsistence take has been sustainable. Because the quota for the hunt is tied to the population size and population parameters (IWC, 2003; NMFS, 2003), it is unlikely this source of mortality will contribute to a significant adverse effect on the recovery and long-term viability of this population.

Currently, Native Alaskan hunters from 11 communities harvest bowheads for subsistence and cultural purposes under a quota authorized by the IWC. Chukotkan Native whalers from Russia also are authorized to harvest bowhead whales under the same authorized quota. Bowheads are hunted at Gambell and Savoonga on St. Lawrence Island, and along the Chukotkan coast. On the northward spring migration, harvests may occur by the villages of Wales, Little Diomede, Kivalina, Point Lay, Point Hope, Wainwright, and Barrow. During their westward migration in autumn, whales are harvested by Kaktovik, Nuiqsut, and Barrow. At St. Lawrence Island, fall migrants can be hunted as late as December (IWC, 2004). The status of the population is closely monitored, and these activities are closely regulated.

There are adverse impacts of the hunting to bowhead whales in addition to the death of animals that are successfully hunted and the serious injury of animals that are struck but not immediately killed. Available evidence indicates that subsistence hunting causes disturbance to the other whales, changes in their behavior, and sometimes temporary effects on habitat use, including migration paths. Modern subsistence hunting represents a source of noise and disturbance to the whales during the following periods and in the following areas: during their northward spring migration in the Bering Sea, the Chukchi Sea in the spring lead system, and in the Beaufort Sea spring lead system near Barrow; their fall westward migration in subsistence hunting areas associated with hunting from Kaktovik, Cross Island, and Barrow; hunting along the Chukotka coast; and hunting in wintering areas near St. Lawrence Island. Lowry et al. (2004) reported that indigenous hunters in the Beaufort Sea sometimes hunt in areas where whales are aggregated for feeding. When a subsistence hunt is successful, it results in the death of a bowhead. Data on strike and harvested levels indicate that whales are not always immediately killed when struck, and some whales are struck but cannot be harvested. Whales in the vicinity of the struck whale could be disturbed by the sound of the explosive harpoon used in the hunt, the boat motors, and any sounds made by the injured whale.

Noise and disturbance from subsistence hunting serves as a seasonally and geographically predictable source of noise and disturbance to which other noise and disturbance sources, such as shipping and oil and gas-related activities, add additional stressors to marine mammals. To the extent such activities occur in the same habitats during the period of whale migration, even if the activities (for example, hunting and shipping) themselves do not occur simultaneously, cumulative effects from all noise and disturbance could affect whale habitat use. Subsistence hunting attaches a strong adverse association to human noise for any whale that has been in the vicinity when other whales were struck.

4.6.2.2 Beluga Whales

The subsistence take of beluga whales within U.S. waters is reported by the Alaska Beluga Whale Committee (ABWC). The annual subsistence take of the Beaufort Sea stock of beluga whales by Alaska Natives averaged 25 belugas during the 5-year period from 2002-2006 (Allen and Angliss, 2011). The annual subsistence take of Eastern Chukchi Sea stock of beluga whales by Alaska Natives averaged 59 belugas landed during the 5-year period 2002-2006 based on reports from ABWC representatives and on-site harvest monitoring. Data on beluga that were struck and lost have not been quantified and are not included in these estimates (Allen and Angliss, 2011). As with bowhead whale subsistence hunts, noise during the hunts may disturb other animals not struck and taken for subsistence purposes. Again, the disturbance occurs during specific time periods in specific locations to which other activities could add. To the extent such activities occur in the same habitats during the period of whale migration, even if the activities (for example, hunting and shipping) themselves do not occur simultaneously, cumulative effects from all noise and disturbance could affect whale habitat use. Subsistence hunting attaches a strong adverse association to human noise for any whale that has been in the vicinity when other whales were struck.

4.6.2.3 Ice Seals

The Division of Subsistence, Alaska Department of Fish and Game (ADF&G) maintains a database that provides additional information on the subsistence harvest of ice seals in different regions of Alaska (ADF&G 2000a,b). Information on subsistence harvest of bearded seals has been compiled for 129 villages from reports from the Division of Subsistence and a report from the Eskimo Walrus Commission (Sherrod, 1982). Data were lacking for 22 villages; their harvests were estimated using the annual per capita rates of subsistence harvest from a nearby village. As of August 2000, the subsistence harvest database indicated that the estimated number of bearded, ribbon, ringed, and spotted seals harvested for subsistence use per year are 6,788, 193, 9,567, and 244, respectively (Allen and Angliss, 2011).

At this time, there are no efforts to quantify the current level of harvest of bearded seals by all Alaska communities. However, the USFWS collects information on the level of ice seal harvest in five villages during their Walrus Harvest Monitoring Program. Results from this program indicate that an average of 239 bearded seals were harvested annually in Little Diomede, Gambell, Savoonga, Shishmaref, and Wales from 2000 to 2004, 13 ribbon seals from 1999 to 2003, and 47 ringed seals from 1998 to 2003 (Allen and Angliss, 2010). Since 2005, harvest data are only available from St. Lawrence Island (Gambell and Savoonga) due to lack of walrus harvest monitoring in areas previously monitored. There were 21 bearded seals harvested during the walrus harvest monitoring period on St. Lawrence Island in 2005, 41 in 2006, and 82 in 2007. There were no ringed seals harvested on St. Lawrence Island in 2005, 1 in 2006, and 1 in 2007. The mean annual subsistence harvest of spotted seals in north Bristol Bay from this stock over the 5-year period from 2002 through 2006 was 166 seals per year. No ribbon seal was harvested between 2005 and 2007 (Allen and Angliss, 2010).

4.6.2.4 Contributions of the Alternatives to Cumulative Effects of Subsistence Hunting

Alternative 2 would not contribute any additional effects beyond those already analyzed to the cumulative effects from subsistence hunting, as the IHAs would not be issued. Alternative 1 would allow for the issuance of an IHA for the take of marine mammals incidental to conducting seismic and shallow geohazard surveys in the Beaufort Sea during the open-water season. However, the proposed action is not anticipated to result in serious injury or mortality of any marine mammals; therefore, there would not be additional deaths beyond those from subsistence hunting activities. While both activities (i.e., the proposed surveys and subsistence hunting) can disturb marine mammals, NMFS considers the contribution of such disturbance to overall cumulative effects to be minimal because of the mitigation measures that would be required under the IHA, which are included to reduce impacts to the lowest level practicable.

4.6.3 Climate Change

Section 3.1.4.4 in NMFS' Draft EIS on the Effects of Oil and Gas Activities in the Arctic Ocean (NMFS, 2011) describes changes to climate in the Arctic environment. That information is summarized here and incorporated herein by reference. Evidence of climate change in the Arctic has been identified and appear to generally agree with climate modeling scenarios of greenhouse gas warming. Such evidence suggests (NSIDC, 2011a):

- Air temperatures in the Arctic are increasing at an accelerated rate;
- Year-round sea ice extent and thickness has continually decreased over the past three decades;
- Water temperatures in the Arctic Ocean have increased;
- Changes have occurred to the salinity in the Arctic Ocean;
- Rising sea levels;
- Retreating glaciers;
- Increases in terrestrial precipitation;
- Warming permafrost in Alaska; and
- Northward migration of the treeline.

Concurrent with climate change is a change in ocean chemistry known as ocean acidification. This phenomenon is described in the IPCC Fourth Assessment Report (IPCC, 2007a), a 2005 synthesis report by members of the Royal Society of London (Raven et al., 2005), and an ongoing BOEM-funded study (Mathis, 2011). The greatest degree of ocean acidification worldwide is predicted to occur in the Arctic Ocean. This amplified scenario in the Arctic is due to the effects of increased freshwater input from melting snow and ice and from increased CO_2 uptake by the sea as a result of ice retreat (Fabry et al., 2009). Measurements in the Canada Basin of the Arctic Ocean demonstrate that over 11 years, melting sea ice forced changes in pH and the inorganic carbon equilibrium, resulting in decreased saturation of calcium carbonate in the seawater. At this time, we do not know the precise timeframe, or the series of events that would need to occur before an adverse population level effect on the marine mammals or other resources in the Arctic would be realized. However, this information is unobtainable at this time due to the fact that such conditions do not exist to conduct studies.

Bowhead and other Arctic whales are associated with and well adapted to ice-covered seas with leads, polynyas, open water areas, or thin ice that the whales can break through to breathe. Arctic coastal peoples have hunted bowheads for thousands of years, but the distribution of bowheads in relation to climate change and sea ice cover in the distant past is not known. It has been suggested that a cold period 500 years ago resulted in less ice-free water near Greenland, forcing bowheads to abandon the range, and that this in turn led to the disappearance of the Thule culture. However, it is not clear if larger expanses and longer periods of ice-free water would be beneficial to bowheads. The effect of warmer ocean temperatures on bowheads may depend more on how such climate changes affect the abundance and distribution of their planktonic prey rather than the bowheads' need for ice habitat itself.

Climate change associated with Arctic warming may also result in regime change of the Arctic Ocean ecosystem. Sighting of humpback whales in the Chukchi Sea during the 2007 Shell seismic surveys (Funk et al., 2008), 2009 COMIDA aerial survey (Clarke et al., 2011c), and south of Point Hope in 2009 while transiting to Nome (Brueggeman, 2010) may indicate the expansion of habitat by this species as a result of ecosystem regime shift in the Arctic. These species, in addition to minke and killer whales, and four pinniped species (harp, hooded, ribbon, and spotted seals) that seasonally occupy Arctic and subarctic habitats may be poised to encroach into more northern latitudes and to remain there longer, thereby competing with extant Arctic species (Moore and Huntington, 2008).

In the past decade, geographic displacement of marine mammal population distributions has coincided with a reduction in sea ice and an increase in air and ocean temperatures in the Bering Sea. Continued warming is likely to increase the occurrence and resident times of subarctic species such as spotted seals and bearded seals in the Beaufort Sea. The result of global warming would significantly reduce the extent of sea ice in at least some regions of the Arctic (ACIA, 2004).

Ringed seals, which are true Arctic species, depend on sea ice for their life functions, and give birth to and care for their pups on stable shorefast ice. The reductions in the extent and persistence of ice in the Beaufort Sea almost certainly could reduce their productivity (NRC, 2003b), but at the current stage. Ongoing and projected changes in sea ice habitat pose significant therats to the Alaska ringed seal stock. In addition, spotted seals and bearded seals would also be vulnerable to reductions in sea ice, although insufficient data exist to make reliable predictions of the effects of Arctic climate change on these two species (Allen and Angliss, 2010).

The implications of the trends of a changing climate for bowheads and other Arctic cetaceans are uncertain, but they may be beneficial, in contrast to affects on ice-obligate species such as ice seals, polar bears, and walrus (ACIA, 2004). There will be more open water and longer ice-free seasons in the arctic seas, which may allow them to expand their range as the population continues to recover from commercial whaling. However, this potential for beneficial effects on bowheads and other whales will depend on their ability to locate sufficient concentrations of planktonic crustaceans to allow efficient foraging. Since phytoplankton blooms may occur earlier or at different times of the season, or in different locations, the timing of zooplankton availability may also change from past patterns. Hence, the ability of bowheads to use these food sources may depend on their flexibility to adjust the timing of their own movements and to find food sources in different places (ACIA, 2004). In addition, it is hypothesized that some of the indirect effects of climate change on marine mammal health would likely include alterations in pathogen transmission due to a variety of factors, effects on body condition due to shifts in the prey base/food web, changes in toxicant exposures, and factors associated with increased human habitation in the Arctic.

With the large uncertainty of the degree of impact of climate change to Arctic marine mammals, NMFS recognizes that warming of this region which results in the diminishing of ice could be a concern to ice dependent seals, walrus, and polar bears. Nonetheless, NMFS considers the effects of the proposed action and the specified activity proposed by SAE and Hilcorp during 2015 on climate change are too remote and speculative at this time to conclude definitively that the issuance of an MMPA IHAs for the 2015 open-water seismic and shallow geohazard surveys would contribute to climate change, and therefore a reduction in Arctic sea ice coverage. More research is needed to determine the magnitude of the impact, if any, of global warming to marine mammal species in the Arctic and subarctic regions. Finally, any future oil and gas activities that may arise as a result of this year's open-water seismic and shallow geohazard surveys would likely need to undergo separate permit reviews and analyses.

4.6.4 Oil and Gas Exploration and Development

4.6.4.1 Marine and Seismic Surveys

BOEM-permitted seismic surveys have been conducted in the Federal waters of the Beaufort Sea since the late 1960's/early 1970's (MMS 2007a). For activities since July 2010, NMFS issued an IHA to Shell to take 8 species of marine mammals by Level B behavioral harassment incidental to conducting site clearance and shallow hazards surveys in the Beaufort and Chukchi Seas on August 6, 2010 (75 FR 49710; August 13, 2010). No seismic surveys were conducted in the Beaufort Sea in 2011. In 2012, NMFS issued an IHA to BP Exploration (Alaska), Inc. (BPXI) and ION Geophysical (ION) to take small numbers of marine mammals by harassment incidental to conducting open-water 3D OBC seismic surveys in the Simpson Lagoon of the Beaufort Sea (77 FR 40007; July 6, 2012) and in-ice 2D seismic surveys in the Beaufort and Chukchi Seas (77 FR 65060; October 24, 2012), respectively. In 2013, NMFS issued IHAs to Shell for its open-water marine surveys in the Chukchi Sea (78 FR 47496; August 5, 2013), and to ION for its 2D seismic survey in the Chukchi Seas (78 FR 51147; August 20, 2013). In 2014, NMFS issued IHAs to BP for its 3D seismic survey in the Beaufort Sea (79 FR 36730; June 30, 2014) and its geohazard survey in the Beaufort Sea (79 FR 36769; June 30, 2014), and to SAE for its marine seismic survey in the Beaufort Sea (79 FR 51963; September 2, 2014).

Given the growing interest of oil and gas companies to explore and develop oil and gas resources on the Arctic Ocean OCS, seismic surveys will continue in the Beaufort and Chukchi Seas into the near future and be dependent on: (1) the amount of data that is collected in recent years; and (2) what the data indicate about the subsurface geology. NMFS anticipates that future marine and seismic surveys will continue as the demands on oil and gas are expected to grow worldwide.

Available information does not indicate that marine and seismic surveys for oil and gas exploration activities has had detectable long-term adverse population-level effects on the overall health, current status, or recovery of marine mammals species and populations in the Arctic region. For example, data indicate that the BCB bowhead whale population has continued to increase over the timeframe that oil and gas activities have occurred. There is no evidence of long-term displacement from habitat (although studies have not specifically focused on addressing this issue). Past behavioral (primarily, but not exclusively, avoidance) effects on bowhead whales from oil and gas activity have been documented in many studies. Inupiat whalers have stated that noise from seismic surveys and some other activities at least temporarily displaces whales farther offshore, especially if the operations are conducted in the main migration corridor. Monitoring studies indicate that most fall migrating whales avoid an area with a radius about 20 - 30 km around a seismic vessel operating in nearshore waters (Miller et al. 2002). NMFS is not aware of data, however, that indicate that such avoidance is long-lasting after cessation of the activity or results in significant adverse effects to subsistence users.

An assessment of the cumulative impacts of seismic surveys must consider the decibel levels used, location, duration, and frequency of operations from the surveys as well as other reasonably foreseeable seismic-survey activity. In general, the high-resolution, site clearance and shallow hazards surveys are of lesser concern regarding impacts to cetaceans than the deep 2D/3D surveys. High-resolution and 2D/3D seismic surveys usually do not occur in proximity to each other, as they would interfere with each others' information collection methods. This operational requirement indirectly minimizes the potential for adverse effects on marine mammals that could otherwise be exposed to areas with overlapping intense noise originating from multiple sources.

In addition, the potential for significant cumulative impacts to marine mammals from all proposed seismic surveys would be limited through a series of mitigation and monitoring measures under Alternative 1.

Finally, the proposed 3D seismic and shallow geohazard surveys by SAE and Hilcorp would occur in small areas for a short duration of time. In addition, these activities would occur at different geographic locations that do not overlap.

4.6.4.2 Oil and Gas Development and Production

Oil and gas exploration and production activities have occurred on the North Slope since the early 1900's, and production has occurred for more than 50 years. Since the discovery and development of the Prudhoe Bay and Kuparuk oil field, more recent fields generally have been developed not in the nearshore environment, but on land in areas adjacent to existing producing areas. Pioneer Natural Resources Co. is developing its North Slope Oooguruk field, which is in the shallow waters of the Beaufort Sea approximately 8 mi northwest of the Kuparuk River unit.

BPXA is currently producing oil from an offshore development in the Northstar Unit, which is located between 3.2 and 12.9 km (2 and 8 mi) offshore from Point Storkersen in the Beaufort Sea. This development is the first in the Beaufort Sea that makes use of a subsea pipeline to transport oil to shore and then into the Trans-Alaska Pipeline System. The Northstar facility was built in State of Alaska waters on the remnants of Seal Island ~9.5 km (6 mi) offshore from Point Storkersen, northwest of the Prudhoe Bay industrial complex, and 5 km (3 mi) seaward of the closest barrier island. The unit is adjacent to Prudhoe Bay, and is approximately 87 km (54 mi) northeast of Nuiqsut, an Inupiat community. To date, it is the only offshore oil production facility north of the barrier islands in the Beaufort Sea.

On November 6, 2009, BPXI submitted an application requesting NMFS issue regulations and subsequent LOAs governing the taking of marine mammals, by both Level B harassment and serious injury and mortality, incidental to operation of the Northstar development in the Beaufort Sea, Alaska. Construction of Northstar was completed in 2001. The activities for 2012-2017 include a continuation of drilling, production, and emergency training operations but no construction or activities of similar intensity to those conducted between 1999 and 2001. NMFS published a notice of proposed rulemaking in the *Federal Register* on July 6, 2011, requesting comments and information from the public (76 FR 39706). NMFS is currently working on the final rulemaking governing BP’s marine mammal take authorizations for operating its Northstar facility.

In addition, Shell conducted two exploratory drilling activities at exploration wells in the Beaufort (77 FR 27284; May 9, 2012) and Chukchi (77 FR 27322; May 9, 2012) Seas, Alaska, during the 2012 Arctic open-water season (July through October). In December 2012, Shell submitted two additional IHA applications to take marine mammals incidental to its proposed exploratory drilling in Beaufort and Chukchi Seas during the 2013 open-water season. However, Shell withdrew its application in February 2013. Shell is planning another exploration drilling program in the Chukchi Sea in the 2015 Arctic open-water season and a *Federal Register* notice for the proposed IHA was published on March 4, 2015 (80 FR 11726).

However, the proposed SAE and Hilcorp seismic and shallow geohazard surveys would occur at a different ocean basin in the Beaufort Sea, and would not overlap with the 2015 Shell’s drilling activities in the Chukchi Sea.

4.6.4.3 Vessel Traffic

Vessel traffic in the Alaskan Arctic generally occurs within 12.4 mi (20 km) of the coast and usually is associated with fishing, hunting, cruise ships, icebreakers, Coast Guard activities, and supply ships and barges. No extensive maritime industry exists for transporting goods. Traffic in the Beaufort and Chukchi Seas, at present, is limited primarily to late spring, summer, and early autumn.

For cetaceans, the main potential for effects from vessel traffic is through vessel strikes and acoustic disturbance. Regarding sound produced from vessels, it is generally expected to be less in shallow waters (i.e., background noise only by 6.2 mi [10 km] away from vessel) and greater in deeper waters (traffic noise up to 2,480 mi [4,000 km] away may contribute to background noise levels) (Richardson et al., 1995). Aside from the drillships and other vessels associated with the drilling programs, seismic-survey vessels, barging associated with activities such as onshore and limited offshore oil and gas activities, fuel and supply shipments, and other activities contribute to overall ambient noise levels in some regions of the Beaufort and Chukchi Seas. Whaling boats (usually aluminum skiffs with outboard motors) contribute noise during the fall whaling periods in the Alaskan Beaufort Sea. Fishing boats in coastal regions also contribute sound to the overall ambient noise. Sound produced by these smaller boats typically is at a higher frequency, around 300 Hz (Richardson et al., 1995a).

Overall, the level of vessel traffic in the Alaskan Arctic, either from oil and gas-related activities or other industrial, military, or subsistence activities, is expected to be greater than in the recent past. With increased ship traffic, there could potentially be deep water port construction in the region.

Ships using the newly opened waters in the Arctic likely will use leads and polynyas to avoid icebreaking and to reduce transit time. Leads and polynyas are important habitat for polar bears and belugas, especially during winter and spring, and heavy shipping traffic could disturb polar bears and belugas during these times.

The propsoed 3D seismic and shallow geohazard surveys proposed by SAE and Hilcorp would employ a few seismic and support vessels in limited geographic regions. Therefore, these activities would not contribute to noticeable increase in the total number of vessels already operating in the Arctic Ocean.

4.7.6 Conclusion

Based on the analyses provided in this section, NMFS has determined that the proposed SAE and Hilcorp's proposed 3D seismic and shallow geohazard surveys in the Beaufort Sea during the 2015 Arctic open-water season would not be expected to add significant impacts to overall cumulative effects on marine mammals from past, present, and future activities. The potential impacts to marine mammals and their habitat are expected to be minimal based on the limited noise footprint, and temporal or spatial separation from the activities analyzed above. In addition, mitigation and monitoring measures described in Chapter 2 are expected to further reduce any potential adverse effects.

Chapter 5 List of Preparers and Agencies Consulted

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Agencies Consulted
No other persons or agencies were consulted in preparation of this EA.

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